Sir Arthur Lewis Community College

**Division of Technical Education and Management** ~~ugies~~

**Department of Engineering**

Final Examination Fall 2013


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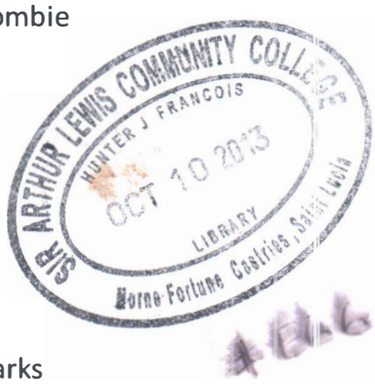
| **PROGRAMME TITLE(S)** | Computer System Engineering; Electronic Engineering Automotive Engineering, Mechanical Engineering |
| **PROGRAMME CODE(S)** | 3EE-CMS-AD 3EE-ESC-AD 3ME-MEC-AD 3ME-AUT-AD |
| **COURSE TITLE** | Applied Engineering Science 1 |
| **COURSE CODE** | ESC103 |
| **DURATION** | 3 HOURS |
| **TIME AND DATE** | 9:00 am Friday 10th May 2013 |
| **ROOM** | **TRB-LAB** |
| **COURSE TUTOR(S)** | Mr. Narpaul Heeralall & Mr. Florian Combie |
| **INVIGILATOR(S)** | **F. Joseph;** K. Numa & A. Alcindor |




**INSTRUCTIONS**

1. This paper has **TWELVE** questions. All questions carry equal marks
2. You are to answer **EIGHT QUESTIONS – no more than FOUR** from each section.
3. Ensure your answers and pages are numbered correctly
4. You will be rewarded for neat clear explanations and presentation.
5. Ray diagrams MUST be neat and clear.
6. Do all work in blue or black ink pen.
7. Ensure that you complete the table at the bottom of this cover sheet and attached to your answer booklet.

*Note: Accurate ray constructions are not necessary but your ray diagrams must convey a clear sense of how the final images are formed.*

**DO NOT TURN THIS COVER SHEET UNTIL YOU ARE TOLD TO DO SO**

Write the numbers of the questions you attempted (in the same order you attempted them) in this table and attach it to your answer booklet

| Questions | |
|---|---|
| Marks | |

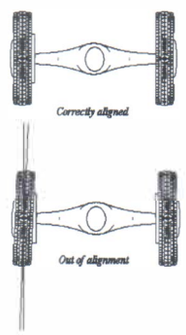
## SECTION A
## (ANSWER ANY 4 QUESTIONS)

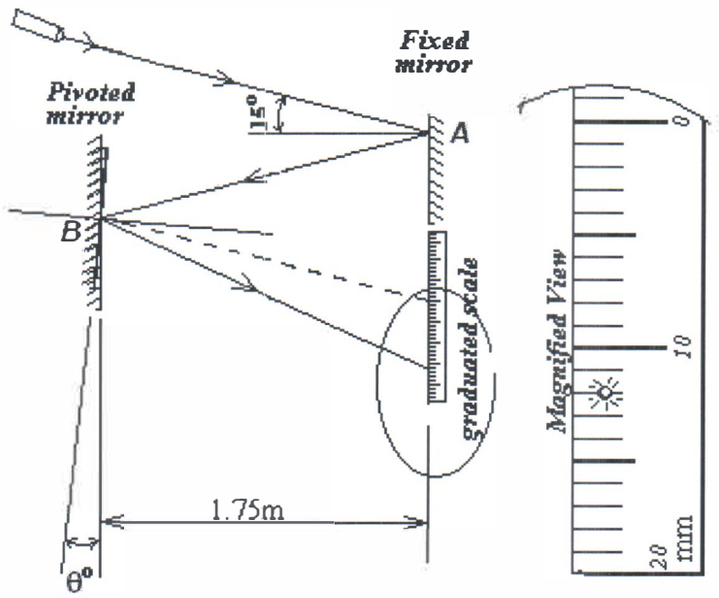
**Question 1 -** *12 marks*

a) State the Laws Of Reflection [2]

b) Show that if a plain mirror rotates through an angle $\theta^0$, the reflected ray will rotate twice $\theta^0$. [3]

c) An applied engineering student developed an optical means of measuring the alignment of the wheels of a vehicle ***(the wheels of vehicles must be parallel to each other)***. The device consists of two mirrors, one fixed and the other free to rotate. They are mounted parallel to each other on a frame. A fixed LASER beam is directed onto the fixed mirror and is reflected onto the pivoted mirror and then onto a graduated scale.




The out-of-alignment wheel causes the pivoted mirror to rotate thereby causing the laser bean to strike the scale away from the Zero mark.

i. Determine the distance from A to the zero point when the wheels are perfectly aligned? [4]

ii. Calculate the angle θ° when the laser strikes the graduated scale at 12mm. [3]

**Question 2 -***12 marks*

A spherical mirror of radius of curvature 120 mm is used to form an image of an object. The image is upright and 2.5 times as tall as the object.

a) What type of mirror should be used? [1]

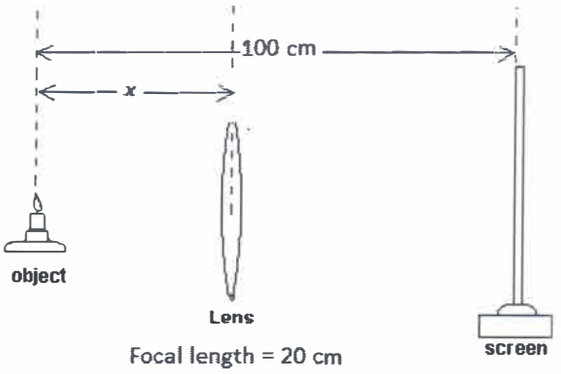
b) Draw the ray diagram showing the position of the object relative to the mirror [3]

c) Calculate the distance between the object and the mirror. [4]

d) What is the nature of the object when placed 120 mm from the mirror? [4]

**Question 3 -*12 marks***

A luminous object is placed 100 cm away from a screen as shown in the diagram to the right. A converging lens of focal length 20 cm is placed between the object and the screen and moved left and right until a sharp image is formed on the screen.




Focal length = 20 cm

a) Draw the ray diagram showing how a diminished image can be produces by this lens. [4]

b) What distance(s) from the object should the lens be located to produce the sharp image? [6]

c) What is the magnification in each case? [2]

**Question 4 -*12 marks***

a) In a simple pipe (fig 4), a ray of light must be transmitted, with minimum loss, along a core. List **three** major conditions, for this to be possible. [3]

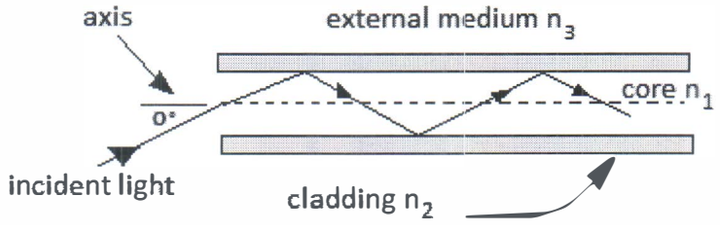


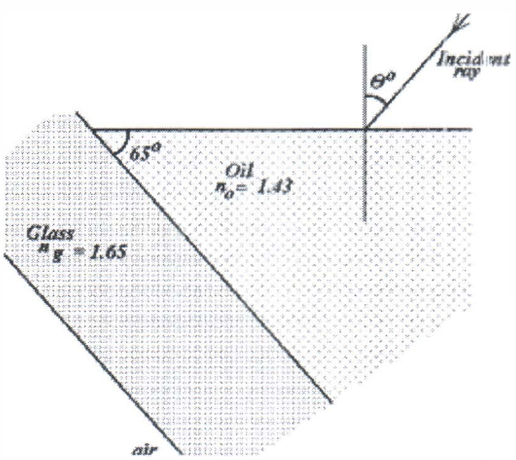

fig 4

b) The diagram shows a ray light, entering the surface of oil at an unknown angle of incidence $\theta^{\circ}$. 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]

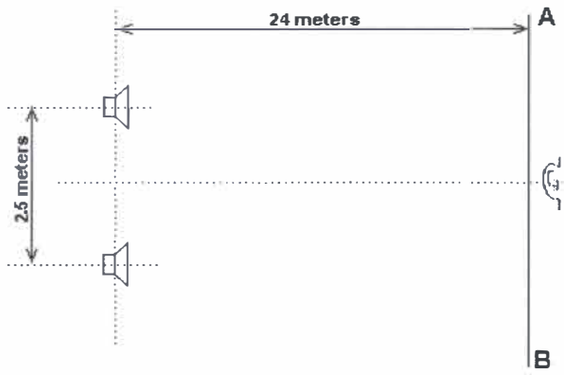
***Refractive index of Oil $n_{oil}$ = 1.45***
***Refractive index of Glass $n_{glass}$ = 1.65***
***Refractive index of water $n_{water}$ = 1.55***



**Question 5** *-12 marks*

a) Use relevant diagrams to explain constructive and destructive interference. [4]

b) Two identical loud speakers 2.5 m apart connected to the same channel emitting a frequency of 1000Hz. A listener moves along the line AB parallel to the line of the speakers and observes diminishing and increasing loudness.



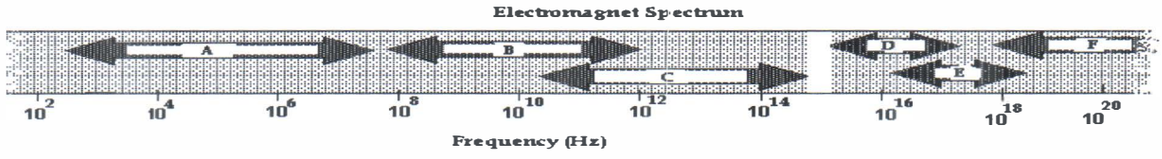

i. What is the significance of the speakers being connected to the same channel and emitting the same frequency? [2]

ii. Assuming sound travels at a speed of 340m/s, how far away from the centre will the listener observe the first and second minimum loudness? [3]

c) In a Young's Double slit experiment light of unknown wavelength is directed on to two slits 0.12mm apart. If the distance between the screen and slits is 2.50 meters, and the distance between the central bright fringe and the first dark band was 6.5 mm. Calculate the wavelength of the light used in the experiment. [3]

**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]