MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 504: THEORY OF PRODUCTION PROCESSES

DATE: 26/3/2021 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

- *This paper contains FIVE questions*
- *Question ONE is compulsory and carries 30 Marks while the rest (Questions TWO – FIVE) carries 20 Marks each*

QUESTIONS ONE (30 MARKS)

a) Using relevant diagrams and equations, explain the difference between engineering stress and true stress in a tensile test. (4 marks)

b) Describe the three basic forms of stress–strain relationship that describe the behavior of nearly all types of solid materials (6 marks)

c) A shaft is subjected to a maximum bending torque of 10 KNm and a maximum bending moment of 7.5 KNm at a particular section, if the allowable equivalent stress in simple tension is 160 MPa, determine the diameter of the shaft according to von-mises yield criterion and compare the answer with that obtained using Tresca's yield criterion. (10 marks)

d) Give four reasons why friction is generally undesirable in metal forming operations (4 marks)

e) i Indicate the mathematical equation for the flow curve (1 mark)

ii How does increasing temperature affect the parameters in the flow curve equation? (1 mark)

f) Indicate some of the advantages of cold working relative to warm and hot working (4 marks)

QUESTION TWO (20 MARKS)

a) An element in plane stress is subjected to stresses $\sigma_x = 84\ Mpa$, $\sigma_y = -30\ Mpa$ and $\tau_{xy} = -32\ Mpa$.

(i) determine the principal stresses and show them on a sketch of a properly oriented element (5 marks)

(ii) determine the maximum shear stresses and show them on a sketch of a properly oriented element. (3 marks)

b) A single-pass rolling operation reduces a 20 mm thick plate to 18 mm. The starting plate is 200 mm wide. Roll radius = 250 mm and rotational speed = 12 rev/min. The work material has a strength coefficient = 600 MPa and a strength coefficient = 0.22. Determine:

i. roll force, (3 marks)

ii. roll torque, and (3 marks)

iii. power required for this operation. (2 marks)

c) Name any two products that are produced by extrusion. (2 marks)

d) What are the two basic types of forging equipment? (2 marks)

QUESTIONS THREE (20 MARKS)

a) What are the reasons why the bulk deformation processes are important commercially and technologically? (3 marks)

b) A 40 mm thick plate is to be reduced to 30 mm in one pass in a rolling operation. Entrance speed =16 m/min. Roll radius = 300 mm, and rotational speed = 18.5 rev/min. Determine:

i. the minimum required coefficient of friction that would make this rolling operation possible, (2 marks)

ii. exit velocity under the assumption that the plate widens by 2% during the operation, and (2 marks)

iii. forward slip. (1 marks)

c) Distinguish between direct and indirect extrusion. (6 marks)

d) A hot upset forging operation is performed in an open die. The initial size of the workpart is: D_o = 25 mm, and h_o = 50 mm. The part is upset to a diameter = 50 mm. The work metal at this elevated temperature yields at 85 MPa (n = 0). Coefficient of friction at the die -work interface = 0.40.Determine:

i. final height of the part, and (3 marks)

ii. maximum force in the operation. (3 marks)

QUESTIONS FOUR (20 MARKS)

a) A cylindrical billet that is 100 mm long and 40 mm in diameter is reduced by indirect (backward) 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 = 750 MPa and n = 0.15, determine: (a) extrusion ratio, (b) true strain (homogeneous deformation), (c) extrusion strain, (d) ram pressure, and (e) ram force. (6 marks)

b) Wire of starting diameter = 3.0 mm is drawn to 2.5 mm in a die with entrance angle = 15° degrees. Coefficient of friction at the work-die interface = 0.07. For the work metal, K = 500 MPa and n =0.30. Determine:

i. area reduction, ($1^1/_2$ marks)

ii. draw stress, and (3 marks)

iii. draw force required for the operation. ($1^1/_2$ marks)

c) What is spring-back in sheet metal bending? (2 marks)

d) A cylindrical workpiece 125 mm in diameter and 900 mm long is to be turned in an engine lathe. Cutting conditions are: v = 2.5 m/s, f = 0.3 mm/rev, and d = 2.0 mm. Determine:

i. Cutting time (2 marks)

ii. Metal removal rate. (2 marks)

e) What are some of the possible defects in drawn sheet metal parts? (2 marks)

QUESTION FIVE (20 MARKS)

a) What are some of the simple measures used to assess the feasibility of a proposed cup drawing operation? (3 marks)

b) A sheet-metal blank is to be bent as shown in Figure Q5b. The metal has a modulus of elasticity = 205 (10^3) MPa, yield strength = 275 MPa, and tensile strength = 450 MPa. Determine;

(i) the starting blank size and (3 marks)

(ii) the bending force if aV-die is used with a dieopening dimension = 25 mm. (2 marks)

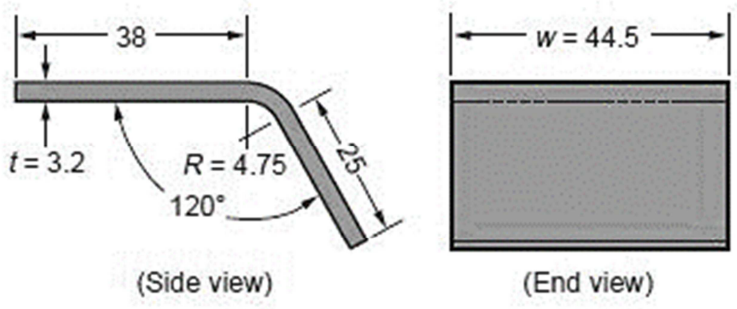

Figure Q5b

c) Turning is performed on a work material with shear strength of 250 MPa. The cutting tool has a rake angle of 7° in the direction of chip flow. The width(w) of the orthogonal cutting operation is 3mm and the chip thickness before the cut is 0.2mm. The resulting chip ratio = 0.5. Using the orthogonal model as an approximation of turning, determine:

i. the shear plane angle; ($1^1/_2$ marks)

ii. the shear force; ($1^1/_2$ marks)

iii. cutting force and feed force. (3 marks)

d) Tool life tests in turning yield the following data: (1) v = 100 m/min, T = 10 min; (2) v = 75 m/min,T = 30 min.

Determine the n and C values in the Taylor tool life equation. (2 marks)

Based on your equation, compute

i. the tool life for a speed of 90 m/min (2 marks)

ii. the speed corresponding to atool life of 20 min. (2 marks)