DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations 2021/2022

FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN MACHINE TOOL DESIGN AND MANUFACTURING

EMM 6101 DESIGN PRINCIPLES OF INJECTION AND BLOW MOULDING

DATE: AUGUST 24TH 2021 TIME: 3 HOURS

INSTRUCTIONS

1. This paper contains **FOUR** questions. Question 1 is COMPULSORY.
2. Answer Question 1 and any other two questions.
3. All symbols have usual meaning unless otherwise stated.

QUESTION 1 - 40 MARKS (COMPULSORY)

(a) Differentiate between;

(i) A die and a mould (2 Marks)

(ii) A jig and a fixture (2 Marks)

(b) Fig. Q. 1(b) shows a typical arrangement for the flash land and the flash gutter on a forging.

(i) Explain two reasons why the choice of the appropriate width and thickness of the flash land is an important part of the forging process design. (3 Marks)

(ii) The basic data for this part are as follows:
Part volume V = 49.9 cm3
Perimeter P_r = 31.4 cm
The empirical formula to be used to determine the area of the flash during forging is as follows:

$$\text{Flash thickness, } T_f = 1.13 + 0.0789\, V^{0.5} - 0.000134V$$

$$\text{Flash land ratio, } W_f/T_f = 3 + 1.2e^{-0.00857V}$$

Calculate the projected area of the flash land. (4 Marks)

(c) For deformation during bending, it may be assumed that a plane normal section in the sheet will remain plane and normal and converge on the center of curvature as shown in Fig. Q. 1(c).

(i) Starting from the figure, derive the expression for bending strain in the case of bending with radius of curvature much larger compared to the thickness. (4 Marks)

(ii) Draw the strain and stress distribution curves across the thickness.
(2 Marks)

(iii) Explain in detail the phenomenon of spring back in bending of thin sheets.
(4 Marks)

(iv) Explain three techniques employed in minimizing the amount of spring back.
(3 Marks)

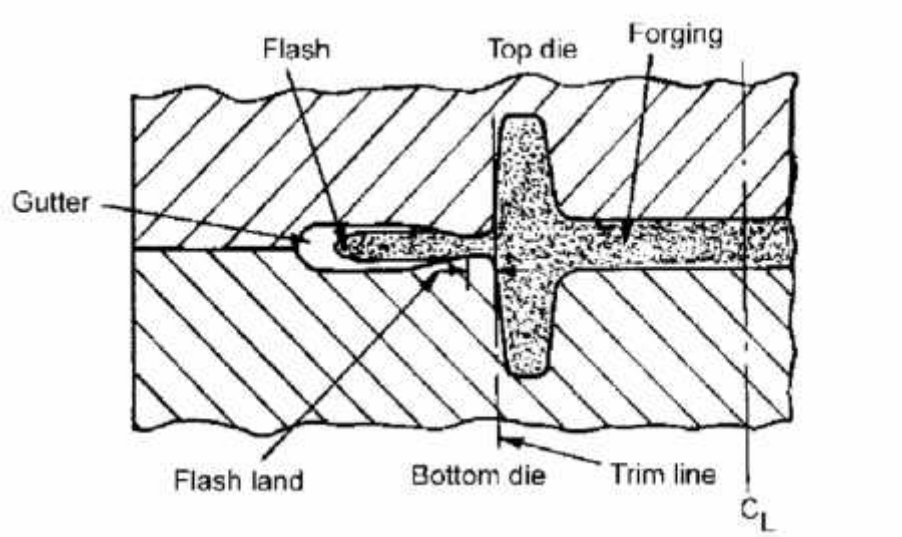

Fig. Q. 1 (b)

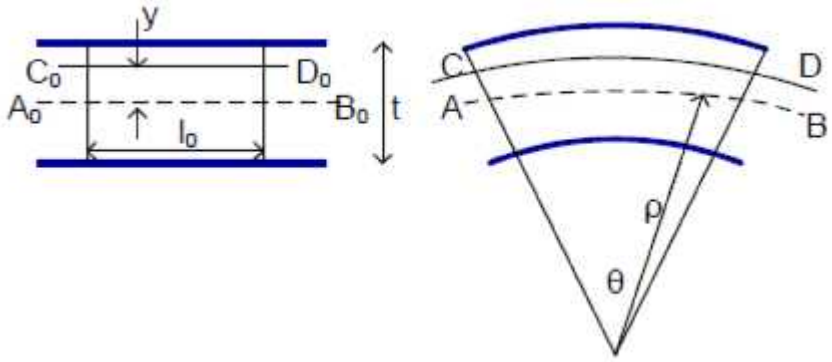

Fig. Q. 1(c)

(d) With aid of neat sketches, describe and differentiate between extrusion blow molding and injection blow molding.
(10 Marks)

(e) A glass for drinking water may be produced by heating the raw materials to an elevated temperature, above melting point and then using press and blow technique. With the aid neat sketches explain the step by the step processes.
(6 Marks)

QUESTION 2 - 30 MARKS

(a) Briefly describe the following die operations.

(i) Blanking (1.5 Marks)
(ii) Roll forming (1.5 Marks)
(iii) Piercing (1.5 Marks)
(iv) Swaging (1.5 Marks)

(b) A certain company in the US has established the cost of die sets is directly proportional to the usable area between the guide pillars and satisfies the following empirical equation:

$$C_{ds} = 120 + 0.36\,A_u$$

where
C_{ds} = die set purchase cost, \$
A_u = usable area, cm^2

The basic manufacturing points were found to be determined by the size of the punch and by the complexity of the profile to be sheared (Fig. Q. 2(b)). For a blank of 200mm long by 150mm wide with plain semicircular ends of radius 75 mm, and assuming 50mm space is allowed around the part for securing of the die plate and installation of strip guides, calculate;

(i) the die set purchase price (2 Marks)
(ii) the basic manufacturing points (3 Marks)
(iii) the percentage scrap (3 Marks)

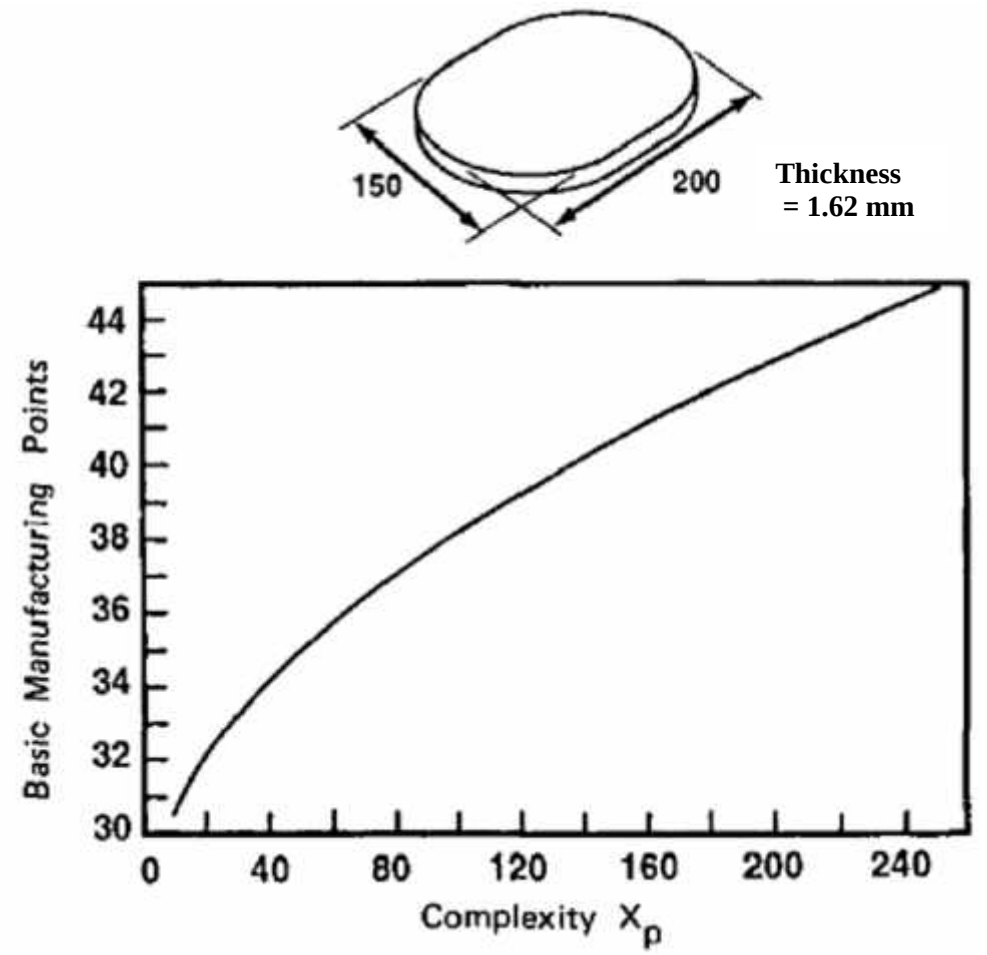

Fig. Q. 2(b)

(c) (a) One of the elements of jigs and fixtures are clamping devices.
(i) What is the purpose of the clamping devices?

(1 Mark)

(ii) With the aid of simple sketches, illustrate the bridge and the heel clamping devices.
(4 Marks)

(iii) What is the principal desirable requirement in the designs of such clamps?
(1 Mark)

(d) (i) With the aid of a neat sketch, briefly explain the process of compression molding. What is the major advantage with this process compared to other molding processes?
(6 Marks)

(ii) Briefly explain how compression molding is extended to transfer molding.
(2 Marks)

(iii) Compression and transfer molding are manufacturing techniques that lend themselves to the inclusion of molded inserts. Briefly explain the insert molding process.
(2 Marks)

QUESTION 3 - 30 MARKS

(a) (i) Briefly describe the two main sections of the construction of die casting dies.
(3 Marks)

(ii) Explain the phenomenon referred to flashing in die casting and detail its disadvantages.
(4 Marks)

(iii) One main difference between injection molding and die casting process is the construction of overflow wells in the later. Explain in detail why the wells are necessary.
(4 Marks)

(b) (i) State and explain any three die casting principles with regard to die construction.
(6 Marks)

(ii) Several operations in die casting may be automated in order to reduce cycle times and to produce more consistent quality. Name four such operations.
(2 Marks)

(c) A 20 cm long by 15 cm wide by 10 cm deep box-shaped die casting is to be made from A3 60 aluminum alloy whose cavity pressure should not exceed 48 MN/m^2. The mean wall thickness of the part is 5 mm and the part volume is 500 cm^3.

(i) Determine the appropriate clamp stroke if a two-cavity die is to be used.
(5 Marks

(ii) Sketch a layout of the two cavity die.
(2 Marks)

(d) A well-designed, well-manufactured, and well-functioning part must be sturdy enough but not exaggerated in size or weight. Explain how each of the following features enhances sturdiness in sheet metal work.

(i) Beads and ribs (strips) (2 Marks)

(ii) Flanges (2 Marks)

QUESTION 4 - 30 MARKS

(a) Explain why;

(i) Crystalline thermoplastics are usually opaque.
(1.5 Marks)

(ii) Thermoplastic polymers are more suited for injection molding compared to thermosetting polymers.
(1.5 Marks)

(iii) Reciprocating screw units are preferred to cylinder and plunger systems as injection units in injection molding process.

(1.5 Marks)

(iv) When calculating the cooling time in injection molding, the thermal resistance of the mold is neglected.

(1.5 Marks)

(b) With the aid of a well labeled pressure verses time graph, explain how pressure varies during the injection processing cycle.

(6 Marks)

(c) Explain why;

(i) There is a chance for reverse flow of the material from the mold during injection molding. Further, explain how this reverse flow can be minimized.

(3 Marks)

(ii) Although it appears economical to have quick opening and closing of the mold during ejection and resetting, this is often discouraged.

(3 Marks)

(d) Name two common types of clamp designs in injection molding. In each case, explain the principle of operation and give one major advantage and one major disadvantage of the design.

(6 Marks)

(e) The size of the runner in injection molding system depends upon the size of the part as shown in Table 1. A batch of 15 cm diameter disks with a thickness of 4 mm are to be molded from acrylonitrile-butadiene-styrene (ABS) in a six-cavity mold.

(i) Determine the maximum separating force of the clamping system if the recommended injection pressure for ABS is 1000 bars.

(4 Marks)

(ii) Explain how the correct size of molding machine will be determined.

(2 Marks)

Table 1: Runner Volumes

Part volume (cm^3)	Shot size (cm^3)	Runner %
16	22	37
32	41	28
64	76	19
128	146	14
256	282	10
512	548	7
1024	1075	5

END!!