



MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 504: THEORY OF PRODUCTION PROCESSES

DATE: 16/8/2021

TIME: 8.30-10.30 AM

INSTRUCTIONS

Answer question ONE and any other two questions.

QUESTIONS ONE (30 MARKS)

- a) What is the difference between engineering stress and true stress in a tensile test (3 marks)
- b) Give three reasons why bulk deformation processes are important in industry? (3 marks)
- c) What is strain hardening (2 marks)
- d) Describe two basic types of forging equipment? (2 marks)
- e) Describe five common defects that can occur in a drawn sheet metal product (5 marks)
- f) What are the differences between hot and cold extrusion. Discuss the advantages and disadvantages of each of them. (6 marks)
- g) What is the major factor that distinguish bulk deformation processes from sheet metal processes? (2 marks)
- h) In a tensile test, a metallic material with a Poisson's ratio of 0.3 fails at a stress level of 500 MPa. In a bi-axial stress situation, the same steel is subjected to stress levels of $\sigma_x = 300 \text{ Mpa}$, $\sigma_y = 200 \text{ Mpa}$ and $\tau_{xy} = 0 \text{ Mpa}$. Determine the factor of safety according to:
 - i. Maximum Shear Stress Theory (2 marks)
 - ii. Maximum Principal Strain Theory (3 marks)
 - iii. Distortion energy theory (Von Misses failure criteria) (2 marks)

QUESTIONS TWO (20 MARKS)

- a) What is the major difference between shape rolling and flat rolling (2 marks)
- b) Discuss four important factors that are required in order to reduce the force and power needed to roll a strip of a given width of a work material. (4 marks)
- c) A 250mm wide plate, 25 mm thick is to be reduced to 22 mm in a single pass by passing it through a rolling mill with 2 powered rolls each of radius 250mm. The rolling speed is set at 50 RPM and friction between rollers and work material is 0.12. The strength coefficient (K) and strain hardening exponent (n) of the work material are 275MPa and 0.15 respectively.
- i. Find out whether the friction is sufficient for the rolling operation to succeed (2 marks)
- Determine
- ii. Roll force (4 marks)
- iii. Roll torque (2 marks)
- iv. Power required (1 mark)
- d) Sketch five configurations of rolling mills (5 marks)

QUESTIONS THREE (20 MARKS)

- a) Describe two types of forging hammers and two types of forging presses. (4 marks)
- b) What is the major difference between open die forging and impression die forging? (4 marks)
- c) A cylindrical part is warm upset forged in an open die. $D_o = 50$ mm and $h_o = 75$ mm. Final height = 65mm. Coefficient of friction at the die-work interface = 0.10. The work material has a flow curve defined by: $K = 350$ MPa and $n = 0.17$. Determine the force in the process
- i. Just as the process is beginning (strain at yield = 0.002) (3 marks)
- ii. At $h = 65$ mm (3 marks)
- d) What is spring-back in sheet metal bending? (2 marks)
- e) With aid of sketches describe four edge bending operations carried out on sheet metal work. (4 marks)

QUESTIONS FOUR (20 MARKS)

- a) Under similar production conditions, why is the extruding force lower in indirect extrusion than in direct extrusion? (2 marks)
- b) A cylindrical billet that is 120 mm long and 40 mm in diameter is reduced by indirect extrusion to a 15 mm diameter. Die angle = 90° . If the Johnson equation has 'a' = 0.8 and 'b' = 1.5, and the flow curve for the work metal has 'K' = 600 MPa and 'n' = 0.17, determine:
- i. Extrusion ratio (1 mark)
 - ii. True strain (homogeneous deformation) (2 marks)
 - iii. Extrusion strain (2 marks)
 - iv. Ram pressure (2 marks)
 - v. Ram force (2 marks)
- c) A spool of wire has a diameter of 2.5mm. It is drawn through a die with an opening diameter of 2.1 mm. The entrance angle of the die is 18° , coefficient of friction at work die interface is 0.08. The work metal strength coefficient is 450MPa and its strain hardening coefficient is 0.26. The drawing process is carried out at room temperature. Determine:
- i. Area reduction (3 marks)
 - ii. Draw stress (4 marks)
 - iii. Draw force required for the operation (2 marks)

QUESTION FIVE (20 MARKS)

- a) A drawing operation is used to form a cylindrical mild steel cup with inside diameter = 50mm and height = 75mm. The starting blanking size = 138mm. What are the steps necessary to achieve a successful cup drawing operation (6 marks)
- b) In an orthogonal cutting operation, the tool has a rake angle $\alpha=15^\circ$. The chip thickness before the cut $t_o=0.3\text{mm}$ and the cut yields a deformed chip thickness $t_c=0.65\text{mm}$. Determine
- i. The shear plane angle (3 marks)
 - ii. The shear strain of the operation (2 marks)
- c) Supposing the rake angle in (b) above was to be changed to $\alpha=0^\circ$, assuming that friction angle remains the same, determine
- i. The shear plane angle (3 marks)
 - ii. The chip thickness (3 marks)
 - iii. The shear strain of the operation (3 marks)