Bioen 326 2014 MIDTERM

Covers: Weeks 1-4, FBD, stress/strain, stress analysis, rods and beams (not deflections).

Rules: Closed Book Exam: Please put away all notes and electronic devices

Reminders:

- Show equations you use to answer questions. Even if your final answer is wrong, we give **partial credit** for the various steps needed to solve a problem, but we can't do this if you don't write the equations you used.
- We give **extra credit** if you realize your final answer is wrong and explain why, even if you do not have time to go back and find and fix the error. Since this can partially or fully make up for the mistake (depending on the type of mistake), I advise that you don't go back to fix until you finish the rest of the exam. Even then, don't erase what you have, but use the extra sheet and then cross out the first once you finish successfully, or you may run out of time and have erased your points.

Equations Provided on the Exam:

The following equations are provided on this cover sheet for the exam. It is your responsibility to known how to use them.

- $F_R = \int F_d(x)dx$ or $F_R = \int F_d(\vec{r})d\vec{r}$
- $x_R = \frac{\int xF_d(x)dx}{F_R}$, or $x_R = \frac{\int xF_d(\vec{r})d\vec{r}}{F_R}$
- $y_{COM} =$
- $\sigma_{av} = \frac{\sigma_x+\sigma_y}{2}$
- $R = \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + \tau^2}$
- $\sigma_{x\theta} = \sigma_{av} + \frac{\sigma_x-\sigma_y}{2}\cos(2\theta) + \tau\sin(2\theta)$
- $\tau_\theta = -\frac{\sigma_x-\sigma_y}{2}\sin(2\theta) + \tau\cos(2\theta)$
- $\sigma_{1,2} = \sigma_{av} \pm R$
- $\tau_{MAX} = R$
- $\epsilon_x = \frac{1}{E}\sigma_x - \frac{\nu}{E}\sigma_y - \frac{\nu}{E}\sigma_z$
- $\gamma_{xy} = \frac{1}{G}\tau_{xy} = \frac{2(1+\nu)}{E}\tau_{xy}$
- $\sigma_x = \frac{E}{(1+\nu)(1-2\nu)}((1-\nu)\epsilon_x + \nu\epsilon_y + \nu\epsilon_z)$
- $\tau_{xy} = G\gamma_{xy} = \frac{E}{2(1+\nu)}\gamma_{xy}$
- $e = \frac{\Delta V}{V_0} = \epsilon_x + \epsilon_y + \epsilon_z$
- $e = \frac{1-2\nu}{E}(\sigma_x + \sigma_y + \sigma_z)$
- $\delta = \int_0^L \frac{N(x)}{E(x)A(x)}dx$
- $k_a = \frac{EA}{L}$; $F = k_a\delta$
- $k_t = \frac{GI_p}{L}$; $T = k_t\phi$
- $\int_A y^2 dA = I$
- $I = \frac{\pi}{4}r^4$
- $I = \frac{H^3W}{12}$
- $I = \frac{H^3W}{36}$, (neutral plane is at H/3 from flat edge).
- $\int_A r^2 dA = I_p$
- $I_p = \frac{\pi}{2}r^4$
- $\kappa = M/EI$
- $\sigma_x = N/A$
- $\tau(r) = \frac{T}{I_p}(r)$
- $\sigma_x(x,y) = -\frac{M(x)}{I}y$
- $\tau_{xy}(x,y) = \frac{V(x)}{2I}\left(\frac{H^2}{4} - y^2\right)$, $\max\left(\tau_{xy}(x)\right) = \frac{3V(x)}{2A}$
- $\max\left(\tau_{xy}(x)\right) = \frac{4V(x)}{3A}$
- $\max\left(\tau_{xy}(x)\right) = \frac{4V(x)}{3A}\frac{(r_2^2+r_2r_1+r_1^2)}{r_2^2+r_1^2}$

If you need more room, please use one of the extra pages and indicate here: continued on page ____________