

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
DEPARTMENT OF MATERIALS AND METALLURGICAL ENGINEERING

RAIN SEMESTER 2018/2019 EXAMINATIONS

COURSE: MME 502 - MATERIALS PROCESSING

DATE: 22/10/2019

TIME ALLOWED: 2.5 HOURS

INSTRUCTION: ANSWER ANY FOUR (4) QUESTIONS.

1. a) What does the acronym MST stand for? With the aid of a sketch, explain the concept of MST. Illustrate how the concept of MST can be applied to a cutting tool material. (Hint: assume that carbon coating is required through CVD process).
b) In a flowsheet form, list the two (2) classes of materials processing together with their various subgroups/families.
c) What are the two (2) important aims/objectives of materials processing? [15 mrks]
2. a) State five (5) practical ways by which fine grains (ONLY) can be obtained in the microstructure of a machine part during casting.
b) Sketch and label the equilibrium cooling curve for pure metal solidification.
c) Derive the Scheil equation. What is the equation used for in zone refining? [15 mrks]
3. a) Use well labelled sketches (ONLY) to show the various forces/loadings encountered in metal forming operations.
b) Use sketches to show the differences between engineering stress-strain curve and true stress-strain curve. Why are the curves different from each other? In what processes can we apply each of the curves?
c) In a table format, list five differences between cold working and hot working operations. [15 mrks]
4. a) State the two (2) classes of vapour deposition processes and explain how they differ from each other.
b) An important CVD reaction employed in the fabrication of Si microelectronic devices is
$$\text{SiCl}_4 + 2\text{H}_2 = \text{Si}(s) + 4\text{HCl} \quad 1400^\circ\text{K} \quad (1)$$

Published thermodynamic data on the free energy of formation of SiCl_4 and HCl from the elements at 1400°K reveal.
$$\text{Si} + 2\text{Cl}_2 = \text{SiCl}_4 \quad \Delta G^\circ = -351 \text{ KJ/mol} \quad (2)$$

$$\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{Cl}_2 = \text{HCl} \quad \Delta G^\circ = -105 \text{ KJ/mol} \quad (3)$$

Determine ΔG° and the equilibrium constant for the reaction (1) at 1400°K . Will this reaction occur? Give reason for your choice of answer.
- c) One major problem encountered during materials recycling is the issue of mixed scrap streams. Explain how materials in mixed scrap streams can be separated from each other before recycling. [15 mrks]
5. a) The cost structure for producing 500 units of motorcycle-connecting rods in Nigerian foundries Ltd is as follows: direct labour (\$0.3/connecting rod), diesel (\$190), raw materials (\$110), machining (\$0.15/connecting rod), sealing (\$0.2/connecting rod) and security (\$80). If selling price is \$2.2/connecting rod,
i. calculate the company's total fixed cost;
ii. calculate the company's total variable cost per connecting rod;
iii. calculate the company's variable cost;
iv. calculate the company's total cost;
v. plot the company's break-even chart and show the following: the break-even point (BEP), profit area and loss area;
vi. state the company's break-even income and units; and
vii. estimate the company's margin of safety at a production level of 450 units.
- b) Draw and label the flowsheet of the important stages in Powder Metallurgy (PM). At what PM stage are the properties of a PM product enhanced?
c) With the aid of a sketch, explain the water atomization powder manufacture process. [15 mrks]