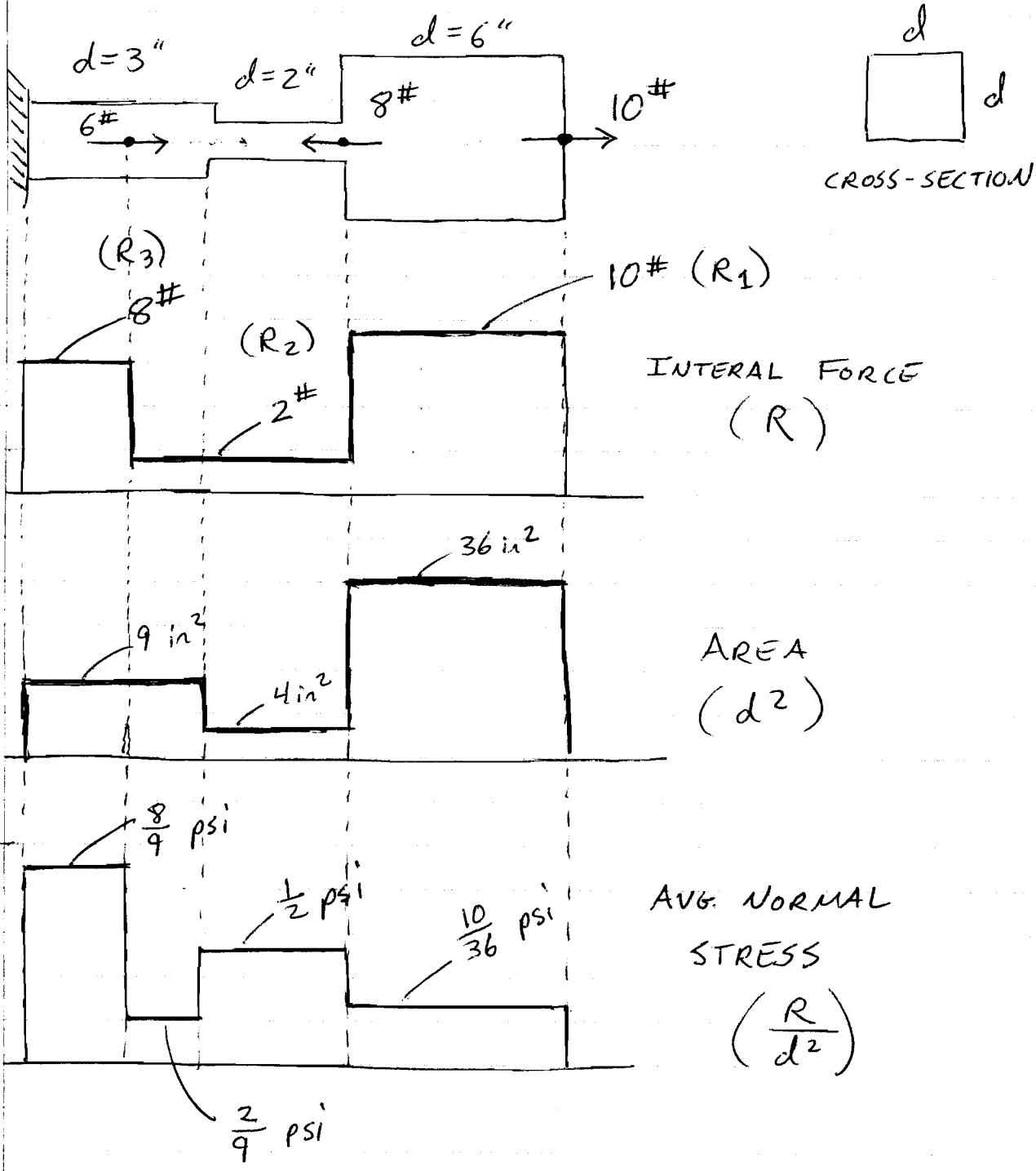
CE 130 : section 1 : FALL 2006

DISCUSSION 1 : Sept. 1

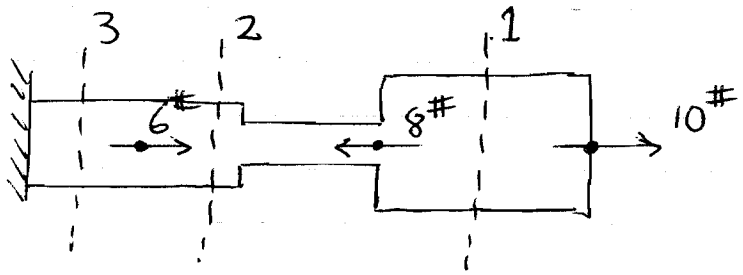
EXAMPLE 1 :

FIND AVERAGE NORMAL STRESS THROUGH OUT MEMBER



HOW TO FIND INTERNAL FORCE?

MAKE IMAGINARY CUT THROUGH MATERIAL!

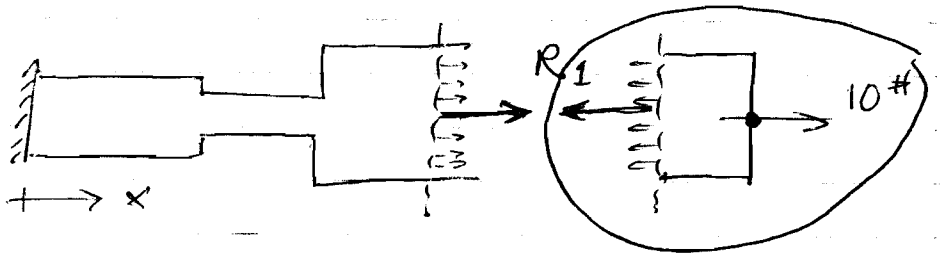


DOT REPRESENTS POINT OF APPLICATION OF A CONCENTRATED LOAD.

CUT ON EITHER SIDE OF EACH APPLIED FORCE.
EACH CONCENTRATED FORCE CAUSES A DISCONTINUITY IN THE INTERNAL FORCE DIAGRAM (A SUDDEN JUMP).

LET'S LOOK TO THE RIGHT OF CUT.
THE ISOLATED BODY MUST BE IN FORCE EQUILIBRIUM.

CUT 1:



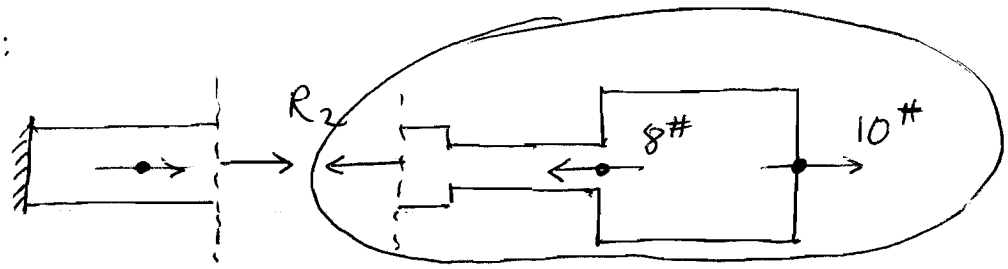
FROM $\Sigma F_x = 0$, $10 - R_1 = 0$, $R_1 = 10^{\#}$

R IS THE INTERNAL FORCE

R_1 IS THE FORCE RESULTANT OF ALL NORMAL STRESSES ACTING ON THE SURFACE EXPOSED BY MAKING THE CUT.

I IGNORE THE BODY TO THE LEFT. IT IS IN EQUILIBRIUM ALSO, BUT I WOULD HAVE TO SOLVE FOR THE SUPPORT REACTION TO WRITE ΣF_x FOR IT.

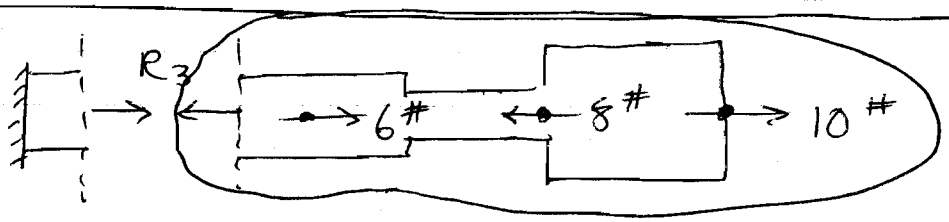
CUT 2:



$\Sigma F_x = 0$

$10 - 8 - R_2 = 0 \qquad R_2 = 2^{\#}$

CUT 3:

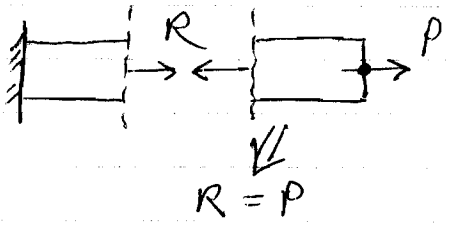


$\Sigma F_x = 0$

$10 - 8 + 6 - R_3 = 0 \qquad R_3 = 8^{\#}$

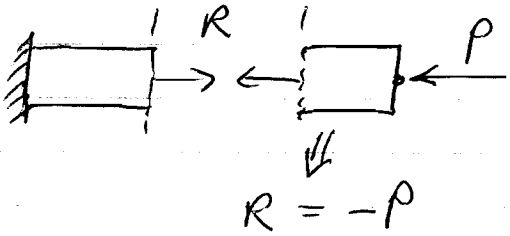
NOTE MY SIGN CONVENTION. OUTWARD NORMAL (AWAY FROM FACE) IS POSITIVE. THIS MEANS TENSION IS POSITIVE & COMPRESSION IS NEGATIVE.

TENSION



$R = P$

COMPRESSION



$R = -P$

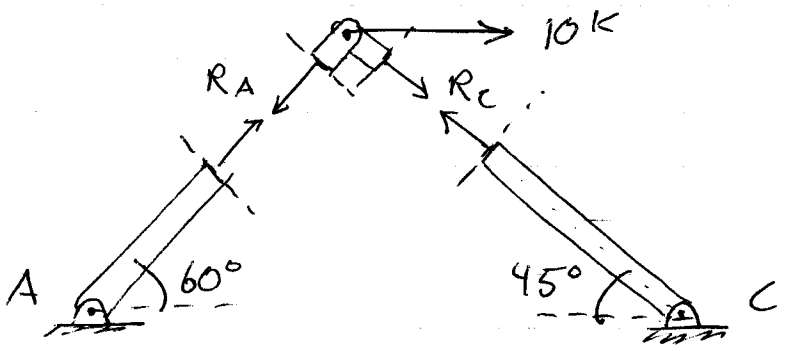
IN THIS EXAMPLE, IT HAPPENS THAT THE ENTIRE MEMBER IS IN TENSION.

FOR THIS EXAMPLE, I ASKED FOR AVERAGE NORMAL STRESS. THIS MEANS YOU ASSUME THE STRESS IS UNIFORM OVER EACH CROSS-SECTION. (SEE ST. VENANT'S PRINCIPLE)

THUS, $\sigma_{avg} = \dfrac{R}{\text{Area}}$

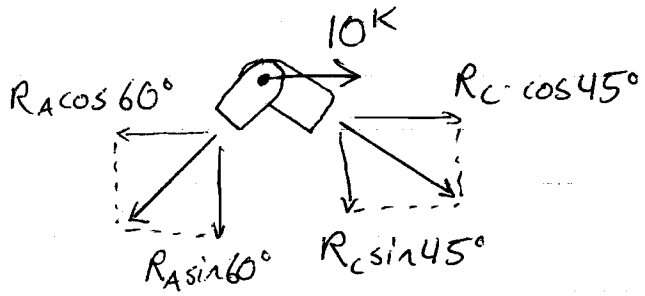
EXAMPLE 2 . (1.10 in book)

FIND INTERNAL FORCE IN EACH MEMBER, THEN DIVIDE BY THE SMALLEST AREA OF THE MEMBER TO GET THE MAXIMUM AVERAGE NORMAL STRESS.



K = kip = 1000 #
# = pound
" = inch or in.
' = foot or ft
psi = $\#/in^2$
ksi = K/in^2

I'VE CHOSEN TO ISOLATE TOP JOINT W/ SECTION CUTS. EACH MEMBER IS A TWO-FORCE MEMBER.



$$\rightarrow \Sigma F_x = 10 + R_C \cdot \cos 45° - R_A \cos 60° = 0$$

$$\uparrow \Sigma F_y = -R_C \sin 45° - R_A \sin 60° = 0$$

INDICATES POSITIVE DIRECTION FOR ΣF

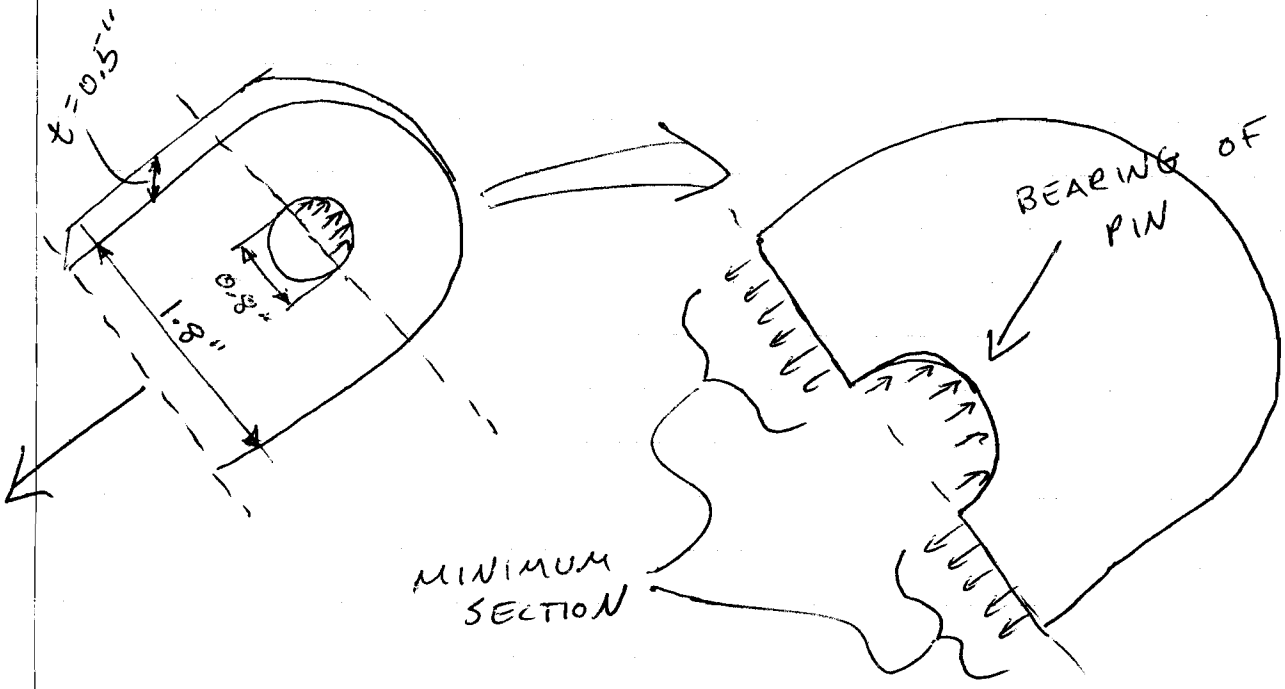
2 EQUATIONS, 2 UNKNOWNS $\Rightarrow$ SOLVE

$R_A = 7.32^K$ (TENSION)

$R_C = -8.97^K$ (COMPRESSION)

MINIMUM SECTION (SMALLEST AREA) OF MEMBER 'A'.

SINCE MEMBER 'A' IS IN TENSION, PINS AT EITHER END BEAR ON OUTSIDE HALF OF PIN HOLE.



$$A_{min} = (1.8" - 0.8")\,0.5" = 0.5\ in^2$$

$$\sigma_{avg.\,max} = \frac{R_A}{A_{min}} = \frac{7.32^K}{0.5\ in^2} = 14.64\ ksi$$

MINIMUM SECTION OF MEMBER 'C'

$$AREA = 1.8" \times 0.5" = 0.9\ in^2$$

$$\sigma_{avg.\,max} = \frac{R_C}{Area} = \frac{-8.97^K}{0.9\ in^2} = -9.97\ ksi$$