

CARLETON UNIVERSITY
Department of Mechanical and Aerospace Engineering
MAAE 4102A: Materials: Strength and Fracture
Midterm Examination: Wednesday, 21 October 2020

Duration: 1 hr 30 min

Maximum Marks: 30

Note: All questions are compulsory.

Q1. For a sepcific test, the load-displacement-crack area relation takes the form **[6]**

$$F = \frac{350u}{A} \left(1 - 5.4uA^{-\frac{1}{2}} + 15u^2A^{-1} \right),$$

where F is in kgf , u is in cm and A is in cm^2 . In the test, a crack of area 50 cm^2 starts to grow when $u = 0.5 \text{ cm}$. Determine the load (in N) at the onset of crack growth and $R = J_c$ (in J/m^2) for this material. [Given: $1 \text{ kgf} = 9.8 \text{ N}$].

Q2. A 1 m wide rectangular panel is subject to a tensile load of 100 MN perpendicular to the width. The smallest crack size that can be detected is 1 mm remote from all edges. Steel A with $\sigma_{ys} = 0.86 \text{ GPa}$ and $K_{Ic} = 100 \text{ MPa}\sqrt{m}$ and steel B with $\sigma_{ys} = 1.55 \text{ GPa}$ and $K_{Ic} = 55 \text{ MPa}\sqrt{m}$ are being considered for constructing the panel. Find which material gives the smallest thickness of the panel and what that thickness is. You must test for failure by yielding as well as failure in fracture. **[9]**

Q3. A beam is rigidly built at both ends and is subjected to a uniformly distributed load of magnitude ω_0 per unit length for half of its span ℓ . Locate the intermediate hinge of the plastic collapse mechanism and find ω_0 in terms of M_p and ℓ . **[15]**

