UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DGE 1103
COURSE	: MATERIALS SCIENCE
SEMESTER/SESSION	: 1-2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **3** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Define the definition given.

i. Covalent bond. (2 marks)

ii. Proton. (2 marks)

iii. Isotope. (2 marks)

iv. Relative mass. (2 marks)

b) By referring to periodic table (see appendix 2) , find for element Ni (nickel), from information obtained :-

i. Describe the element by its group of element, atomic number, mass number and period. (2 marks)

ii. Construct electron configuration for the element by using aufbau's rule. (4 marks)

iii. Given the crystal structure of Ni is face centred cube (FCC) with lattice constant a = 350 pm , calculate the radius of Ni atom. (2 marks)

iv. Using information from iii), calculate the atomic packing factor of the element. (4 marks)

QUESTION 2

a) Converting pig iron into steel involves several steps in oxygen furnace. Regarding the process :-

i. List four (4) main component used in the steel production process. (2 marks)

ii. Describe the process of steel production from pig iron (5 marks)

b) Iron with relative mass of 56, can be strengthen by adding carbon which has a relative mass of 12. Regarding to this strengthening methods :-

i. State the types of hardening mechanism. (2 marks)

ii. Illustrate by sketching on how carbon atom will take part in the atomic plane of iron (label your drawings). (4 marks)

iii. Explain from your sketching on how carbon addition in iron will make it much stronger. (4 marks)

c) As an engineer in a metal production company, you have been assigned to proposed a prevention method for products listed below from corrosion. Suggest one (1) method and show how it will protect the metal from corrosion.

i. Automotive body. (4 marks)

ii. Laptop aluminium case. (4 marks)

d) Describe the Hall-Herot process in converting alumina into aluminium. (9 marks)

e) Describe for aluminium alloys listed below on term of its major composition and application.

i. 1xxx aluminium alloys. (2 marks)
ii. 3xxx aluminium alloys. (2 marks)
iii. Cast aluminium alloys. (2 marks)

QUESTION 3

a) Define for a given term below.

i. Mer. (2 marks)
ii. Hydrocarbon. (2 marks)
iii. Trifunctional mer. (2 marks)
iv. Unsaturated hydrocarbon. (2 marks)
v. Co-polymer. (2 marks)

b) Polymerisation process of ethylene (Figure 1) consist of three (3) steps, which is initiation, propagation and termination. Describe on how a polymer chain will formed by this steps. (12 marks)

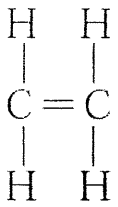

Figure 1

c) Choose one (1) suitable co-polymer for the applications given and explain why it is suitable for that purpose.

i. Automotive tyre. (3 marks)

ii. Engine seals and gaskets. (3 marks)

iii. Tubes for transferring food. (3 marks)

iv. Formula 1 racing suit. (3 marks)

d) Analysis sample taken from polycarbonate manufacturing plant. Given polycarbonate molecular chain formula $(C_{16}H_{22}O_4)_n$. Sample of chain molecular weight distribution was taken and tabulated in Table 1. Redraw Table 1 in your answer booklet, and use it to calculate the average molecular weight and degree of polymerisation for the particular sample.

(6 marks)

Table 1

Molecular weight (gram/ mol)	**weight fraction**
7500	**0.06**
12500	**0.07**
17500	**0.02**
22500	**0.20**
27500	**0.29**
32500	**0.20**
37500	**0.20**

**********END OF QUESTIONS**********

APPENDIX 1

CRYSTAL PROPERTIES

$4R = a\sqrt{3}$ BCC CRYSTAL

$4R = a\sqrt{2}$ FCC CRYSTAL

atoms volume = number of atoms in unit cell $\times \frac{4}{3}\pi R^3$

unit cell volume for BCC and FCC = a^3

$$\text{total atoms mass} = \frac{\text{relative mass}}{N_A} \times \text{number of atom in a unit cell}$$

$$APF = \frac{\text{total atoms volume}}{\text{unit cell volume}}$$

$$density, \rho = \frac{\text{total atoms mass}}{\text{unit cell volume}}$$

APPENDIX 2

1 **H** Hydrogen 1.00794																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)