CARLETON UNIVERSITY

FINAL
EXAMINATION
December 1992

DURATION: 3 HOURS No. of Students: 55

Department Name & Course Number: Engineering 87.370
Instructor(s) P.V. Straznicky

AUTHORIZED MEMORANDA
1 Calculator; one 8½" x 11" crib sheet

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy immediately to a proctor. This question paper has 3 pages.

This examination question paper MAY be taken from the examination room.

BE BRIEF AND CONCISE IN ALL YOUR ANSWERS.

1.[20] Answer the following questions in point form:

a/ What is crazing, where does it occur, what types of problems can it cause?

b/ Describe the two major inspections of completed single crystal turbine blades.

c/ What is consolidation in the PM processes?

d/ What are the advantages and limitations of precision forging?

e/ What are the advantages/disadvantages of honeycomb construction, and how are the honeycomb parts made in different materials (plastics, metals)?

f/ Sketch out the cross-section of boron fibres. How are they manufactured and where are they used?

g/ Sketch out the strain vs time relation for high temperature creep in metals. What happens as the temperature increases? Show the zone of interest to designers and describe why this is so.

h/ Why is it difficult to diffusion bond some metals such as aluminum alloys?

i/ What is GTAW and what are its advantages?

j/ What is thermoforming?

2.[25] a/ Describe the strengthening mechanisms used for metal alloys.

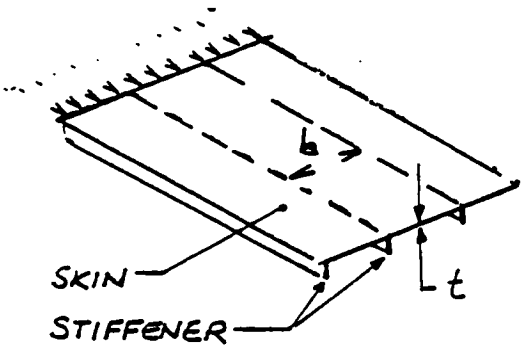
b/ A polycrystalline aluminum alloy contains a dispersion of hard particles of diameter 1E-8 m with an average centre-to-centre spacing of 6E-8 m on the slip planes. Considering a shear modulus of 26 GPa and Burger's vector of 0.286E-9 m, estimate the contribution of these particles to the yield strength in shear and in tension.

3.[25] A unidirectional composite material has been proposed for flight vehicle panels loaded in compression, along the direction of fibres.

a/ For the data given below, estimate the longitudinal stiffness and the density of the material.

Fibre: $E = 235$ GPa
$\rho = 1750$ kg/m^3
Volume Fraction = 0.7

Matrix: $E = 3.45$ GPa
$\rho = 1200$ kg/m^3



b/ The compressive buckling load of a panel is proportional to Et^3/b where t = thickness, and b = panel width. Determine which material would be preferable for this application, the proposed composite material or a titanium alloy with

$E = 116$ GPa
$\rho = 4500$ kg/m^3.

c/ Comment on the practical aspects of using a unidirectional composite for this application.

4.[10] Briefly discuss the requirements for materials to be used in propellant tanks of launch vehicles storing LOX (liquid oxygen) and LH_2. Consider the loading and the environment, and suggest materials that may be used.

5.[20] Consider **thermal shock**:

a/ Define this condition and give examples where it can occur.

b/ Describe its effects on brittle materials.

c/ What parameter can be used to rank performance of brittle materials, and why?

d/ How do ductile materials behave?