MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 409: MANUFACTURING PROCESSES I

DATE: 8/3/2023 **TIME: 10.30-1:00 PM**

INSTRUCTIONS

Answer question ONE and any other two questions.

QUESTION ONE (30 MARKS) (COMPULSORY)

a) Why is friction generally undesirable in metal forming operations? (2 marks)

b) What is powder metallurgy? (4 marks)

c) Describe various steps involved in powder metallurgy with each step controlling properties of final sintered component. (7 marks)

d) Give advantages, limitation & applications of powder metallurgy. (9 marks)

e) Given a large volume of metallic powders, all of which are perfectly spherical and having the same exact diameter, what is the maximum possible packing factor that the powders can take? (Hint maximum packing factor is achieved when the spherical particles are arranged as a face-centered cubic unit cell) (4 marks)

f) A bearing of simple geometry is to be pressed out of bronze powders, using a compacting pressure of 200 MPa. Outside diameter of the bearing 35 mm, inside diameter 20 mm, and length = 18 mm. What is the required press tonnage to perform this operation? (4 marks)

QUESTION TWO (20 MARKS)

a) Enumerate some of the advantages of cold working relative to warm and hot working. (4 marks)

b) Explain the significance of the following phenomena/processes in metal forming. (4 marks)

i. Isothermal forming (4 marks)

ii. Strain rate (4 marks)

c) A metal has a flow curve with strength coefficient = 850 MPa and strain-hardening exponent 0.30. A tensile specimen of the metal with gage length 100 mm is stretched to a length 157 mm. Determine the flow stress at the new length and the average flow stress that the metal has been subjected to during the deformation. (6 marks)

d) A bending operation is to be performed on 5.00 mm thick cold-rolled steel. The part drawing is given in Figure Q2D. Determine the blank size required. (6 marks)

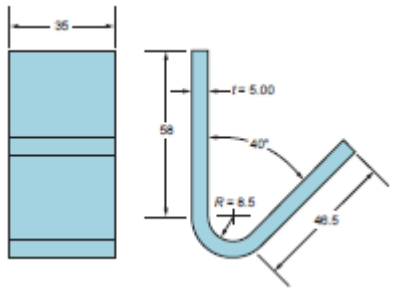

Fig Q2D Part in bending operation (dimensions in mm).

QUESTION THREE (20 MARKS)

a) Using clear illustrations, distinguish between direct and indirect extrusion as applied in the production of both solid and hollow profiles. (8 marks)

b) A cold heading operation is performed to produce the head on a steel nail. The strength coefficient for this steel is 600 MPa, and the strain hardening exponent is 0.22. Coefficient of friction at the die-work interface is 0.14. The wire stock out of which the nail is made is 5.00 mm in diameter. The head is to have a diameter of 9.5 mm and a thickness of 1.6 mm. The final length of the nail is 120 mm.

i. What length of stock must project out of the die in order to provide sufficient volume of material for this upsetting operation? (6 marks)

ii. Compute the maximum force that the punch must apply to form the head in this open-die operation. (6 marks)

QUESTION FOUR (20 MARKS)

a) Distinguish between rolling and forging operations (5 marks)

b) A 42.0-mm-thick plate made of low carbon steel is to be reduced to 34.0 mm in one pass in a rolling operation. As the thickness is reduced, the plate widens by 4%. The yield strength of the steel plate is 174 MPa and the tensile strength is 290 MPa. The entrance speed of the plate is 15.0 m/min. The roll radius is 325 mm and the rotational speed is 49.0 rev/min. Determine

i. The minimum required coefficient of friction that would make this rolling operation possible (3 marks)

ii. Exit velocity of the plate (3 marks)

iii. Forward slip. (3 marks)

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

i. Final height of the part (3 marks)

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

QUESTION FIVE (20 MARKS)

a) What distinguishes machining from other manufacturing processes? (1 mark)

b) What is the difference between peripheral milling and face milling? (3 marks)

c) What is a machining center and what can a mill-turn center do that a conventional turning center cannot do? (4 marks)

d) A peripheral milling operation is performed on the top surface of a rectangular workpart which is 400 mm long by 60 mm wide. The milling cutter, which is 80 mm in diameter and has five teeth, overhangs the width of the part on both sides. Cutting speed = 70 m/min, chip load = 0.25 mm/tooth, and depth of cut = 5.0 mm. Determine

i. The actual machining time to make one pass across the surface and (5 marks)

ii. The maximum material removal rate during the cut. (4 marks)

e) Discuss some of the problems brought about by dry machining (machining without the use of a cutting fluid) (3 marks)