



PROGRAM : BACHELOR OF ENGINEERING TECHNOLOGY IN
PHYSICAL METALLURGY

SUBJECT : MECHANICAL DEFORMATION TECHNOLOGIES 3A

CODE : MDEMTA3

DATE : JUNE EXAMINATION
06 JUNE 2019

DURATION : 12:30 – 15:30

WEIGHT : 40:60

TOTAL MARKS : 90

ASSESSOR : MR E. GONYA

MODERATOR : MR JM PROZZI

NUMBER OF PAGES : 3 PAGES

INSTRUCTIONS : ANSWER ALL QUESTIONS

REQUIREMENTS : CALCULATOR

QUESTION 1 (30 MARKS)

- 1.1 Wire drawing is an indirect-compression process where tensile stresses are applied and indirect compressive forces developed due to the reaction between the metal and the die. Using Mohr's circle of stress diagram, explain how these indirect compressive stresses in addition to applied tensile stress ensure sufficient deformation without inducing fracture in a rod wire. (10)
- 1.2 In metal-working processes, it is important to use proper lubricants such that deformation loads are reduced and maximum reduction per pass is attained. Apply appropriate equations to explain how the above can be achieved using the lubricants. (6)
- 1.3 What steps can you take to increase deformation efficiency of a wire drawing process. (4)
- 1.4 Using any forming process, explain the main cause of residual stresses in metal-working process and the mechanism of how they are developed in the material. (8)
- 1.5 What is the role of hydrostatic pressure in metal-working process? (2)

QUESTION 2 (40 marks)

2. During wire drawing process, a 20% reduction in diameter was achieved in a 10mm diameter stainless steel rod wire. The material obeys power law and its flow stress is given by $\sigma_o = 1300\bar{\epsilon}^{0.30}$ (MPa). Given the following data: α (die angle) = 12° , $\mu = 0.09$ and $\Phi \approx 0.8$

$$+ \frac{\Delta}{4.4}$$

2.1.1 Calculate the deformation efficiency of the process. (20)

2.1.2 Calculate the maximum reduction (% r) per pass that can be obtained. (5)

2.2 Find the mathematical relation between the draw stress and true stress obtained from tensile test. (5)

2.3 Explain the condition leading to sticking friction in metal-working processes and assume Coloumb coefficient model to calculate the value friction under sticking friction. (5)

2.4 Why is Tresca coefficient model preferably over Coulomb coefficient model in forging and extrusion deformation processes. Illustrate your answer using a suitable graph. (5)

QUESTION 3 (20 marks)

3.1 Discuss how dynamic recovery occur during hot working. Your discussions should include the following:

- Type of alloys and why such alloys. (3)
- Microstructural development during dynamic recovery. (7)
- How are optimum mechanical properties attained. (5)

3.2 What is strain induced precipitation and its effect on flow stress and ductility of the material during hot working. (5)