Module 1 Practice Problems (with solutions)

MEGN 498A

2020

Problem 1
The support behind each solar panel on the ISS can be idealized as a piece of aluminum with $E = 72$ GPa and $\nu = 0.33$. The rectangular piece is loaded on its thin edges by constant pressure P_0 such that the stress state is:

$$\sigma_x(x,y) = +2P_0$$
$$\sigma_y(x,y) = -P_0$$
$$\sigma_{xy} \equiv \tau_{xy} = 0$$

All other stresses are zero.

Neglecting body forces, determine:

(a) if the structures is in equilibrium

(b) all nonzero normal and shear strains

Ans: *(a) Yes (b) normal strains are nonzero and there are 3 of them* $\epsilon_x = \frac{1}{72E9}(2.33P_0)$, $\epsilon_y = \frac{1}{72E9}(-1.66P_0)$, $\epsilon_z = \frac{1}{72E9}(-0.99P_0))$

Problem 2

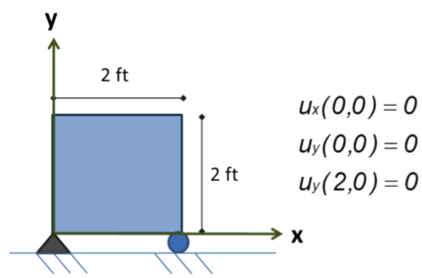
The engine inlet on an experimental aircraft in steady level flight can be simplified by the following static structural system of a cylinder with varying cross-section given by $A = A_0(1 + \frac{x}{L})$. The cylinder is considered fixed at $x = 0$ and has a uniform compressive load P (that is an idealized constant head wind) which acts at $x = L$. Calculate the x displacement of the cylinder (assuming no body forces).

Ans: $x = \frac{PL}{EA_0}\ln(1 + \frac{x}{L})$

Problem 3

Given a strain field associated with the following simplified model for a rock collector structure off the Mars Science Lab (pictured below) with associated boundary conditions:

$$\epsilon_x = 2xy$$
$$\epsilon_y = 3xy^2$$
$$\gamma_{xy} = 2\epsilon_{xy} = x^2 + y^3$$

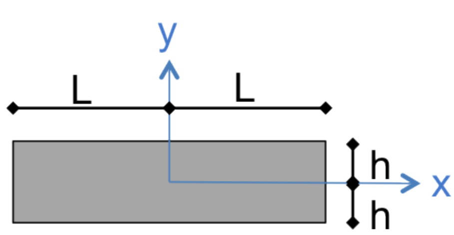


i Is this an admissible solution?

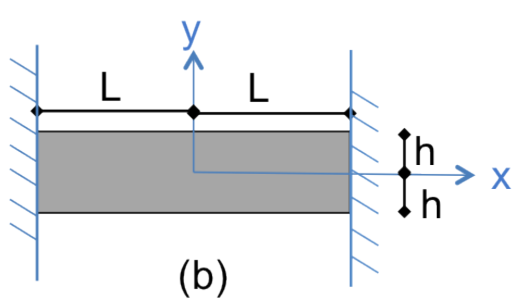
ii Assuming it IS an admissible solution, what are the displacements in the x and y directions, u_x and u_y.

Ans: $u_x(x, y) = x^2y$ *and* $u_y(x, y) = v(x, y) = xy^3$

Problem 5 A beam of rectangular geometry, very small thickness t, depth of $2h$, and length of $2L$ is subjected to an arbitrary variation of temperature throughout its depth, $T = T(y)$. Find the strain distribution for the case where (a) the beam is entirely free of surfaces forces and (b) the beam is held by rigid walls that prevent the x-direction displacement only.



(a)



(b)

Ans: *Nonzero components for a:*
$\epsilon_x = \frac{\sigma_x}{E} + \alpha T$
$\epsilon_y = -\frac{\nu\sigma_x}{E} + \alpha T$
Ans: *Nonzero components for b:*
$\epsilon_y = (1 + \nu)\alpha T$