

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SUMMER EXAMINATIONS 2000

**Second University Examination in
Industrial Engineering and Information Systems**

Production Engineering

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Instructions: Time allowed: three hours
Attempt all questions from section A
Attempt three questions from section B
See further instructions at beginning of section A

Section A

Instructions: Attempt all questions
Correct answers: 2 marks
Use Answer Sheet at back of examination paper for your answers
There are a total of 20 correct answers

1. Which one of the following is not a point defect in a crystal lattice structure
(a) interstitialcy (b) edge dislocation (c) Schottky defect (d) vacancy
2. Which of the following stress-strain relationship best describes the behaviour of brittle materials
(a) elastic and perfectly plastic (b) elastic and strain hardening
(c) perfectly elastic (d) none of these
3. In an electrolytic cell, the anode is the electrode that is:
(a) positive (b) negative
4. Which of the following is not a common alloying ingredient in steel
(a) chromium (b) manganese (c) nickel (d) vanadium (e) zinc
5. The treatment in which the brittleness of Martensite is reduced is which
(a) normalizing (b) annealing (c) tempering
6. The basic difference between low and high density polystyrene is the latter has a much higher degree of crystallinity
(a) true (b) false
7. Ceramic matrix composites are designed to overcome which of the following weaknesses of ceramics
(a) Modulus of elasticity
(b) Compressive strength
(c) Hot hardness
8. Chvorinov's rule states that solidification time is proportional to which one of the following
(a) A/V^n (b) V/A (c) $(V/A)^2$
9. A misrun is which one of the following defects in casting:
(a) Globules of metal are entrapped
(b) Metal not properly poured into the downsprue
(c) Metal solidifies before filling the cavity

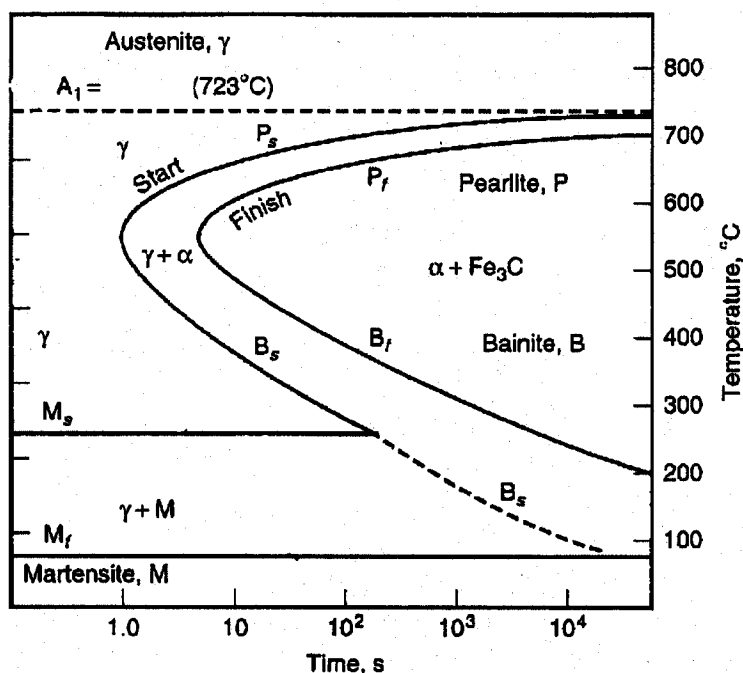
10. Use of a parison is associated with which one of the following processes
(a) compression moulding (b) blow moulding (c) thermoforming
11. Hot working of metals refers to which of the following melting temperature regions
(a) $0.2T_m$ (b) $0.4T_m$ (c) $0.6T_m$
12. Production of pipes and tubes is associated with which of the following bulk deformation processes:
(a) extrusion (c) upsetting (c) hobbing
13. The cutting force in a blanking operation depends on which of the following
(a) compressive strength (b) modulus of elasticity (c) shear strength
14. If the cutting conditions in a turning operation are $v=300\text{ft/min}$, $f=0.01\text{in/rev}$ and $d=0.1\text{ in}$, which of the following is the material removal rate
(a) $0.3\text{ in}^3/\text{min}$ (b) $3.0\text{ in}^3/\text{min}$ (c) $3.6\text{ in}^3/\text{min}$
15. On the various methods for testing machinability which one of the following is the most important:
(a) cutting forces (b) surface roughness (c) tool life
16. Which of the following in grinding would give higher material removal rates
(a) larger grain size (b) smaller grain size
17. Applications of electron beam machining are limited to metals due to need for electrical conductivity
(a) true (b) false
18. Groove welds are most closely associated with which of the following joint types
(a) butt (b) corner (c) tee (d) edge
19. Copper is a relatively easy metal to weld because its thermal conductivity is high:
(a) true (b) false
20. Adhesive bonding joints are strongest under which type of stresses
(a) cleavage (b) peeling (c) shear

Section B

1. Heat treatment of ferrous and non-ferrous metals enhances their behaviour in a number of ways.

- (a) List the principle reasons for the heat treatment of metals (4)
 (b) Describe briefly the four main heat treatment processes (8)

The figure below illustrates a time-temperature-transformation curve for eutectoid steel. Copy this figure into your answer book and answer the following:



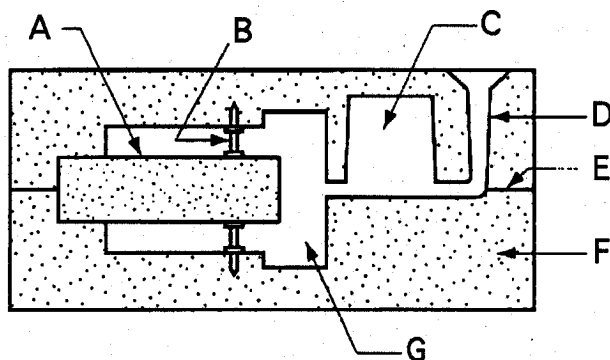
- (c) Explain what happens if the structure required is Bainite (4)
 (d) What happens to the curves if a hardening alloy such as chromium is added to the steel (4)
2. (a) What are the three basic categories of polymer (4)
 (b) Briefly describe the two main types of polymerisation process (4)
 (c) Cross-linking (curing) of thermosetting polymers occurs in one of three ways. Describe each (6)
 (d) Elastomers and polymers are both cross-linked. Why are they so different in behaviour (6)
3. (a) Illustrate the geometry of the single screw extrusion process for polymers. Your diagram should clearly show details including flight, pitch, barrel, screw, channel and flight angle. (6)

(b) Derive an expression for calculating the flow rate of a polymer through a single screw extrusion process. (6)

(c) An extruder barrel has a diameter, $D = 75\text{mm}$. The screw rotates at $N = 1$ rev per second, Channel depth $d_c = 6.35\text{mm}$ and flight angle $A = 20^\circ$. Head pressure at the end of the barrel $p = 6.895\text{ MPa}$, length of barrel $L = 1.875\text{m}$ and viscosity of the polymer melt is assumed to be 103 Ns/m^2 . Determine the flow rate of the plastic in the barrel. (8)

4. (a) Explain the sequence of steps taken in the investment casting process. Give examples of some products produced using investment casting. What material can be used in creation of the mould? (10)

(b) The casting process is used mainly for metals and ceramics. From the figure below for a sand casting mould answer the following questions:



- (i) Name each of the labels in the figure (4)
- (ii) Explain the purpose of 'C' (2)
- (iii) Explain the importance of buoyancy in sand casting (2)
- (iv) Name five types of casting defect (2)

5. Answer two of the following.

(a) Write a short note on the application of primary and secondary motion to six common multi-point and single-point cutting tools. In your note differentiate between those tools used for prismatic and cylindrical shaped workparts (10)

(b) Describe one non-traditional machining process in each of the following categories:

- (i) Mechanical Energy Processes (3)
- (ii) Electrochemical Machining Processes (3)
- (iii) Thermal Energy Processes (2)
- (iv) Chemical Machining (2)

(c) A billet of aluminium, 25mm in diameter by 38mm long is compressed between two parallel steel anvils to a length of 19mm. The initial yield stress is 65.4N/mm^2 and after a 50% reduction the yield stress is 82.7N/mm^2 .

- (i) Find the frictionless work done in deforming the material and the mean force which would produce this amount of work. (6)
- (ii) If the coefficient of friction is 0.14 find the maximum load to be exerted to cause deformation. (4)