



NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

DEPARTMENT OF CIVIL, MINING AND PROCESS ENGINEERING

QUALIFICATION: BACHELOR OF ENGINEERING IN METALLURGY	
QUALIFICATION CODE: O8BMET	LEVEL: 7
COURSE CODE: PDF7IIS	COURSE NAME: PHASE DIAGRAMS AND FORMING PROCESSES 314
SESSION: JUNE 2023	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 65

FIRST OPPORTUNITY QUESTION PAPER	
EXAMINER(S)	Mrs. Jaquiline Tatenda Kurasha
MODERATOR:	Professor Sofya Mitropolskaya

INSTRUCTIONS
<ol style="list-style-type: none">1. Answer all questions.2. Read all the questions carefully before answering.3. Marks for each question are indicated at the end of each question.4. Please ensure that your writing is legible, neat and presentable.

PERMISSIBLE MATERIALS

1. Examination paper.
2. Non-programmable calculator.

THIS QUESTION PAPER CONSISTS OF 4 PAGES (Including this front page)

Question 1 (20 Marks)

(a) Some metals crystallize in the FCC and HCP crystal structures.

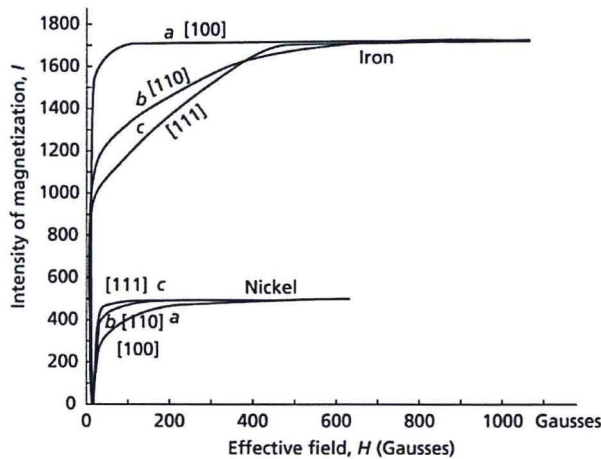
- (i) Give any two similarities found in the FCC and HCP unit cells. [2]
- (ii) Give any three differences found in the FCC and HCP unit cells. [3]
- (iii) Although they have some similarities, FCC metals are generally more ductile compared to HCP metals. Explain why. [1]
- (iv) Give one example of a metal that have the FCC and HCP crystal structure at room temperature respectively. [2]

(b) Distinguish between the following terms:

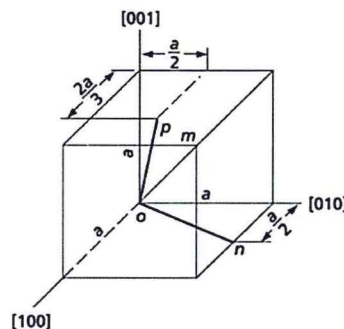
- (i) Vacancy and interstitial defect. [1]
- (ii) Stacking sequence and a stacking fault. [1]
- (ii) Dislocation and grain boundary. [1]

(c) Magnetic susceptibility is a characterization technique employed in metals to determine their magnetic behaviour. The diagram below shows the intensity of magnetization observed in iron and nickel in different crystallographic directions.

- (i) It is clear that the intensity of magnetization is different in different crystallographic directions in the effective field of below 700 Gauss and below 400 Gauss in iron and nickel respectively. What is the common term used for this behaviour? [1]
- (ii) Calculate the linear density for [100] and [111] directions in iron and nickel respectively. [4]
- (iii) Comment on the observed magnetic behaviour in relation to linear density. [1]



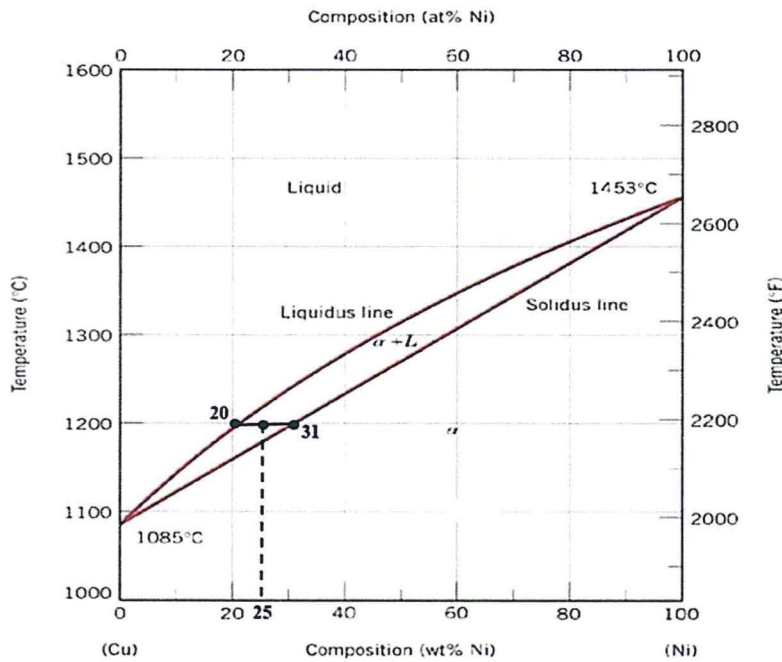
(d) Determine the direction indices for (i) line om , (ii) line on , and (iii) line op in the cubic unit cell shown below. [3]



Question 2 (15 marks)

The diagram below shows the Cu-Ni phase diagram.

- (a) Comment on the solubility of the two elements in each other, and explain your answer. [1]
- (b) What type of solid solution is formed in this alloy system. Explain your answer. [2]
- (c) If Cu is alloyed with Zn, will a similar phase diagram be generated? Explain your answer. [2]
- (d) Consider a Cu-25Ni alloy.
 - (i) Sketch the cooling curve for the alloy given that the pouring temperature during casting is 1300°C. [3]
 - (ii) Calculate the phase fractions. [4]
 - (iii) If the alloy is cast into a sand mould where it cools slowly, explain and sketch the expected microstructure and clearly label all the zones. [3]



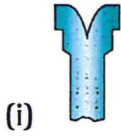
Question 3 (20 Marks)

- (a) A single pass rolling operation reduces a 20mm thick plate to 18 mm. the starting plate width is 200mm, and the roll radius is 250mm, with a rotational speed of 12 rpm. The contact length is 22.36mm, and the true average stress is 300 MPa. Calculate
 - (i) The draft. [2]
 - (ii) The reduction. [2]
 - (iii) The coefficient of friction. [2]

(iv) The roll force. [3]

(v) The power required in this operation. [2]

(b) The pictures below show defective products. Identify the defect, in which process each defect is commonly experienced, and corrective action to be taken. [9]



Question 4 (10 marks)

(a) Weldability is often considered to be a material property. What other two factors affect the weldability of a material? [2]

(b) Distinguish between the two broad types of welding, and give two examples under each class. [3]

(c) With the aid of a well labelled schematic diagram, briefly describe the fusion weld structure. [5]

End of Question Paper.