**OLLSCOIL NA hÉIREANN, CORCAIGH**
THE NATIONAL UNIVERSITY OF IRELAND, CORK

COLÁISTE NA hOLLSCOILE, CORCAIGH
UNIVERSITY COLLEGE, CORK

**SUMMER 2000**

**B.E. (ELECTRICAL) DEGREE**

# ME4002 - PRODUCTION ENGINEERING

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Answer **three** questions from **EACH** section

Approved calculators are permitted

**TIME ALLOWED**
3 hours

## SECTION A: MATERIALS PROCESSING & DESIGN FOR MANUFACTURE

1. (a) Describe the main differences between thermosetting and thermoplastic polymers, giving a suitable example of each, and explain why different forming processes are required for each material.

   (b) Using diagrams where necessary, describe manufacturing processes suitable for making the following components from a thermoplastic polymer:
   - (i) a 2 litre fizzy drinks bottle
   - (ii) packaging for a chocolate Easter egg
   - (iii) a domestic bath

2. In any manufacturing process which uses dies or moulds, the final geometry of any component may be difficult to control. Show that both mechanical and thermal effects may make dimensional accuracy difficult to achieve. Explain why draft angles are required, even for components made in consumable moulds. Use example calculations for both a metal and a polymer to illustrate your answers.

3. Describe the reasons for shrinkage and distortion when arc-welding butt joints, and explain how they may be reduced by careful joint design. What other pre- and post-welding techniques may be used to prevent or remove distortion in the final welded assembly? Give advantages and disadvantages, and use diagrams where appropriate to illustrate your answers.

4. (a) Explain what is mean by ‘die kick’, how it may be avoided in die design, and why it is important to use a minimum number of die pieces in a forging process. Explain why it is difficult to forge very thin sections, and explain the role of flash lands.

   (b) Using the sizing chart shown overleaf in Figure 2, estimate the minimum size forging hammer that could be used to manufacture the component shown below in Figure 1 by hot forging from a medium carbon steel. Indicate on a sketch of the component where draft angles and radiusing will be necessary.

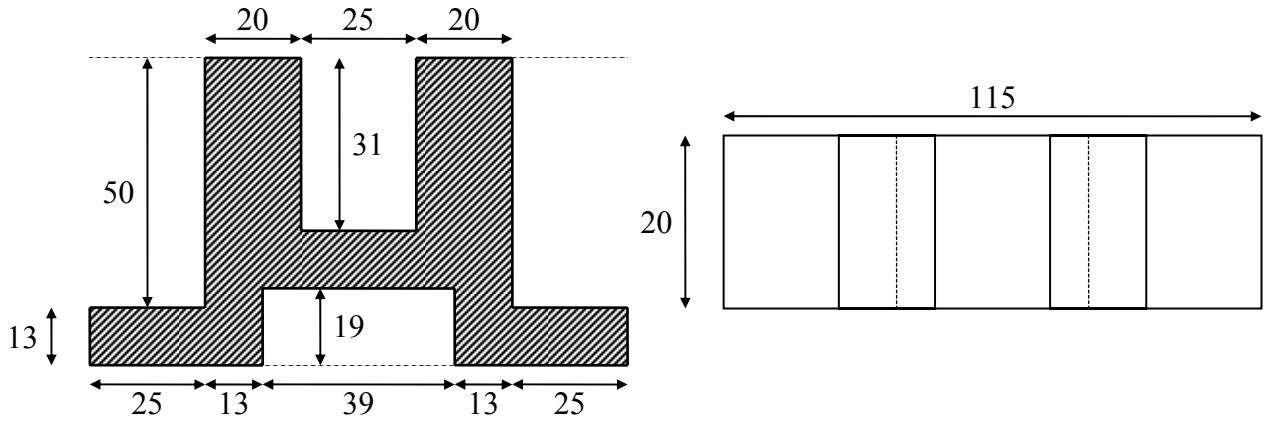


Figure 1: All dimensions in mm

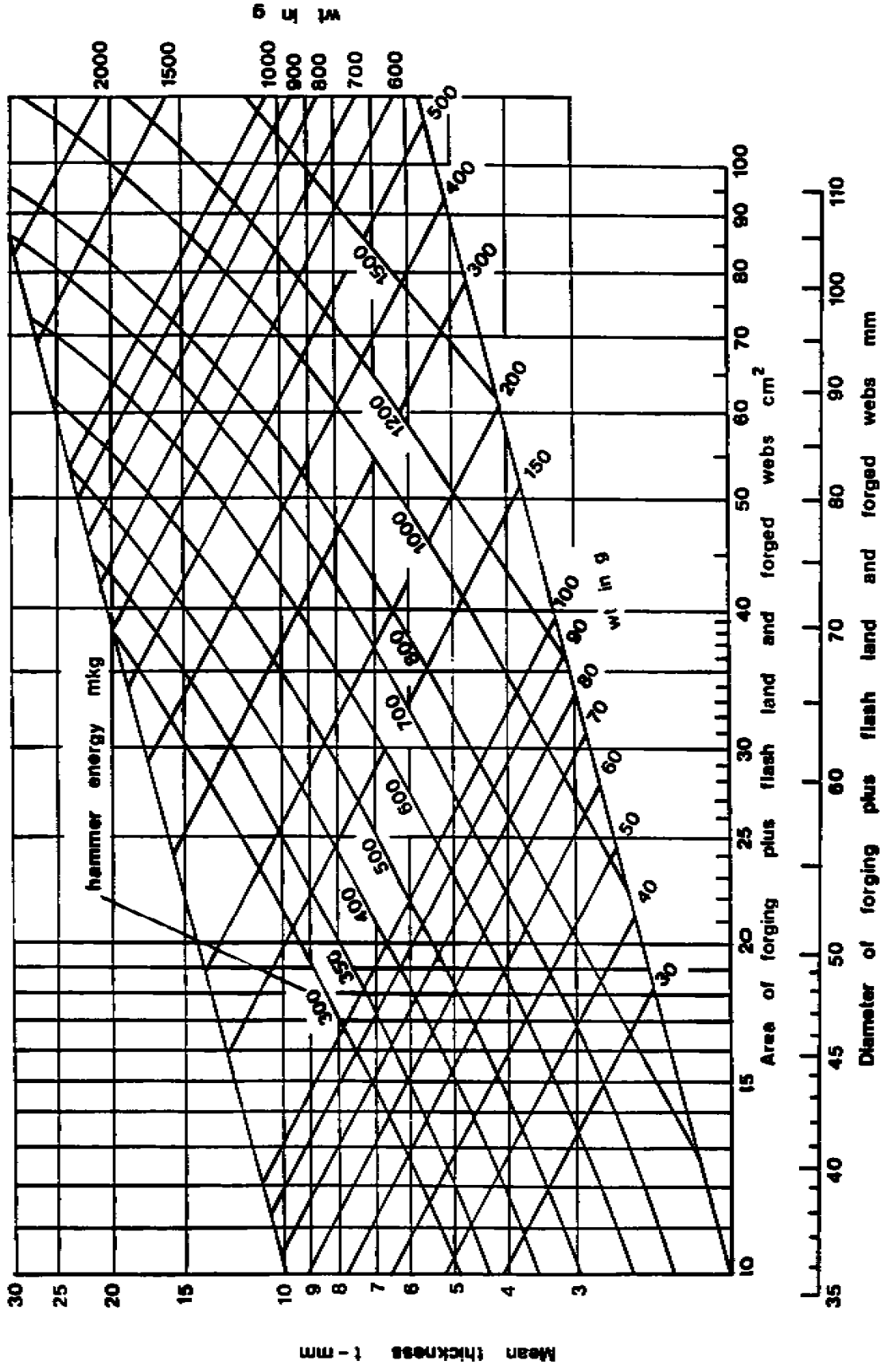
wt in g
2000
1500
1000
900
800
700
600
500
400
300
200
150
100
90
80
70
60
50
40
30
1500
1200
1000
800
700
600
500
400
350
300
hammer energy mkg
30
25
20
15
10
9
8
7
6
5
4
3
Mean thickness t – mm
Area of forging plus flash land and forged webs cm²
10
15
20
25
30
40
50
60
70
80
90
100
Diameter of forging plus flash land and forged webs mm
35
40
45
50
60
70
80
90
100
110

Figure 2

## SECTION B: NON-DESTRUCTIVE TESTING

5. (a) Describe the four main scattering mechanisms which may occur as X-rays or γ-rays pass through a material. Explain how the scattered radiation may degrade the quality of a radiographic image, and hence define the term "build up factor".

   (b) A butt weld joining two lengths of steel plate 10 mm thick is to be inspected using X-rays. A radiographic film is placed 0·5 m from the far side of the joint, and an X-ray tube with a 5 mm diameter aperture and 150 kV potential is situated 150 mm from the near side of the joint. For a 2 mm wide defect located on the far side of the joint at the weld root, calculate:

   (i) the minimum wavelength of the source;
   (ii) the geometric unsharpness;
   (iii) the magnification of the defect;
   (iv) the size of the defect as it appears on the radiograph.

   ($h = 6{\cdot}626 \times 10^{-34}$ J·s, $c = 3 \times 10^{8}$ m·s$^{-1}$, $e = 1.602 \times 10^{-19}$ C)

6. For each NDT requirement given below, describe a suitable method of achieving the stated objective. Give a brief outline of the underlying theory and outline any precautions to be taken to ensure consistent, reproducible results. State any advantages or limitations of the particular methods chosen, supporting your answers with quantitative arguments wherever possible.
   (a) detecting surface cracks down to 1μm long in silicon nitride ceramic discs.
   (b) monitoring delamination of composite panels, consisting of five layers of 1 mm thick polymer sheet, bonded together with adhesive.
   (c) detecting sub-surface hairline cracks down to 0.2 mm long in steel shafts.

7. (a) Describe the mechanisms by which ultrasound may be generated remotely using a pulsed laser. In each case, state the type(s) of waves that may be generated, and any advantages and disadvantages of the technique.

   (b) Using diagrams where appropriate, briefly describe the operation of the following types of laser-based detectors, highlighting any benefits or shortcomings for each:
   (i) Michelson interferometer.
   (ii) beam deflector.

8. Explain the general principles involved in eddy current testing and describe TWO applications in which eddy current evaluation techniques would be an appropriate choice of material characterisation method. For each application, outline:
   - the advantages of eddy current testing as opposed to any other NDT technique;
   - what characteristics of the material that the test is intended to reveal;
   - the limitations of eddy current testing in respect of sensitivity to the specified characteristics;
   - the cross-sensitivity of eddy current techniques to other material or geometrical factors, and how this sensitivity can be reduced.