UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS TECHNOLOGIAE *ENGINEERING: METALLURGY*
SUBJECT	:	**MECHANICAL METALLURGY IV**
CODE	:	**TMP42-2**
DATE	:	FINAL EXAMINATION 23/05/2019
DURATION	:	12:30 – 15:30
WEIGHT	:	40:60
TOTAL MARKS	:	95

ASSESSOR	:	MR E. GONYA
MODERATOR	:	MR JM PROZZI FILE: NO 5138
NUMBER OF PAGES	:	3 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
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REQUIREMENTS	:	CALCULATOR

QUESTION 1 (40 marks)

1.1 Briefly discuss how does cross-slip influence the strain hardening coefficient of metals and alloys. **(4)**

1.2 Brittle failures at low temperatures are prevented by ensuring a minimum of 3:1 in Mn:C explain the significance of maintaining this ratio. **(5)**

1.3 What are the limitations of Charpy impact test and how it can be overcome. Illustrate your answer by using a suitable digram **(5)**

1.4 Why are charpy impact values for FCC materials independent of temperatures. **(3)**

1.5 Name and briefly explain two metallurgical phenomena associated with the environment that leads to brittle failure. **(10)**

1.6 Why do FCC materials deform easily as compared to BCC materials?. **(4)**

1.7 Use sketches to differentiate between a jog and a kink formed as results of interaction between the two edge dislocations. **(6)**

1.8 What will be the contribution of jogs towards plastic deformation as a result of interaction between two edge dislocations? **(3)**

QUESTION 2 (38 Marks)

2.1 A tensile test was conducted on a metal specimen, and it was found that a true strain of 0.25 is produced when a true stress of 575 MPa is applied; for the same metal, the value of K is 806 MPa. Calculate the true strain that results from the application of a true stress of 600 MPa. **(6)**

2.2 Determine the partial dislocations formed from (a/2)[$\bar{1}$10] slip direction on the ($\bar{1}\bar{1}\bar{1}$) plane in the FCC material. **(12)**

2.3 Determine whether the dislocation dissociation is feasible on the reaction found in 2.2 (**8)**

2.4 Derive an expression linking the yield strength and the reduction in cross sectional at the yield point. **(6)**

2.5 Use the expression derived in 2.4 to calculate 0.2% offset yield strength given that the flow stress-strain curve equation for the material is $\boldsymbol{\sigma = 65\bar{\varepsilon}^{0.384}}$ **(6)**

QUESTION 3 (17 Marks)

3.1 Use a suitable dislocation theory model to explain the following:

3.1.1 Causes of strengthening during strain hardening. **(5)**

3.1.2 The dependence of yield strength on the grain size of the material during grain-boundary strengthening mechanism. **(5)**

3.2 What is dislocation core energy and its role in strengthening mechanism? **(3)**

3.3 Would you expect the energy of the crystal to be higher or lower after the formation of a jog between two edge dislocations? Apply suitable equation when giving your answer. **(4)**