Sir Arthur Lewis community college
DEPARTMENT OF TECHNICAL EDUCATION AND MANAGEMENT STUDIES

END OF SEMESTER EXAMINATION 2005
FINAL

PROGRAMME TITLE(S)	:	Computer Maintenance and System Engineering Electronic Service and Communication Engineering Automotive Engineering; Mechanical Technician Electrical Mechanical Technicians
PROGRAMME CODE(S)	:	CMSE ESCE; AUTE MECE
COURSE TITLE	:	Applied Engineering Science 1
COURSE CODE	:	**ESC 103**
DURATION	:	3 HOURS
TIME AND DATE	:	**Monday 9th May 2005. 9:00 a.m.**
ROOM	:	TRT-R1, TRT-R2, TRT-R4, TRT-L1 & L2, SME R1
COURSE TUTOR	:	Mr. Narpaul Heeralall
INVIGILATOR(S)	:	Mr. J. Preville

INSTRUCTIONS

1. This paper has two sections, you are required to answer **EIGHT** questions choosing no more than **four from each section**.
2. Ensure your answers and pages are numbered correctly
3. You will be rewarded for neat clear explanations and presentation.
4. Ray diagrams need not be to scale, but MUST be neat and clearly show how images are formed.
5. Do not work in pencil.

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

Section A

Answer ANY FOUR Questions

1. Figure shows a prism being used as a colour separator. An incident beam containing a combination of red and blue light is incident on face AB of the separator as shown. Calculate the following

(i) The incident angle θ_{blue} that would cause the blue light to strike the face AC at the critical angle. ...(4 marks)

(ii) The incident angle θ_{red} that would cause the red light to strike the face AC at the critical angle. ...(4 marks)

(iii) State the range of incident angle θ_{blue} that would cause the **blue light** to be always totally internal reflected when it strikes face AC. ...(1 marks)

(iv) State the range of incident angle θ_{red} that would cause the **red light** to be always totally internal reflected when it strikes face AC ...(1 marks)

(v) Hence find that range of angle that would cause the blue light and the red light to become separated. ...(2 marks)

[TOTAL 12 MARKS]

Colour	Wavelength	Refractive index
Red light	λ_{red} 680 nanometers	n_{red} 1.500
Blue light	λ_{blue} 480 nanometers	n_{blue} 1.520

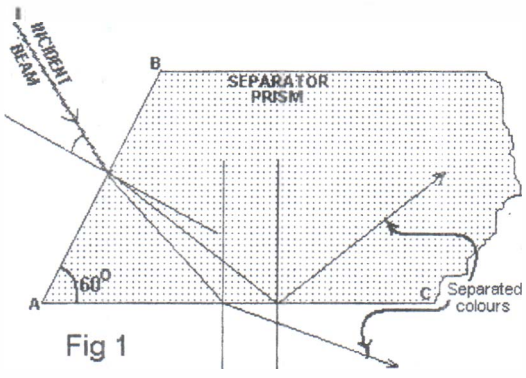


Fig 1

2a. Draw a ray diagram showing how a spherical lens produces a inverted magnified image.

If the focal length of the length is 25cm, state the distance at which the object should be located. ...(4 marks)

b. If the lens, in part 2a above, is immersed below the surface of water, is used to view an object in the water, what effect will this have on the final image? ...(2 marks)

c. A certain lens when placed between a luminous object and a screen produced a sharp image 2.5 times the size of the object on the screen. When the lens was moved 1.50 cm closer to object and the screen adjusted the image formed was then found to be 4 times the size of the object.

(i) Where should the object be placed for the image to be exactly three times the object?

...(6 marks)

[TOTAL 12 MARKS]

3a. You are given two lens A and B of power 20 Diopters and 2.5 Diopters respectively to form a simple microscope.

i. Draw a diagram showing how these lenses may be arranged to form the microscope, clearly explain its operation. ...(4 Marks)

ii. Assuming normal operation and that the length of the barrel of the microscope is 60 cm, calculate the magnification of the final image. ...(3 Marks)

b. i. Explain what is meant by the resolution of an optical instrument. ...(2 Marks)

ii. What is Rayleigh Criteria for the limits of resolution and what factors determine the limits of resolution of an optical instrument? ...(3 Marks)

[TOTAL 12 MARKS]

4a. 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

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

ii. Calculate the distance between the object and the mirror ...(4 Marks)

b A child sits in a barbers' chair and views a mirror in front of him. However the bottom of the mirror is 25 cm above his eyes. Given the dimensions in fig 3 calculate the following:

(i) How high up the wall is the child able to see. ...(2 Marks)

(ii) What angle should the mirror be tilted for the child to see his face. ...(2 Marks)

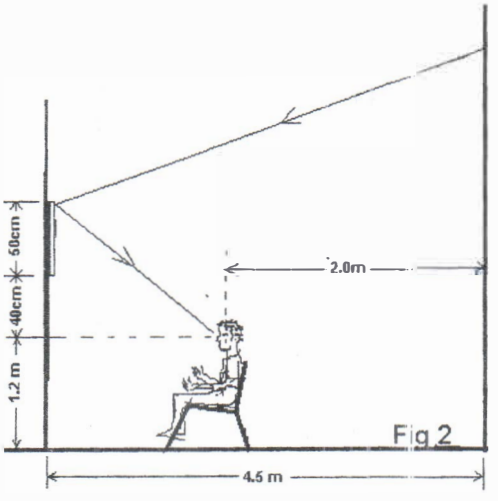


Fig 2

[TOTAL 12 MARKS]

5a. State Huygen's Principe, what is it used for and illustrate one example of how it is applied ...(4 marks)

b. Explain the following terms:

i. Diffraction ...(1 marks)

ii. Interference ...(1 marks)

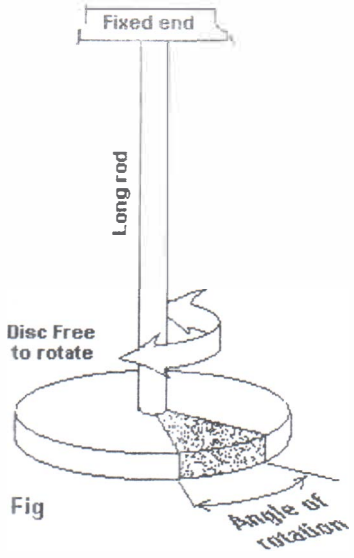
iii. Polarization ...(1 mark)

c. A screen containing two slits 0.100 mm apart is 1.50m from the viewing screen. Mono light of wavelength $\lambda = 560$ nm is directed on to the slits. Calculate the distance between and second bright interference fringe ...(5 marks)

[TOTAL 12 MARKS]

Section B
Answer ANY FOUR Questions

Fig 1 shows a heavy disc attached to one end of a rod with the other end of the rod fixed to the ceiling. The rod was observed to twists when a tangential force is applied to the edge of the disc but when the force was removed, the disc immediately rotated back to its original position. Also sudden removal of the force caused the disc to rotate back and forth.



A student investigating this behaviour recorded the angle of rotation θ^o when various force F (Newton) was applied.

The results plotted on a graph appeared as shown in Fig 1b above.

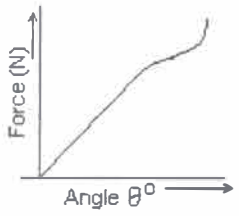


Fig 1b

What evidence is there to suggest that this is a simple Harmonic Oscillator?

b) A vertical spring, fixed at the upper end, has a mass of 420g 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 160g mass is attached to the spring, it oscillated at a rate of 25 cycles per minute. Calculate the spring constant.

(i) If the spring is then given a deflection of 12cm, what will be the Potential energy stored in the system.

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

(iii) What is the maximum acceleration of the mass?

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

(v) Calculate the displacement at a time t= 0.5 second.

[TOTAL 12 MARKS]

7 A cord of mass 75 grams and length 3.2 m is stretched between two supports 2.8 meters apart

(i) If the tension in the cord is 450N, how long will it take for a pulse to travel from one support to the other? **...(5 Marks)**

(ii) What are the first three resonant frequency will the string produce if struck?...**(3 Marks)**

(iii) By what percentage should the tension be adjusted for the fundamental frequency to change by 10% **...(4 Marks)**

[TOTAL 12 MARKS]

8a. A person standing a certain distance away from five equally loud speakers feels a loudness at a level of 100dB.

(i) What loudness (in decibels) will the person experience if all but one of the speaker got disconnected from the amplifier? ...(5 Marks)

(ii) With just one speaker running, how close should the person approach for the loudness to be at the same level as before the speakers got disconnected? ...(4 Marks)

b. A fisherman sitting in his boat hears the sound of an explosion through the bottom of his boat and 2.5 seconds later, hears the sound of the same explosion through the air. Given that the speed of sound in air is 343m/s and the speed of sound in sea water is 1560m/s, calculate how far away did the explosion occur. ...(3 Marks)

[TOTAL 12 MARKS]

9a. The predominant frequency of a police siren is known to be 2500Hz when at rest. What frequency will you detect if you approach at a constant speed of 80 kilometers per hour? ...(4 Marks)

b. 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? ...(5 Marks)

c. What will be if the temperature of the atmosphere at the racetrack was 33°C? ...(3 Marks)

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

[TOTAL 12 MARKS]

10. Briefly explain the following terms as they relate to sound:

(i) Wavefront. ...(2 Marks)

(ii) Harmonics ...(1 Marks)

(iii) Decibel ...(1 Marks)

(iv) Transverse wave ...(1 Marks)

(v) Fundamental note ...(1 Marks)

(vi) Resonance ...(2 Marks)

(vii) Human audio range ...(1 Marks)

(viii) Beats ...(2 Marks)

(ix) Inverse square law ...(1 Marks)

[TOTAL 12 MARKS]

End of Exam