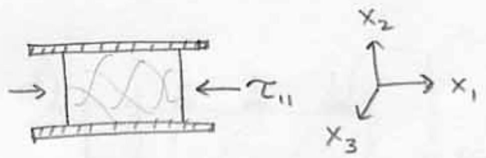
BEH. 410 QUIZ #1

(1)



a) $\epsilon_{22} = 0$; $\tau_{33} = 0$; NOTE: $\tau_{22} \neq 0$

$$E_a = \frac{\tau_{11}}{\epsilon_{11}}$$

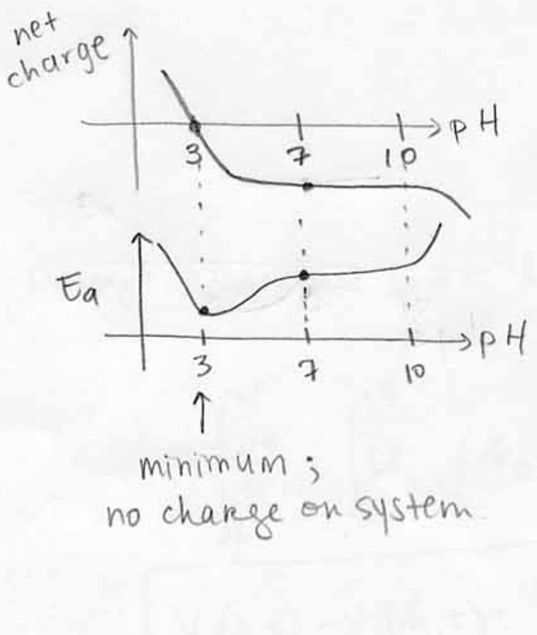
$$\epsilon_{11} = \frac{1+\nu}{E}\tau_{11} - \frac{\nu}{E}(\tau_{11} + \tau_{22} + \cancelto{0}{\tau_{33}}) = \frac{1}{E}\tau_{11} - \frac{\nu}{E}\tau_{22}$$

$$\left(\tau_{22} = 2G\cancelto{0}{\epsilon_{22}} + \lambda(\epsilon_{11} + \cancelto{0}{\epsilon_{22}} + \overset{\epsilon_{11}}{\overset{\shortparallel}{\epsilon_{33}}}) = 2\lambda\epsilon_{11}\right)$$

$$\epsilon_{22} = 0 = \left(\frac{1+\nu}{E}\right)\tau_{22} - \frac{\nu}{E}(\tau_{11} + \tau_{22} + \cancelto{0}{\tau_{33}}) = \frac{1}{E}\tau_{22} - \frac{\nu}{E}\tau_{11} = 0$$

$$\epsilon_{11} = \left[\frac{1}{E}\tau_{11} - \frac{\nu}{E}(\nu\tau_{11})\right] = \left(\frac{1-\nu^2}{E}\right)\tau_{11} \Rightarrow \boxed{E_a = \frac{E}{1-\nu^2}}$$

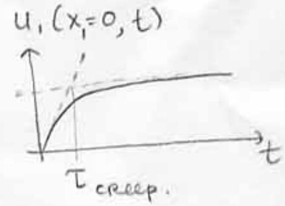
b)

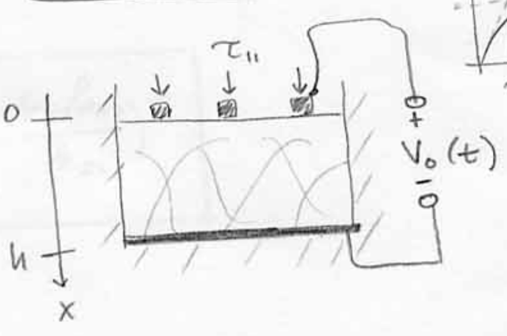


minimum ;
no charge on system

c) Displacement vs. time behavior is unchanged after treatment with stromelysin. Since H_A decreases by a factor of 3, the permeability must increase by 3.

$$\boxed{k' = 3k}$$





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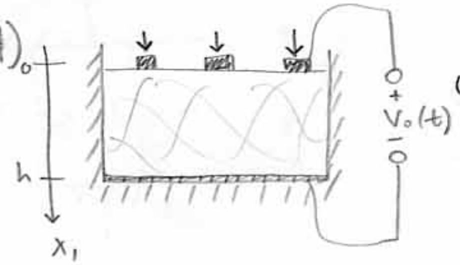
(1) d)



(i) The pressure at the interface at $x_1 = 0$ is equal to the ambient pressure. Therefore, the pressure difference at the interface is zero. Pressure does not change or vary with time even if the electrodes are shorted together.

(ii) $$\tau_{11}\Big|_{x_1=0} = H\epsilon_{11}\Big|_{x_1=0^+} + \overset{\nearrow 0}{p}\Big|_{x_1=0^+}$$

$$\boxed{\epsilon_{11}\Big|_{x_1=0^+} = \frac{\tau_{11}}{H}}$$

(iii) $p(x_1=0^+) = 0 \Rightarrow \epsilon_{11}\Big|_{0^+} = \tau_{11}/H$ independent of time

e) Open circuit $J = 0$ (no current flow)

Ohm's equivalent law: $J = k_{21}\frac{\partial p}{\partial x_1} - k_{22}\frac{\partial v}{\partial x_1} = 0$

$$\frac{\partial v}{\partial x_1} = \frac{k_{21}}{k_{22}}\frac{\partial p}{\partial x_1} \rightarrow \frac{\partial p}{\partial x_1} = \frac{k_{22}}{k_{21}}\frac{\partial v}{\partial x_1}$$

Darcy's equivalent law: $U_1 = -k_{11}\frac{\partial p}{\partial x_1} + k_{12}\frac{\partial v}{\partial x} = \frac{\partial v}{\partial x_1}\left(k_{12} - \frac{k_{11}k_{22}}{k_{21}}\right)$

$$\Rightarrow \int_h^0 \frac{\partial v}{\partial x_1} = \int_h^0 U_1 \left(k_{12} - \frac{k_{11}k_{22}}{k_{21}}\right)^{-1} dx$$

$$\boxed{V(0,t) - V(h,t) = \int_h^0 U_1 \left(k_{12} - \frac{k_{11}k_{22}}{k_{21}}\right)^{-1}}$$

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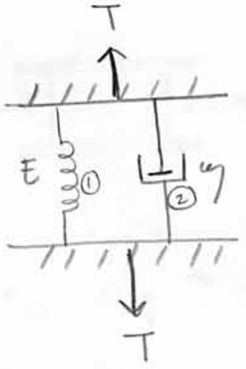
(2)



$+$

e

$-$

$e = e_1 = e_2$

$T = T_1 + T_2$

a) ① $T_1 = Ee$ ② $T_2 = \eta \frac{de}{dt}$

$$\boxed{T = Ee + \eta \frac{de}{dt}}$$

b) periodic stress $T(t) = T_o \cos(\omega t)$

output : $\hat{e}(t) = \hat{e}_o \cos(\omega t)$

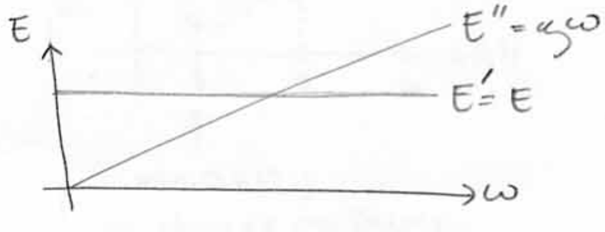
→ frequency domain : replace $\frac{d}{dt} \to j\omega$ where $j = \sqrt{-1}$

$$T = Ee + \eta \frac{de}{dt}$$

$$T_o = E\hat{e}_o + \eta\, \hat{e}_o (j\omega)$$

$$\frac{T_o}{\hat{e}_o} = E + \eta (j\omega) \qquad \boxed{\therefore E' = E, \quad E'' = \eta\omega}$$

c)



As $\omega \to 0$, the dashpot is not felt and the spring dominates ($E' = E$).
As $\omega \to \infty$, the dashpot does not have time to deform
and acts like a solid ($E'' \to \infty$).