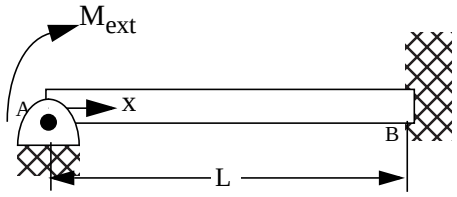
EXAM 1 EM 440 (Quarter system equivalent to MEEM 4150) April 6th, 2000

1. TIn terms of E, I, M_{ext}, L, and x, determine the
   (a) elastic curve and
   (b) the reaction force at A.



2. The principal stresses at a point were found to be σ_1= 40 ksi (T), σ_2= 10 ksi (T), σ_3= 20 ksi (C).

(a) Determine the normal and shear stress on a plane that has an outward normal at 45^o, -60^o, and -60^o, to x, y, and z direction respectively.

σ_{nn} = ---------- τ_{nt} = ----------

(b) Determine the three stress invariants.

I_1= ----------I_2= ----------I_3= ----------

(c) Determine the equivalent von-Mises stress at the point. σ_{von} = ----------

(d) The critical stress intensity factor for the material is $22 ksi\sqrt{in}$, what would be the critical crack length at that point.

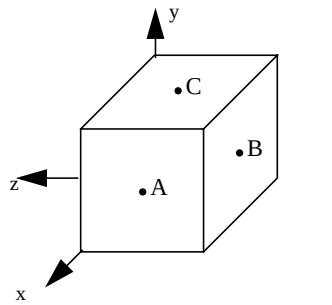
$2a_{crit}$ = ----------

(e) The material has a Modulus of Elasticity of E = 30,000 ksi and Poisson's ratio ν = 0.3. Determine the maximum shear strain.

γ_{max} = ----------

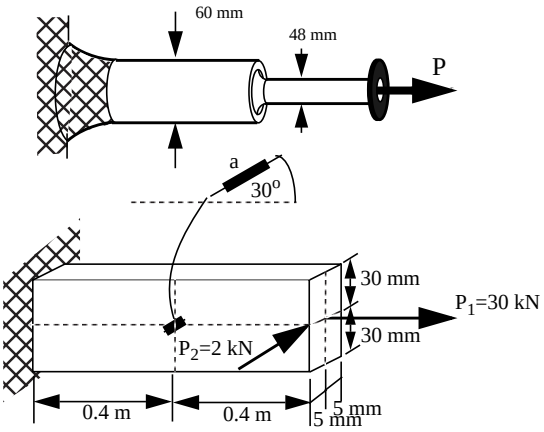
3. (a) Show the following stress components on the faces A, B and C of the cube shown. Use the coordinate system that is given only.

τ_{xy} = 30 MPa τ_{xz} = –70 MPa
τ_{yx} = 30 MPa σ_{yy} = 80 MPa (C)
τ_{zx} = –70 MPa σ_{zz} = 40 MPa (T)



(b) An axial member has a failure stress of 150 MPa in tension. From the charts, the stress concentration factor was found to be 1.75. If a factor of safety of 1.2 is required, then what is the maximum force P that can be applied to the member.

P= ----------



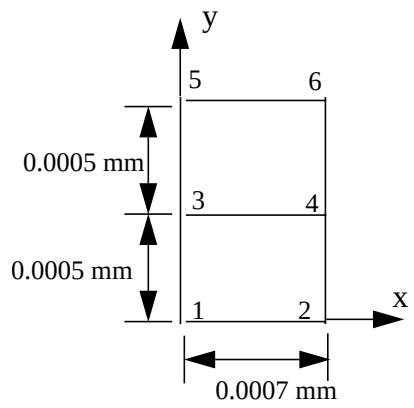
(c)Determine the strain recorded by the strain gage.The Modulus of Elasticity is 200 GPa and the Poisson's ratio is 0.3.

(d) The displacement u and v in the x and y direction, respectively, are given at six points as shown. Using finite difference approximation find the normal strains ε_{xx} and ε_{yy} at point 4. Indicate which finite difference method you *used?*

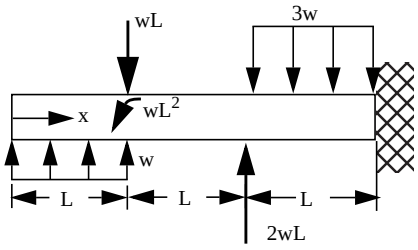
$(\varepsilon_{xx})_4$=----------

$(\varepsilon_{yy})_4$=----------

Point	u (μmm)	v (μmm)
1	0.000	0.000
2	-0.112	0.144
3	0.112	0.176
4	-0.032	0.224
5	0.128	0.384
6	-0.048	0.336



(e) Write the fourth order differential equation (only) using displacement discontinuity functions for the beam and loading shown.



1	$R_A = 3M_{ext}/2L$		
2a	σ_{nn} = 17.5 ksi (T)	τ_{nt} = 24.9 ksi	
2b	I_1= 30 ksi	I_2= -600 ksi	I_3= - 8000 ksi^3
2c	σ_{von} = 52 ksi		
2d	$2a_{crit}$ = 0.1826 in		
2e	γ_{max} = 2600 μ		
3b	P= 129.2 kN		
3c	2870 μ		
3d	$(\varepsilon_{xx})_4$= - 205.7 μ backward		$(\varepsilon_{yy})_4$= 192 μ central