

National Exams December 2002

98-Met-B5 Metal Formation

3 hours duration

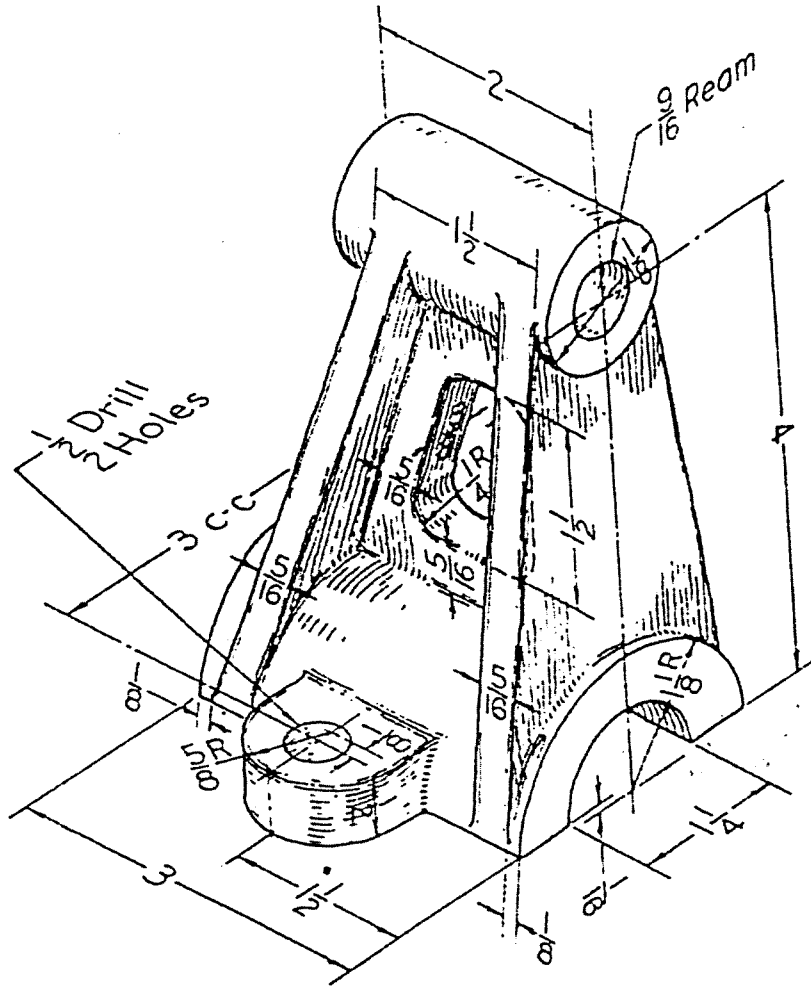
NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a Closed Book exam.
3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are of equal value.

98-Met-B5 Metal Fabrication

(5 of 8 questions are to be attempted)

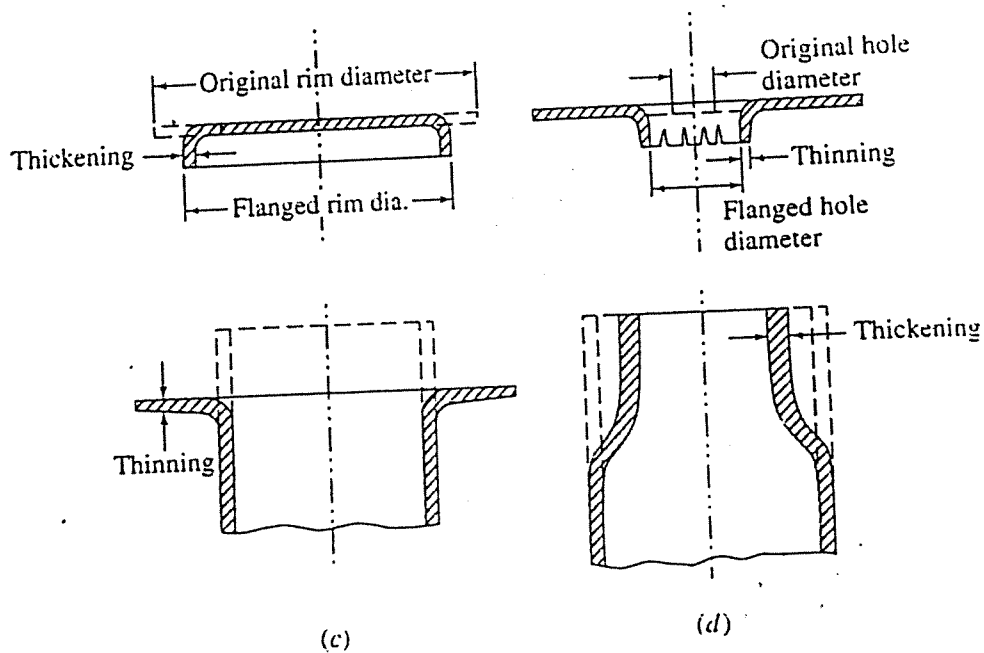
1. The component shown below was forged and it is to be machined to the dimensions given. Develop the machining operation. Design the sequence of the operations; decide what machine will be used. Give reasons for your choices. All dimensions are in inches. [20 marks]



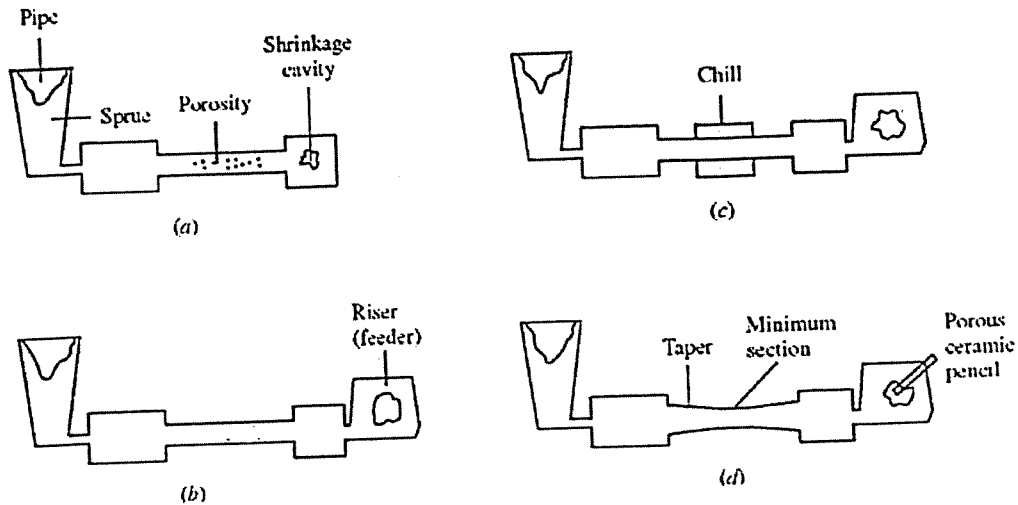
2. With the aid of diagrams explain

- i) Whether cumulative strain hardening occurs in a sequential hot forming operation, such as hot rolling in the roughing or in the finishing train? Give reasons. [7 marks]
- ii) What is the effect of planar or normal anisotropy in deep drawing on the resulting product? [6 marks]
- iii) How is a forming limit diagram created? [7 marks]

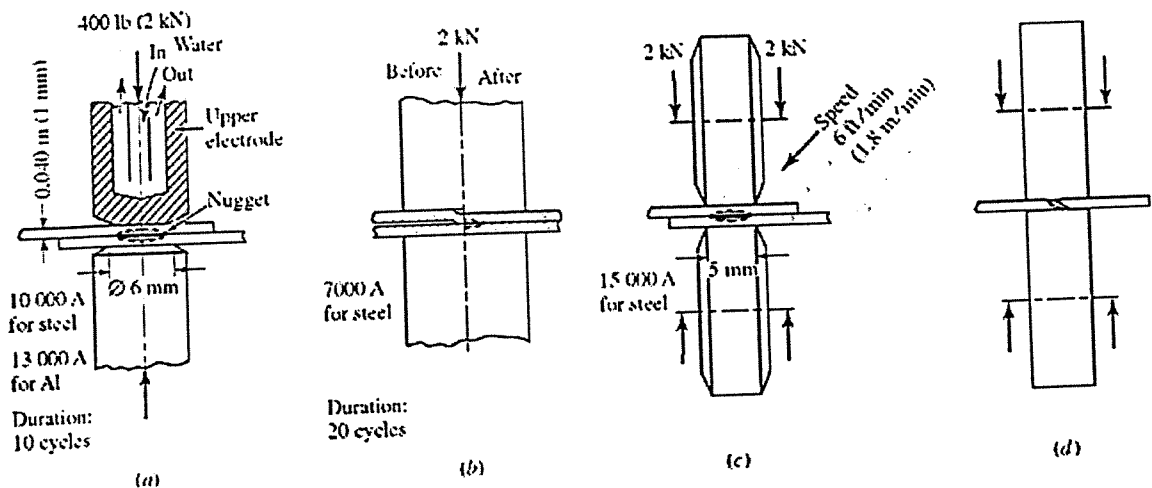
3. Cumulative strain hardening during cold working may be used to increase both the yield stress and the tensile stress of a metal.
 Consider the cold strip rolling process of a steel alloy whose true stress – true strain curve is given by $\sigma = Y(1 + B\varepsilon)^n$ MPa. The strip is reduced by cold rolling from a thickness of h_1 to h_2 in the first pass and from h_2 to h_3 in the second pass. How would you account for the cumulative strain hardening in the second pass? [20 marks]
4. The wall thickness of components formed by various sheet metal forming operations change during the process. Four sheet metal forming operations are shown below and the changes of the wall thickness are identified in each. What are the phenomena that cause these changes? [20 marks]



5. i) A cylindrical riser must be designed for a sand casting mold. The casting itself is a rectangular plate with dimensions 7.6 cm x 12.7 cm x 2.5 cm. Previous observations have indicated that the solidification time for this casting was 1.6 min. The cylinder for the riser will have a diameter-to-height ratio of 1.0. Determine the dimensions of the riser so that the solidification time is 2.0 min. What is the relative volume of the riser to the plate and comment on this result? [10 marks]
- ii) The figure (a) below shows the development of porosity during solidification and various approaches (b, c, d) to control solidification and porosity during cooling of a metal. Describe what is occurring in these figures. [10 marks]



6. List and discuss, with the aid of diagrams if necessary, the advantages and disadvantages of the powder metallurgy process. [20 marks]
7. Resistance spot welding (a), projection welding (b), resistance seam welding (c) and mash seam welding (d) are shown in the figure below. Describe each of the four processes. [20 marks]



8. A cylindrical part (10 mm high, 158 mm diameter) is to be cold forged by open die forging using a drop tower, which has a weight of 20000 N to be dropped on the sample from a height of 10 m. The stock from which the part is to be made is 100 mm high and 50 mm in diameter. [20 marks]

The metal is low carbon steel and its true stress – true strain curve in cold forming is given by $\sigma = 600\epsilon^{0.25}$ MPa.

- Can the part be made in one drop?
- If a second drop is necessary, anneal the part first. How high should the weight be dropped from to produce the 10 mm final height?

- iii) What should be the ductility of the metal to avoid tensile cracking?
- iv) How must the velocity change during the compression process for the strain rate to remain constant? (calculation is not required for this part)