



**SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING  
TRADE DIPLOMA IN ELECTRICAL ENGINEERING (ALL MAJOR)**

**EEE405 Engineering Science**

**FINAL EXAMINATION – SEMESTER 1, 2013**

**DAY/DATE:                   , / /2013   TIME :       PM**

**DURATION: 3 HOURS**

**ROOM: TBA**

**Instructions:**

1. You are allowed 10 minutes extra reading time during which you are **NOT** to write.
2. Begin each answer on a fresh page and use both sides of the sheet.
3. Do not write your name on any answer sheet & attached sheet - only write your examination number.
4. Insert all written sheets, graph paper, drawing paper, etc. in their correct sequence and secure with string.
5. For all sheets of paper of which rough/draft work has been done, cross it through and you **MUST ATTACH** all of them to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. This paper is divided into two parts.
  - a. **Part A** contains **four sections**: 1. multiple choice questions, 2. fill in the blanks, 3. match the following, and 4. State true or false. All of **Part A** needs to be answered.
  - b. **Part B** contains **one section** with long questions. Any six out of eight questions need to be answered.

**ATTEMPT ALL SECTIONS**

**TOTAL MARKS = 100**

## PART A

### SECTION 1. Multiple choice questions

10 marks

i. The term "mass" refers to the same physical concept as:

- A) weight
- B) force
- C) acceleration
- D) inertia

ii. The number of significant figures in 0.00150 is:

- A) 2
- B) 3
- C) 4
- D) 5

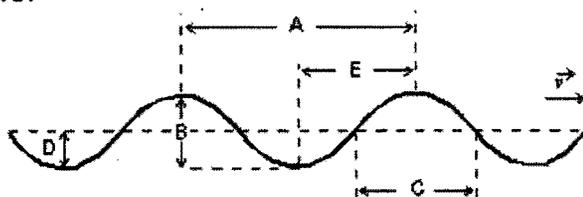
iii. The rise in pitch of an approaching siren is an apparent increase in its:

- A) speed
- B) amplitude
- C) frequency
- D) wavelength

iv. When light passes from air to glass, it bends:

- A) toward the normal and slows down
- B) toward the normal and speeds up
- C) away from the normal and slows down
- D) away from the normal and speeds up

v. A sinusoidal wave is traveling toward the right as shown. Which letter correctly labels the wavelength of the wave?



- A) A
- B) B
- C) C
- D) D

vi. A nanosecond is:

- A)  $10^{-6}$  s
- B)  $10^6$  s
- C)  $10^{-9}$  s
- D)  $10^9$  s

vii. The displacement of a string is given by  $y(x,t) = y_m \sin(kx + \omega t)$ .

The speed of the wave is:

- A)  $\omega/k$
- C)  $\omega k$
- D)  $2\pi/k$
- E)  $k/2\pi$

viii. Which of the following types of electromagnetic radiation travels at the greatest speed in vacuum?

- A) Radio waves
- B) Visible light
- C) X rays
- D) All of these travel at the same speed

ix. If two objects are in thermal equilibrium with each other

- A) they cannot have different pressures
- B) they cannot be at different temperatures
- C) they cannot be moving
- D) they cannot be undergoing an elastic collision

x. A baseball is thrown vertically into the air. The acceleration of the ball at its highest point is:

- A) zero
- B)  $g$ , down
- C)  $g$ , up
- D) none of the above

## SECTION 2. Fill in the blanks

10 marks

- a. In Doppler Effect, the word "toward" is associated with \_\_\_\_\_ in the observed frequency.
- b. Two bodies are said to be at Thermal equilibrium if they are at the same temperature.
- c. \_\_\_\_\_ is the science of measuring visible light in units that are weighted according to the sensitivity of the human eye.
- d. The law of \_\_\_\_\_ states that the angle of incidence is always equal to the angle of reflection.
- e. When object starts from rest and undergoes constant acceleration, position is proportional to the \_\_\_\_\_ of time.
- f. Newtonian mechanics relates accelerations and \_\_\_\_\_.
- g. The \_\_\_\_\_ of a particular sample is defined as the amount of energy needed to raise the temperature of that sample by  $1^\circ\text{C}$ .
- h. The \_\_\_\_\_ of a light wave corresponds to the color we see and the \_\_\_\_\_ corresponds to brightness.
- i. The \_\_\_\_\_ angle is the angle of incidence that produces an angle of refraction of  $90^\circ$ .

**SECTION 3. Match the following****10 marks**

- |                       |                     |                                    |
|-----------------------|---------------------|------------------------------------|
| a. Wave speed         | (7)                 | 1. Kinetic energy is zero          |
| b. Luminous intensity | (4)                 | 2. Vector quantity                 |
| c. Stefan's law       | ( )                 | 3. Law of refraction               |
| d. Force              | (2)                 | 4. Candela                         |
| e. Stationary         | (1)                 | 5. Virtual image                   |
| f. Steradian          | ( <del>10</del> )96 | 6. Rate of radiation               |
| g. Joule              | (10)                | 7. Deals with the causes of motion |
| h. Snell's law        | (3)                 | 8. Solid angle                     |
| i. Flat mirror        | (5)                 | 9. Property of the medium          |
| j. Dynamics           | (6)                 | 10. SI unit of energy              |

**SECTION 4. State whether the following are true or false****(10 marks)**

- Sound waves are transverse mechanical waves that can travel through solids, liquids, or gases.  $\checkmark$
- The word "latent" comes from a Latin word that means "to lie hidden".  $\checkmark$
- The retina contains rods and cones to detect the intensity and frequency of the light and send impulses to the brain along the optic nerve.  $\checkmark$
- The faster the object moves, the greater is its potential energy.  $\times$
- The dot product of two vector quantities is a vector quantity.  $\times$
- A ray diagram can be used to determine the position and size of an image.  $\checkmark$
- A wave moves a distance of one wavelength in one period of oscillation.  $\times$
- The law of transmission states that the angle of incidence is always equal to the angle of reflection.  $\checkmark$
- The human eye is a fluid-filled object that focuses images of objects on the retina.  $\checkmark$
- Transverse mechanical waves are waves in which the particles of the medium oscillate parallel to the wave's direction of travel.  $\times$

**PART B.****Each question carries 10 marks. Answer any 6 out of the following 8 questions.**

(Make sure to have a sketch for each scenario and the write the variables before solving the problems).

**1.**

- The fastest growing plant on record is a *Hesperoyucca whipplei* that grew 3.7 m in 2 weeks. What was its growth rate in micrometers per second? (use the chain-link conversion) **(5 marks)**
- A 500 kg rocket sled can be accelerated at a constant rate from rest to 1600 km/h in 1.8 s. What is the magnitude of the required net force? **(5 marks)**

2.

- (a) (i) With what speed must a ball be thrown vertically from ground level to rise to a maximum height of 50 m? (ii) How long will it be in the air? (6 marks)
- (b) A 100 kg block is pulled at a constant speed of 5.0 m/s across a horizontal floor by an applied force of 122 N directed  $37^\circ$  above the horizontal. What is the rate at which the force does work on the block? (4 marks)

3.

- (a) A disk, initially rotating at 120 rad/s, is slowed down with a constant angular acceleration of magnitude  $4.0 \text{ rad/s}^2$ . (i) How much time does the disk take to stop? (ii) Through what angle does the disk rotate during that time? (6 marks)
- (b) The angular speed of an automobile engine is increased at a constant rate from 1200 rev/min to 3000 rev/min in 12 s. What is its angular acceleration in revolutions per minute-squared? (4 marks)

4.

- (a) A wave has an angular frequency of 110 rad/s and a wavelength of 1.80 m. Calculate (i) the angular wave number and (ii) the speed of the wave. (4 marks)
- (b) The equation of a transverse wave traveling along a string is given by  $y = (2.0 \text{ mm}) \sin[(20 \text{ m}^{-1})x - (600 \text{ s}^{-1})t]$ . Find the (i) amplitude, (ii) frequency (iii) velocity (including sign), and (d) wavelength of the wave. (6 marks)

5.

- (a) Object O stands on the central axis of a concave mirror. The object distance  $p$  is 15 centimeters, and the focal length  $f$  is 10 centimeters. Find (i) the radius of curvature  $r$  (including sign), (ii) the image distance  $i$ , and (iii) the lateral magnification  $m$ . Also, determine the image is (iv) real or virtual, (v) inverted or non-inverted, and (vi) on the same side of the mirror as O or on the opposite side. (7 marks)
- (b) Draw the ray diagram for the given problem. (3 marks)

6.

- (a) Define Stefan's law of radiation. (2 marks)
- (b) A sphere of radius 0.500 m, temperature  $27.0^\circ\text{C}$ , and emissivity 0.850 is located in an environment of temperature  $77.0^\circ\text{C}$ . At what rate does the sphere (i) emit thermal radiation? and (ii) absorb thermal radiation? (8 marks)
- The Stefan-Boltzmann constant  $\sigma = 5.6696 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$

7.

(a) What is Doppler Effect?

(2 marks)

(b) A submarine A (source) travels at 8.00 m/s emitting at a frequency of 1400 Hz. The speed of sound is 1533 m/s. Submarine B (observer) travels at 9.00 m/s. What is the apparent frequency heard by the observer (i) as the subs approach each other? and (ii) as they recede from each other?

(8 marks)

8.

(a) Define or explain these terms: (i) Electromagnetic spectrum, (ii) Radiometry, and (iii) Photometry.

(4 marks)

(b) Explain human eye and how it is important in photometry.

(6 marks)