



SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

CERTIFICATE IV IN ELECTRICAL ENGINEERING – STAGE 1

EEE325-MATERIAL SCIENCE FINAL EXAMINATION PAPER TRIMESTER 1 – 2014

DAY/DATE: As per TT TIME: As per TT ROOM: As per TT

INSTRUCTIONS TO STUDENTS:

1. You are allowed 10 minutes extra reading time during which you are not allowed to write.
2. Begin each SECTION on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each answer sheet.
4. Insert all foolscaps, graph paper, drawing paper etc in their correct sequence and secure with string.
5. For all sheets of paper on which rough / draft work has been done, cross it through and
you must attach to the answer booklet.
6. Write clearly the number(s) of the question(s) attempted on top of each sheet.
7. **ATTEMPT ALL QUESTIONS**
8. Show all workings where necessary.
9. Programmable calculators are not allowed.

SECTION A (20 MARKS)

In each of the following statements one of the suggested answers is correct. Write the identifying letters beside the question numbering in your answer sheet.

MULTIPLE CHOICE

1. The smallest particle into which a compound can be divided and still retain the characteristics of the compound is called:
 - a. atom
 - b. element
 - c. molecule
 - d. matter

2. When substances are intermingled without being chemically combined they form:
 - a. elements
 - b. chemical
 - c. matter
 - d. mixtures

3. Most organic compounds do not dissolve in:
 - a. water
 - b. mixtures
 - c. solutions
 - d. alcohol

4. One characteristic of metals is that it has:
 - a. tendency to gain or share electrons
 - b. gas
 - c. tendency to lose electrons
 - d. all of the above

5. The atoms in a _____ more readily move in relation to one another and vibrate at a speed dependent on temperature:
 - a. molecule
 - b. solids
 - c. liquids
 - d. gas

6. Materials such as sand rocks, gravels, metals clays and ceramics are known as:
 - a. Inorganic materials
 - b. Organic materials
 - c. ceramics
 - d. insulator

7. In dead mild steel the carbon content is deliberately kept as low as possible so that the steel will have:
 - a. high ductility
 - b. high strength
 - c. more resistance
 - d. greater capacity.

8. Brass alloys are alloys of:
 - a. copper and tin
 - b. copper and zinc
 - c. tin and zinc
 - d. all of the above

9. The property of any material by which it opposes the flow of electric current is known as:
 - a. voltage
 - b. capacitance
 - c. inductance
 - d. resistance

10. Any good conductor would have large numbers of:
 - a. conduction
 - b. resistivity
 - c. protons
 - d. free electrons

11. The rate of change in velocity is known as:
 - a. speed
 - b. acceleration
 - c. density
 - d. pressure

12. The ability of a material to suffer indentation or penetration without fracture is known as:
 - a. brittleness
 - b. ductility
 - c. softness
 - d. hardness

13. _____ contains very few or no free electrons.
 - a. conductors
 - b. insulators
 - c. semi-conductors
 - d. All of the above

14. The best conductors of heat are:
 - a. liquids
 - b. gases
 - c. plastics
 - d. metals

15. _____ is the term used to denote the effect of a force producing or tending to produce rotation of a body about a point.
 - a. friction
 - b. torque
 - c. tenacity
 - d. work

16. The area under the velocity –time graph gives:
 - a. acceleration
 - b. average speed
 - c. time spent
 - d. distance covered

17. The ratio of the power output to the power input as a percentage is:
 - a. machine loss
 - b. power input
 - c. power output
 - d. efficiency

18. The rate of change of velocity is known as:
 - a. gravity
 - b. velocity
 - c. acceleration
 - d. motion

19. The density of a liquid is defined as its:
 - a. distance per time
 - b. volume per weight
 - c. mass per unit area
 - d. mass per unit volume.

20. Pressure within a body of liquid depends upon two factors:
 - a. distance and depth
 - b. density and depth
 - c. voltage and current
 - d. type of material and density

SECTION B

MATCHING

(10 MARKS)

Match Column A with Column B

Write down the correct identifying alphabet of column B alongside the numbers of column A

Column A

1. Power
2. Mixtures
3. Ceramics
4. Ductility
5. Gas
6. Oxidation
7. Di-electric strength
8. Deceleration
9. Covalent compound
10. Losses in a machine

Column B

- A. The ability of a material to be drawn out to a small cross section.
- B. neither have definite volume nor shape.
- C. the addition of oxygen to a substance.
- D. ability of an insulating material to withstand physical breakdown.
- E. slowing down of an object.
- F. friction and windage
- G. composed of molecules
- H. inorganic materials e.g. porcelain high voltage insulators.
- I. Hetrogeneous and homogeneous.
- J. is the rate of doing work.

SECTION C**(30 MARKS)**

1. Define the following:
 - Dielectric Strength
 - Elasticity
 - Viscosity(3 Marks)
2. Outline four basic principles of fluid statics. (4 Marks)
3. List three characteristics of ionic compound AND three characteristics of covalent compound. (6 Marks)
4. Name FOUR (4) insulators and their specific applications in the electrical industry. (6 Marks)
5. Outline four main groups of ceramic materials. (4 Marks)
6. What are the three (3) factors which governs the rate of corrosion? (3 Marks)
7. List down the four (4) physical properties of materials. (4 Marks)

SECTION D **(40 MARKS)**

1. Three forces acting at a point are spaced 120° apart from each other. $F_1 = 55\text{N}$, $F_2 = 65\text{N}$ and $F_3 = 75\text{N}$, find the resultant force acting at a point. (6 Marks)
3. Calculate the uniform acceleration of a sports car which:
 - (a) Starts from rest and reaches a speed of 20 m/s in 8 sec .
 - (b) Changes its speed from 25 m/s to 35 m/s in 3 sec
 - (c) Starts from rest and goes a distance of 100m in 10 sec
 - (d) Starts from rest and travel a distance of 25m during the fifth (5th) sec of its motion.
 - (e) Slows down from a speed of 66m/s and comes to rest in 12 sec . (8 marks)
3. The field windings of a generator has a resistance of $145\ \Omega$ at a temperature of 20°C . What will be the resistance of the windings when the machine temperature rises on full load to 80°C ? ($\alpha_0 = 0.00427$) (4 Marks)
4. A solid block $300\text{mm} \times 250\text{mm} \times 200\text{mm}$ is immersed in water, calculate the buoyant force acting on the block. (Density of water 1000kg/m^3) (3 Marks)

5. During a research project deep sea photographs were made at a depth of 7 kilometers. (Density of sea water is 1025kg/m^3). Calculate the:
- Pressure at this depth
 - force on the plane surface of the window of the camera enclosure that measured $0.14\text{m} \times 0.14\text{m}$
- (5 marks)
6. A stone is thrown vertically upwards with a velocity of 3m/s . Find:
- The maximum height reached.
 - Time taken to reach the maximum height
 - Total time of the flight
 - Time taken to reach 10m above the ground on its way down
 - What will be the velocity of the stone as it strikes on its way down.
- (5 Marks)
7. A 3KW electric motor is operating at 1200rpm . Calculate the:
- torque exerted
 - The efficiency of the motor if the losses were 250W .
- (5 marks)
8. A certain marble landmark has a mass of 2.8 tonnes (2800kg) cools down from 50°C to 30°C and in doing so gives out 1.5 mega joules of heat. What is the specific heat of this marble?
- (4 marks)

The End

MARKING SCHEME/SOLUTION GUIDE

College: CEST

School/Department: SEEE

Programme: C4EL1

Unit Code/Title: EEE325/MATERIAL SCIENCE FOR ELECTRICIANS

Date of Exam: As per TT

Time: As per TT

Examiner's Name: SURENDRA LAL

Signature:.....

SECTION A

(20 MARKS)

1. C
2. D
3. A
4. C
5. C
6. A
7. A
8. B
9. D
10. D
11. B
12. C
13. B
14. D
15. C
16. D
17. D
18. C
19. D
20. B

(EACH CORRECT ANSWER CARRIES ONE MARK)

SECTION B

(10 MARKS)

Match Column A with Column B

Write down the correct identifying alphabet of column B alongside the numbers of column A

1. J
2. I
3. H
4. A
5. B
6. C
7. D
8. E
9. G
10. F

(Each correct answer carries 1 mark)

SECTION C

1. Dielectric Strength

This is the measure of the ability of an insulating material to withstand physical breakdown due to applied forces.

(1 Mark)

Elasticity

The ability of a material to retain its original dimensions after suffering a deformation or strain due to some applied force.

(1 mark)

Viscosity

It is the property of fluids by which they resist forces which tend to change their shape or viscosity is resistance to flow.

(1 mark)

1.

Basic principles of fluid statics

- (i) Pressure exists at every point within the liquid. (2 mark)
- (ii) Pressure at a point is the same in all directions, ie pressure is a scalar quantity. (2 marks)
- (iii) Pressure is directly proportional to the depth below the surface. (2 marks)
- (iv) Pressure is same at all points at the same level within a liquid. (2 marks)

3.

(i) Ionic compound

- Formed by the transfer of electrons
- Formed from both metals and non-metals
- Composed of ions
- Conducts electricity when molten or dissolved
- Are usually solids with high melting points.

(3 marks)

(Any three carries 1 mark each)

(ii) Covalent compound

- Formed by electron sharing
- Formed from non-metals
- Composed of molecules
- Insulators
- Gases, liquids or solids (low melting point).

(Any three carries 1 mark each)

(3 marks)

Insulator name

Application

- | | | | |
|----|-----|-----------------|--|
| 4. | (a) | Glass | Used as outdoor insulation . eg light bulbs |
| | (b) | Porcelain | Normally used in places where dust and misture readily Collect eg highvoltage transformers and overhead lines. |
| | © | Micanite | Used for high temperature insulation applications eg motor. |
| | d) | Asbestos cement | Used in applications where high heat resistance is required and especially as on electric swichgear |

(6 Marks)

(Any 4 carries one and half mark each)

(Use your own discretion where applicable)

5. Four main groups of ceramics:

- i) i) Amorphous ceramics
- ii) ii) Bonded Ceramics
- iii) iii) Cements
- iv) iv) Crystalline ceramics

(4 Marks)

6. There are three factors that govern the rate of corrosion:

- (a) the metal from which the component is made.
- (b) The treatment which the surface of the component receives
- (c) The environment in which the component is kept

(3 Marks)

7. Physical properties of materials

- a) Melting
- b) Boiling
- c) Solubility
- d) Density
- e) Shape or form
- f) Electrical conductivity
- g) color

(4 Marks)

(Any 4 carries 1 mark each)

SECTION D

1. Two ways to answer:

- (i) Can draw the vectors
- (ii) Can use the horizontal and vertical

Force	Horizontal	Vertical
F1	$55\sin 80 = 54.16$	$55\cos 80 = 9.55$
F2	$65 \sin 20 = -22.23$	$65 \cos 20 = -61.08$
F3	$75 \sin 40 = 48.2$	$75 \cos 40 = -57.45$
Totals	80.13	-108.98

$$\begin{aligned} FR &= \sqrt{(80.13)^2 + (-108.98)^2} \\ &= \underline{\underline{135.26 \text{ N}}} \end{aligned}$$

(6 marks)

2. Calculate the uniform acceleration of a sports car which:

- (a) Starts from rest and reaches a speed of 20 m/s in 8 sec.
- (b) Changes its speed from 25 m/s to 35 m/s in 3 sec
- (c) Starts from rest and goes a distance of 100m in 10 sec
- (d) Starts from rest and travel a distance of 25m during the fifth (5th) sec of its

motion.

- (e) **Slows down from a speed of 66m/s and comes to rest in 12 sec.** (8 marks)

Solution

a) $a = ?$ $V_f = V_i + at$
 $V_i = 0$ $15 = 0 + 10(a)$
 $V_f = 15\text{m/s}$ $20 = 8a$
 $t = 10\text{sec}$ **$a = 2.5 \text{ m/s}^2$** (2 marks)

b) $a = ?$ $V_f = V_i + at$
 $V_i = 20\text{m/s}$ $35 = 25 + 3(a)$
 $V_f = 32\text{m/s}$ $35 = 25 + 3a$
 $t = 4 \text{ sec}$ $3a = 35 - 25$
 $3a = 10$
 $a = 3.33\text{m/s}$ (2 marks)

c) $a = ?$ $D = V_i t + \frac{1}{2} at^2$
 $V_i = 0$ $100 = 0 + \frac{1}{2} at^2$
 $D = 98\text{m}$ $100 = 0 + \frac{1}{2}(a)(10)^2$
 $t = 7\text{sec}$ $100 = 0 + 50(a)$
 $a = \frac{100}{50}$
 $a = 2\text{m/s}^2$ (2 marks)

d) $a = ?$ $D = V_i t + \frac{1}{2} at^2$
 $V_i = 0$ $25 = 0 + \frac{1}{2} a(4)^2$
 $D = 22\text{m}$ $25 = 0 + \frac{1}{2}(a)(4)^2$
 $t = 6\text{sec}$ $25 = 0 + 8(a)$
 $a = \frac{25}{8}$
 $a = 3.125 \text{ m/s}^2$ (2 marks)

e) $a = ?$ $V_f = V_i + at$
 $V_i = 66\text{m/s}$ $0 = 66 + 12(a)$
 $V_f = 0\text{m/s}$ $-66 = 12a$
 $t = 12\text{sec}$ **$a = -5.5 \text{ m/s}^2$ (deceleration)** (2 marks)

3. $R_2 = R_1[1 + \alpha_{20} (t_2 - t_1)]$
 $= 150[1 + 0.004273 (60 - 30)]$ (1 mark)
 $= 150[1 + 0.00427 (30)]$
 $= 150[1 + 0.1281]$ (1 mark)
 $= 150 \times 1.1281$
 $R_2 = \underline{169.2 \Omega}$ (1 mark)

4. A solid block 300mm x 250mm x 200mm is immersed in water, calculate the buoyant force acting on the block. (Density of water 1000kg/m³)

Solution

Volume of water displaced:

$$V = 0.3 \times 0.25 \times 0.2 = 0.015 \text{ m}^3 \quad (1 \text{ mark})$$

The buoyant force, equal to the weight of the water displaced –

$$\begin{aligned} F_b &= V \times \rho \times g \\ &= 0.015 \times 1000 \times 9.81 \\ &= \underline{147.15 \text{ N}} \end{aligned} \quad (2 \text{ marks})$$

5. (a) $P = dhg \quad (1 \text{ mark})$

$$= (7.0 \times 10^3) (1025) (9.81) \quad (1 \text{ mark})$$

$$= 7.0386.8 \times 10^7 \text{ Nm}^2 \quad (1 \text{ mark})$$

or $= 70386.8 \text{ kpa}$

(b) $14\text{cm} \times 14\text{cm} = 0.14 \times 0.14 \quad (1 \text{ mark})$
 $= 0.0196\text{M}^2$

$$\begin{aligned} \text{Force} &= \text{pressure} \times \text{area} \\ &= (7.0386.8 \times 10^7) (0.0196) \\ &= \underline{1379.58 \text{ kN}} \end{aligned} \quad (1 \text{ mark})$$

6. A stone is thrown vertically upwards with a velocity of 3m/s .Find:

- a) The maximum height reached.
- b) Time taken to reach the maximum height
- c) Total time of the flight
- d) Time taken to reach 10m above the ground on its way down
- e) What will be the velocity of the stone as it strikes on its way down.

(5 Marks)

Solution

(a) $a = 4\text{m/s}^2 \quad V_f = V_i + at$
 $V_i = 0 \quad = 0 + (4)(8)$
 $V_f = ? \quad \underline{V_f = 32 \text{ m/s}} \quad (2 \text{ marks})$
 $t = 8 \text{ sec}$

(b) $V_i = 0 \quad V_f = V_i + at$
 $a = 4\text{m/s}^2 \quad 36 = 0 + (4)(t)$
 $V_f = 36\text{m/s} \quad 36/4 = t$
 $t = ? \quad \underline{t = 9 \text{ sec}} \quad (1 \text{ mark})$

(c) $D = 200\text{m}$
 $a = 4\text{m/s}^2$
 $t = ?$
 $V_i = 0$

$$D = V_i t + \frac{1}{2} a t^2$$

$$200 = 0 + \frac{1}{2} (4) t^2$$

$$200/2 = t^2$$

$$t = \sqrt{100}$$

$$\underline{t = 10\text{sec}}$$

(1 mark)

(d) $t = 3\text{s}$
 $D = ?$
 $V_i = 0$
 $a = 4\text{m/s}^2$

$$D = V_i t + \frac{1}{2} a t^2$$

$$= 0 + \frac{1}{2} (4)(3)^2$$

$$\underline{D = 18\text{m}}$$

(1 mark)

6.

$$P = 2\pi nT$$

$$T = \frac{P}{2\pi nT}$$

$$= \frac{3000 \times 60}{2\pi \times 1200}$$

(1 mark)

$$\underline{T = 23.87 \text{ Nm}}$$

(1 mark)

Input power = 3000 + losses = 3250 W

(1 mark)

Out power = 4000 (Motor Rating)

$$\eta = \frac{\text{power output}}{\text{power input}} \times 100$$

(1 mark)

$$= \frac{3000}{3250} \times 100$$

$$\eta = \underline{92.30\%}$$

(1 mark)

8. $Q = MC \Delta t$

$$C = \frac{Q}{M \Delta t} \quad (1 \text{ mark})$$

$$= \frac{1.5 \times 10^6}{(2.8 \times 10^3) (50 - 30)} \quad (1 \text{ mark})$$

$$= \frac{1.5 \times 10^6}{2800 \times 20} \quad (1 \text{ mark})$$

$$= \underline{26.78} \quad (1 \text{ mark})$$

%%%%%%%%%%END OF MARKING SCHEME%%%%%%%%%%