UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	SCB23302 (V1)
COURSE TITLE	:	FUNDAMENTALS OF MATERIALS SCIENCE
PROGRAMME NAME	:	BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN MECHANICAL (AUTOMOTIVE)
DATE	:	30 JANUARY 2026
TIME	:	3:00PM - 5:30PM
DURATION	:	2 HOURS 30 MINUTES

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☑ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☑ *Tick if applicable*

THERE ARE 16 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. How many classifications are there for materials?

   A. 3

   B. 6

   C. 5

   D. 4

2. Which one of the following is not basic component of Materials Science?

   A. Performance

   B. Structure

   C. Cost

   D. Properties

3. What is the primary focus of materials engineering?

   A. Developing new materials.

   B. Studying the historical usage of materials.

   C. Understanding material properties.

   D. Applying materials in practical applications.

4. Which of the following properties is generally not associated with metals?

   A. Brittleness

   B. Ductility

   C. High thermal conductivity

   D. High electrical conductivity

5. Which of the following is true about isotopes?

   A. An atom with the same number of neutrons but with a different number of protons.

   B. An atom with the same number of protons but with a different number of neutrons.

   C. An atom without the number of protons but with a number of neutrons.

   D. An atom without the number of neutrons but with a number of protons.

6. What is a molecule?

   A. A collection of ions in a lattice structure.

   B. A cluster of metallic atoms sharing free electrons.

   C. A group of atoms bonded together, representing the smallest fundamental unit of a chemical compound.

   D. A group of electrons bonded together, representing the stable fundamental unit of a chemical compound.

7. Which molecule is held together by covalent bonds?

   A. H_2O

   B. NaCl

   C. CaO

   D. Al_2O_3

8. Which type of primary bond is characterized by a 'sea of electrons' that are free to move throughout the structure?

   A. Metallic bond

   B. Covalent bond

   C. Ionic bond

   D. Hydrogen bond

9. What is the primary factor that determines the type of bonding between atoms in a solid?

   A. Atomic mass

   B. Electronegativity

   C. Atomic size

   D. Number of isotopes

10. What is the atomic number of an element?

   A. The number of protons in the nucleus.

   B. The number of electrons in the outer shell.

   C. The number of neutrons in the nucleus.

   D. The total number of electrons and protons.

11. Which of the following describes the Bohr model of the atom?

   A. Electrons are embedded in a positively charged sphere.

   B. Electrons orbit the nucleus in fixed paths called shells.

   C. Electrons move in a cloud around the nucleus.

   D. Electrons have no specific position or momentum.

12. Which electron configuration corresponds to a neutral carbon atom (atomic number 6)?

   A. $1s^2\ 2s^2\ 2p^6$

   B. $1s^2\ 2s^2\ 2p^2$

   C. $1s^2\ 2s^1\ 2p^3$

   D. $1s^1\ 2s^1\ 2p^6$

13. What does the principal quantum number (n) indicate?

A. The orientation of the orbital.

B. The energy level of the electron.

C. The spin of the electron.

D. The shape of the orbital.

14. According to the Aufbau principle, which orbital is filled first?

A. 2p

B. 2s

C. 3s

D. 1s

15. What is the maximum number of electrons that can occupy a single p orbital?

A. 2

B. 6

C. 8

D. 10

16. What is the term for the specific regions around the nucleus where electrons are likely to be found?

A. Nuclei

B. Shells

C. Clouds

D. Orbitals

17. What is the coordination number in a face-centered cubic (FCC) crystal structure?

A. 8

B. 12

C. 4

D. 6

18. In which of the following types of bonding do all positively charged atoms attract all negatively charged atoms?

A. Van der Waals bond

B. Metallic bond

C. Ionic bond

D. Covalent bond

19. Which of the following is true about the nucleus?

A. The nucleus is made up of protons.

B. The nucleus is made up of protons and neutrons.

C. The nucleus is made up of neutrons.

D. The nucleus is made up of shells and subshells.

20. Which of the following is a secondary bond?

A. Ionic bond

B. Metallic bond

C. Covalent bond

D. Hydrogen bond

21. How many atoms are there per unit cell in a BCC crystal structure?

A. 1

B. 2

C. 4

D. 8

22. Which of the following is a point defect in a crystal lattice?

A. Vacancy

B. Grain boundary

C. Twin boundary

D. Dislocation

23. Which type of defect is a void or pore within a solid?

A. Point defect

B. Planar defect

C. Volume defect

D. Line defect

24. Which type of dislocation is characterized by an extra half-plane of atoms?

A. Edge dislocation

B. Mixed dislocation

C. Surface dislocation

D. Screw dislocation

25. Which of the following types of point defects occupy the spaces between the lattice points?

    A. Substitutional defect

    B. Interstitials defect

    C. Vacancy defect

    D. None of the above

26. Which of the following types of defects is known as a dislocation defect?

    A. Bulk defect

    B. Volume defect

    C. Point defect

    D. Line defect

27. In the context of diffusion, what is meant by activation energy?

    A. The energy required to maintain diffusion at a constant rate.

    B. The minimum energy required for atoms to move from one lattice site to another.

    C. The energy required to start the diffusion process.

    D. The energy needed to create a concentration gradient.

28. Which of the following factors has the most significant impact on the rate of diffusion in solids?

    A. Color of the material

    B. Atomic mass

    C. Temperature

    D. Electrical conductivity

29. How does the size of diffusing atoms or ions affect the diffusion rate?

A. Smaller atoms or ions diffuse faster.

B. Both small and large atoms diffuse at the same rate.

C. Size has no effect on diffusion rate.

D. Larger atoms or ions diffuse faster.

30. In materials with higher atomic packing factors, diffusion tends to be:

A. Slower

B. Random

C. Faster

D. Unaffected

31. Which of the following statements about secondary bonds is true?

A. They can only occur in ionic compounds.

B. They do not influence the physical properties of substances.

C. They involve the sharing of electrons.

D. They are generally weaker than primary bonds.

32. The term 'steady state diffusion' refers to a situation in which the rate of diffusion within a material remains constant across _____.

A. time

B. temperature

C. velocity

D. speed

33. Which Fick's law is used for steady-state diffusion?

A. Kick's second law

B. Fick's first law

C. Fick's second law

D. Kick's first law

34. In a binary phase diagram, what does the eutectic point represent?

A. The point where solid phases melt completely.

B. The temperature above which there is no solid phase.

C. The temperature and composition at which a liquid transforms into two solid phases.

D. The temperature at which a solid transforms into a gas.

35. What does the solidus line on a phase diagram represent?

A. The limit of solubility for a solid solution.

B. The boundary between liquid and solid phases.

C. The temperature at which the material melts.

D. The boundary between different solid phases.

36. What does a tie line in a phase diagram help determine?

A. The phases present at a specific temperature.

B. The compositions of phases in a two-phase region.

C. The melting point of the alloy.

D. The cooling rate of the alloy.

37. Which line on a phase diagram represents the temperatures at which solidification begins upon cooling a liquid?

A. Tie line

B. Solidus line

C. Eutectic line

D. Liquidus line

38. What information can be obtained from a phase diagram?

A. Mechanical properties of the material.

B. Magnetic properties of the material.

C. Phases present at different temperatures and compositions.

D. Electrical conductivity of the material.

39. What is an interstitial defect?

A. An atom missing from its lattice site.

B. An extra atom positioned in the interstitial spaces between atoms in a lattice.

C. A crystal defect involving dislocations.

D. A pair of adjacent vacancies.

40. Which of the following factor is not significant impact on the rate of diffusion in solids?

A. Atomic mass

B. Microstructure

C. Temperature

D. Diffusing species

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Crystallization of solids often leads to the formation of defects due to variations in the rate of crystal growth. Defects are typically irregularities in the atomic or molecular arrangement of the crystal lattice.

(a) Describe the concept of point defects in a crystal lattice.

(10 marks)

(b) Illustrate and describe the formation and types of edge and screw dislocations.

(10 marks)

Question 2

Chemical bonding refers to the attractive forces that hold atoms together in a compound. It involves the sharing, transferring, or pairing of electrons between atoms, leading to the formation of molecules or ions. The primary types of chemical bonds are covalent, ionic, and metallic, each resulting from different interactions between atoms. The concept of chemical bonding is fundamental to understanding the structure and properties of substances in chemistry.

(a) Differentiate between ionic bond and covalent bond with the help of diagrams. Provide an example for each type to support your explanation.

(10 marks)

(b) Sketch the unit cell for each crystal structure, and indicate the number of atoms as well as the number of atoms per unit cell for each structure:

i. Simple cubic

(2 marks)

ii. Body-centered cubic

(4 marks)

iii. Face-centered cubic

(4 marks)

Question 3

A common example of the diverse use of materials is the mobile phone, which comprises various components made from different materials. To ensure user safety, these materials are selected for their non-toxic and non-reactive properties. Each material offers unique benefits and has its own set of drawbacks. For example, the metal parts contribute to the device's structural strength, while some plastic elements add flexibility and reduce the overall weight.

(a) Explain the difference between materials science and materials engineering, providing examples of how each field contributes to technological advancements.

(4 marks)

(b) Discuss the role of advanced materials in current technological applications, highlighting their significance.

(4 marks)

(c) Identify and describe the four key components that influence the design, production, and utilization of materials. Illustrate your answer with examples that demonstrate the interdependence of these components in material innovation.

(12 marks)

Question 4

Comprehending the evolution of microstructures through an understanding of phase diagrams and phase transformations is essential. This knowledge significantly impacts material properties in relation to processing. Most material processing procedures involve a thermal history, whether it's cooling from a high-temperature shaping or deposition process or orchestrating a controlled diffusional change in a solid product.

Refer Below - Figure1 : Phase Diagram Mo-Zr .

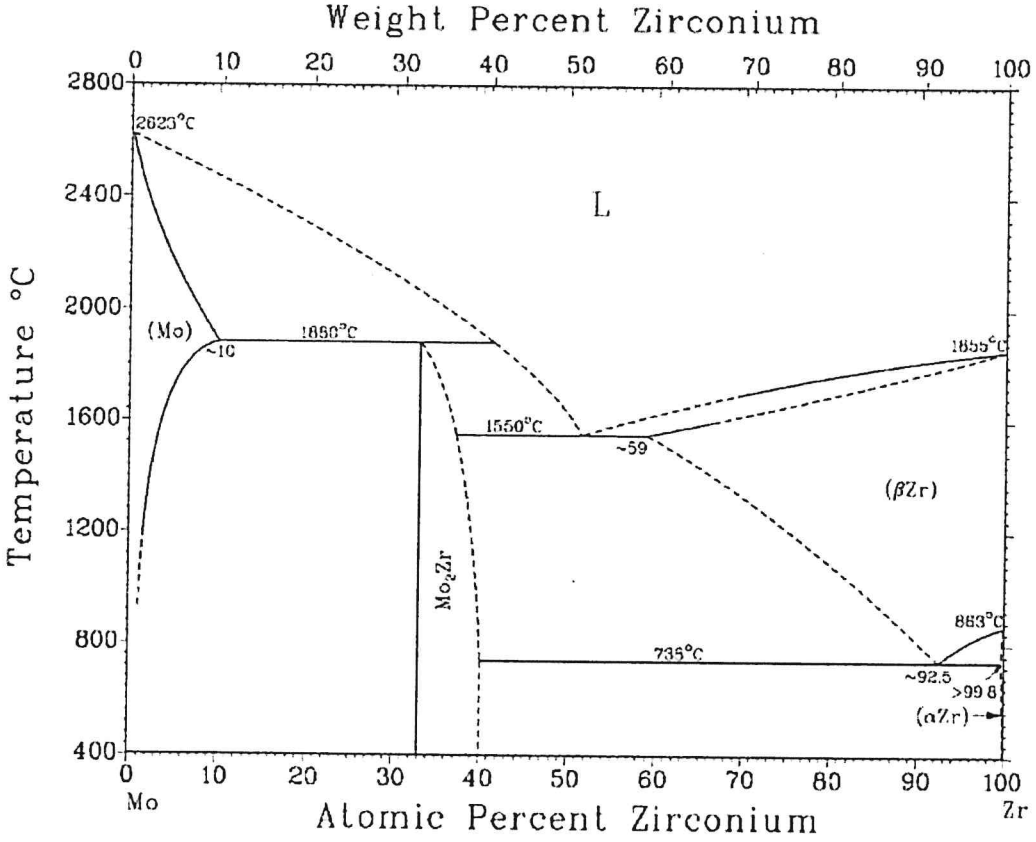

Figure 1: Phase Diagram Mo-Zr

(a) Using figure as attach, for a Mo-Zr alloy with composition of 10wt% zirconium and 90wt% molybdaenum, at 2200°C, determine:

i. Identify the phase(s) that is/are present.

(2 marks)

ii. Determine the chemical composition for each phase.

(4 marks)

iii. Determine the amount of each phase.

(6 marks)

iv. Sketch the microstructure at this temperature.

(3 marks)

(b) Make a similiar analysis at temperature 2000°C for 40wt% of molybdaenum and 60wt% of zirconium.

(5 marks)

END OF EXAMINATION PAPER

APPENDIX

- Avogadro's number, $N_A = 6.023 \times 10^{23}$ atoms/mol
- Volume of cube, $V = a^3$
- Density, $\rho = \dfrac{nA}{V_C N_A}$
- $F_{net} = \dfrac{(Z_1 e)(Z_2 e)}{4\pi\varepsilon_0 r^2}$
- ϵ_0 = permittivity of free space = 8.85×10^{-12} C^2/Nm^2
- e = electron charge = (-1.602×10^{-19})
- p = proton charge = 1.602×10^{-19}
- 1 eV = 1.6×10^{-19} Joule
- Periodic table :

1												13	14	15	16	17	18
1 H 1.008	2																2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.97	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 *	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 #	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

* Lanthanide series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
# Actinide series	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)