THE UNIVERSITY OF IOWA
Department of Mechanical Engineering

Fracture Mechanics	**Homework #6**	**Assigned: April 20, 2020**
ME:5159	**Total Points: 10**	**Due: April 27, 2020**

Problem 1:

As an engineer at a Boiling Water Reactor plant, you are required to conduct an LBB evaluation for a pipe. From preliminary design requirements, a pipe with outer diameter $D_o = 711.2$ mm and wall thickness $t = 33.867$ mm is chosen. The material has been identified to be A515 Gr60 carbon steel with the quasi-static mechanical properties at 288 C (550 F) as following:

Elastic modulus (E)	=	179.2 GPa
Poisson's ratio (v)	=	0.3
Yield strength (S_y)	=	231 MPa
Ultimate strength (S_u)	=	544 MPa

From material characterization data, it has also been determined that:

- $\varepsilon/\varepsilon_0 = \sigma/\sigma_0 + \alpha \, (\sigma/\sigma_0)^n$
  where: $\sigma_0 = 231$ MPa, $\alpha = 1.1$, and $n = 5$

- $J_R = J_{Ic} + C(\Delta a)^m$
  where: $J_{Ic} = 0.195$ MJ/m^2, $C = 1$, and $m = 0.9$

A leak-rate analysis indicates that the crack-opening-area (A_{COA}) must be at least 150 mm^2 to ensure a reliable leak detection using the leak-detection equipment currently installed at the plant. For the loads, assume that the pipe is under pure bending with

Normal operating moment (M_N)	=	1.00 MN-m
N+SSE moment (M_{N+SSE})	=	2.25 MN-m

Using the GE/EPRI method and appropriate influence functions (e.g., tabular values for COA and analytical equations for J-integral), determine if the pipe will satisfy the LBB criterion for NRC licensing. Comments.