Sir Arthur Lewis Community College

Division of Technical Education and Management Studies
Department of Engineering

Final Examination SPRING 2009

PROGRAMME TITLE(S)	:	Automotive Engineering Mechanical Engineering Electronic Engineering Computer Systems Engineering
PROGRAMME CODE(S)	:	3ME-MEC-AD 3ME-AUT-AD 3EE-ESC-AD 3EE-CMS-AD
COURSE TITLE	:	**APPLIED ENGINEERING SCIENCE**
COURSE CODE	:	**ESC 103**
DURATION	:	3 HOURS
TIME AND DATE	:	**9:00 a.m. Wednesday 6th May 2009**
ROOM	:	**TRA R3** and **TRB Lab 1/2**
COURSE TUTOR	:	**Mr. Narpaul Heeralall**
INVIGILATOR(S)	:	**R. John Baptiste L. Philbert** **P. Wilson W. Cadette**

INSTRUCTIONS

1. This paper has two section A and B containing six question each
2. You are to answer EIGHT questions in the time allotted – no more than FOUR from any section
3. Ensure your answers and pages are numbered correctly
4. Enter the number if the questions you attempted in the order you attempted them in the table below
5. You will be rewarded for neat clear explanations and presentation.
6. Do all work in blue or black ink pen.
7. Submit answer booklet with your student registration number clearly marked on each page.

Question								
Marks								

Write the numbers of the questions you attempted on this table

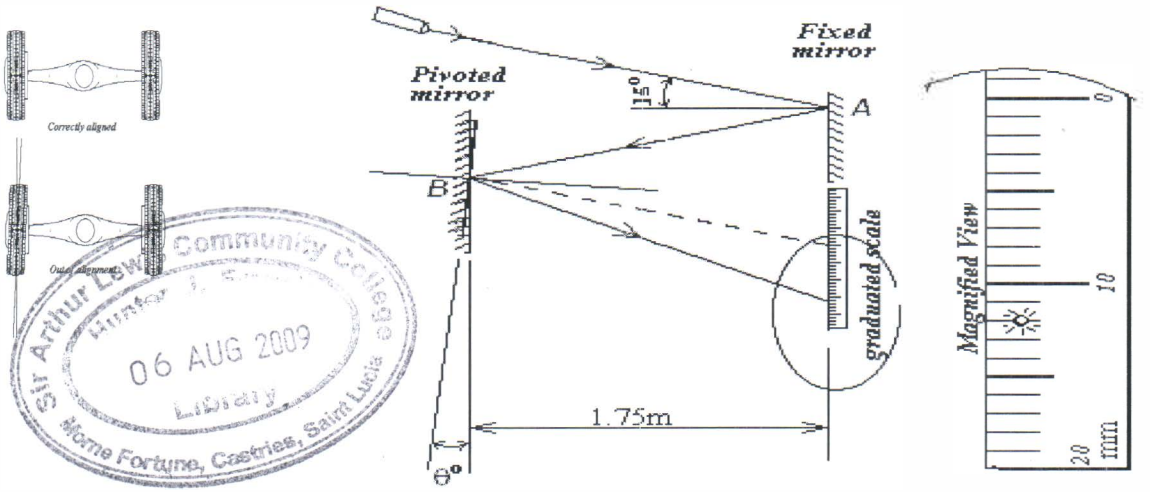
DO NOT TURN THIS COVER SHEET UNTIL YOU ARE TOLD TO DO SO

You may begin
Section A - answer any FOUR
(Questions carry 12 marks each)

Question 1 - *12 marks*

a) Explain how lateral inversion occurs in plain mirrors

b) An applied engineering student developed an optical means of measuring the alignment of the wheels of a vehicle. (vehicles wheels must be parallel to each other). The device consists of two mirrors – one fixed and the other free to rotate - mounted parallel to each other on a frame. A LASER beam is directed onto the fixed mirror and is reflected onto to the pivoted mirror and then onto a graduated the 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.
ii) Calculate the angle between the second incident ray and the final reflected ray when the wheels are perfectly aligned.
iii) Calculate the angle θ^o when the laser strikes the graduated scale at 12mm.

2+(2+4+4) marks

Question 2 - *12 marks*

A spherical mirror of radius of curvature 120 mm is used to form an image of an object. If the image is to be upright and 2.5× times as tall as the object then determine the following.

a) What type of mirror should be used?
b) Draw the ray diagram to show where should the object be placed relative to the mirror?
c) Calculate the distance between the object and the mirror.
d) Calculate the image distance if instead an inverted image 2.5× times was required.

1+4+4+3 marks

Question 3 - *12 marks*

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.

a. Calculate the critical at the glass air boundary.

b. Determine the path the light takes as it passes through the different media stating clearly the incident angle θ.

c. If the area below the glass was occupied by water, determine the path the light would take if it war to be just totally internally reflected at the glass water boundary.

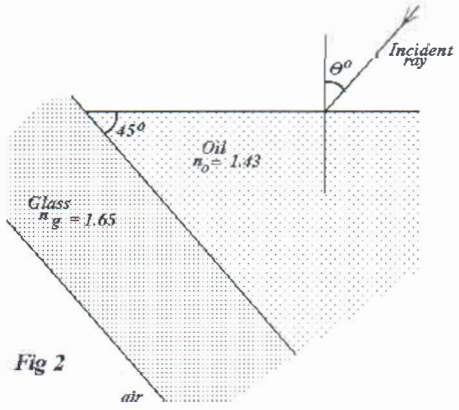


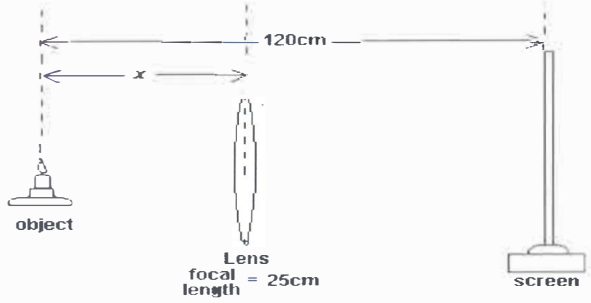
Fig 2

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

2+6+4 marks

Question 4 - *12 marks*

A luminous object is placed 120 cm away from a screen as shown in the diagram to the right. A converging lens of focal length 25 cm is placed between the object and the screen and moved left and right until a sharp image is formed on the screen.



a) Draw the ray diagram showing how a diminished image will be produces by this lens
b) What distance(s) from the object should the lens be located to produce the sharp image?
c) What is the magnification in each case?

4+4+4 marks

Question 5 - *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.

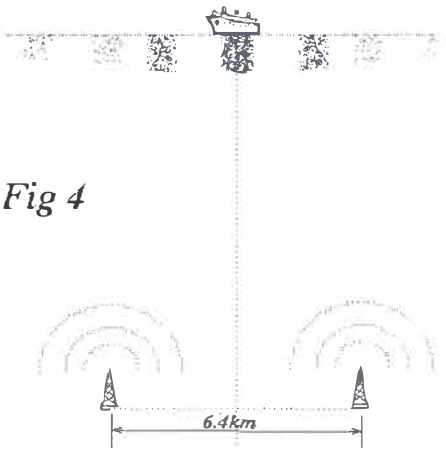


Fig 4

a. Calculate the distance between the points of maximum signal strength.

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

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

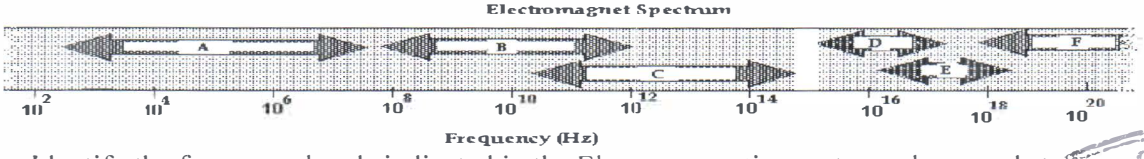
   i) What is its frequency?

   ii) Name the frequency band this signal would classified as.

6+3+2 marks

Question 6 - *12 marks*

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



b. Identify the frequency bands indicated in the Electromagnetic spectrum above and state one application of each.

c. Helen FM transmits its broadcast at 101.1MHz FM.
   i) What is the wavelength of this signal?
   ii) What are the limitations of this type of transmission?

d. Explain why it is usually possible for us to see through the glass door into the domestic microwave oven yet the microwave radiation cannot escape through the door and cause

3+6+2+1 marks

Section B - answer any FOUR

(Questions carry 12 marks each)

Question 7 - *12 marks*

a) Define a simple harmonic oscillator

b) A vertical spring, fixed at the upper end, has a mass of 620g attached to the 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 oscillated at a rate of 30 cycles per minute.

i) Calculate the spring constant

ii) If with the additional mass attached, the spring is then given a deflection of 12cm and released, what will be the maximum potential energy stored in the system.

iii) What is velocity of the mass as it passes the equilibrium point?

iv) What is the maximum acceleration of the mass?

v) What is the velocity of the mass at a distance of 8cm from the equilibrium point?

vi) Calculate the displacement at a time t = 0.35 second.

1+(3+2+1+1+2+2) marks

Question 8 - *12 marks*

a) Explain the difference between loudness and intensity of sound

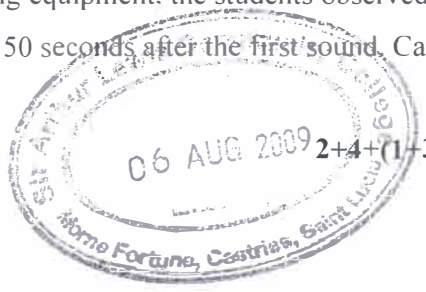
b) An applied engineering student connected a speaker to a signal generator and was assured that the apparatus was functioning properly. However the student was disappointed that no sound was heard coming from the speakers. His classmate suggested that the sound was below the "***threshold of hearing***", while another classmate suggested that the sound was beyond the human "***audio frequency range***".
Explain the highlighted terms (italics) stating the respective values and corresponding units of each and what likely adjustment should be made to the apparatus.

c) A student detonates a small explosion out at sea while a second student monitors the sound 2500 meters away on some sensitive listening device. The second student standing some distance away hears two distinct sounds 5.543 seconds apart.

i) Explain the presence of two sounds.

ii) Given that the temperature of the atmosphere was 20°C, calculate the speed of sound in sea water

iii) On closer examination of the monitoring equipment, the students observed that there was a faint sound occurring exactly 0.150 seconds after the first sound. Calculate the depth of the sea at this location?



2+4+(1+3+2) marks

Question 9 - *12 marks*

a) A string 1.75 cm long under tension is set in vibration so that five antinodes are produced. What is the wavelength of the vibration?

b) A cord of mass 200 grams and length 2.5 m is stretched between two supports 2.2 meters apart and given a tension of 678N.

   i) How long will it take for a pulse to travel from one support to the other?

   ii) What are the first three resonant frequency will the string produce if struck?

c) 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%

2+(2+4)+4 marks

Question 10 - *12 marks*

a. State the characteristics of sound.

b. Calculate the speed of sound in air when the atmospheric temperature is 29°C

c. A technician standing 50 meters away from a bank of six (6) identical loudspeakers observes a sound of 92decibels.

   i) If all but one loudspeaker gets disconnected, what would be the decibel level he would observe?

   ii) How far, and what direction relative to the loudspeakers, should he move for the loudness to return the same level as before (92dB)?

2+2+(4+4) marks

Question 11 - *12 marks*

a. Explain why an observer hears a sound of different frequency as the source approaches compared to when the source is leaving the observer – assuming the source frequency is constant.

b. The predominant frequency of a police siren is known to be 3500Hz when at rest. What frequency will you detect if you approach at a constant speed of 80 kilometers per hour?

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

d. What will be the effect on the observed frequency if the temperature of the atmosphere at the racetrack was 38°C?

Assume the speed of sound in air at 20°C $v_o = 343$ m/s

2+3+5+2 marks

Question 12 - *12 marks*

Explain the following terms

i)	Transverse wave	...1 mark
ii)	Standing wave	...1 mark
iii)	Resonance	...1 mark
iv)	Echo location	...1 mark
v)	Wavefront	...1 mark
vi)	Harmonics	...1 mark
vii)	Decibel	...1 mark
viii)	Fundamental note	...1 mark
ix)	Human audio range	...1 mark
x)	Beats	...2 mark
xi)	Inverse square law	...1 mark

End of Exam
Good luck