$$\left\{\begin{array}{c}\epsilon_{xx}\\ \epsilon_{yy}\\ \epsilon_{zz}\\ \gamma_{xy}\\ \gamma_{xz}\\ \gamma_{yz}\end{array}\right\} = \frac{1}{E}\left[\begin{array}{cccccc}1 & -\nu & -\nu & 0 & 0 & 0\\ -\nu & 1 & -\nu & 0 & 0 & 0\\ -\nu & -\nu & 1 & 0 & 0 & 0\\ 0 & 0 & 0 & 2(1+\nu) & 0 & 0\\ 0 & 0 & 0 & 0 & 2(1+\nu) & 0\\ 0 & 0 & 0 & 0 & 0 & 2(1+\nu)\end{array}\right]\left\{\begin{array}{c}\sigma_{xx}\\ \sigma_{yy}\\ \sigma_{zz}\\ \tau_{xy}\\ \tau_{xz}\\ \tau_{yz}\end{array}\right\}$$

$$\left\{\begin{array}{c}\sigma_{xx}\\ \sigma_{yy}\\ \sigma_{zz}\\ \tau_{xy}\\ \tau_{xz}\\ \tau_{yz}\end{array}\right\} = \frac{E}{(1+\nu)(1-2\nu)}\left[\begin{array}{cccccc}1-\nu & \nu & \nu & 0 & 0 & 0\\ \nu & 1-\nu & \nu & 0 & 0 & 0\\ \nu & \nu & 1-\nu & 0 & 0 & 0\\ 0 & 0 & 0 & \frac{1-2\nu}{2} & 0 & 0\\ 0 & 0 & 0 & 0 & \frac{1-2\nu}{2} & 0\\ 0 & 0 & 0 & 0 & 0 & \frac{1-2\nu}{2}\end{array}\right]\left\{\begin{array}{c}\epsilon_{xx}\\ \epsilon_{yy}\\ \epsilon_{zz}\\ \gamma_{xy}\\ \gamma_{xz}\\ \gamma_{yz}\end{array}\right\}$$

$$\left\{\begin{array}{c}\epsilon_{xx}\\ \epsilon_{yy}\\ \gamma_{xy}\end{array}\right\} = \frac{1}{E}\left[\begin{array}{ccc}1 & -\nu & 0\\ -\nu & 1 & 0\\ 0 & 0 & 2(1+\nu)\end{array}\right]\left\{\begin{array}{c}\sigma_{xx}\\ \sigma_{yy}\\ \tau_{xy}\end{array}\right\}$$

$$\left\{\begin{array}{c}\sigma_{xx}\\ \sigma_{yy}\\ \tau_{xy}\end{array}\right\} = \frac{E}{(1-\nu^2)}\left[\begin{array}{ccc}1 & \nu & 0\\ \nu & 1 & 0\\ 0 & 0 & \frac{(1-\nu)}{2}\end{array}\right]\left\{\begin{array}{c}\epsilon_{xx}\\ \epsilon_{yy}\\ \gamma_{xy}\end{array}\right\}$$

$$\underset{\sim}{\rho_n} = \underset{\sim}{\sigma}\underset{\sim}{N} \qquad \sigma_n = \underset{\sim}{\rho_n}\cdot\underset{\sim}{N} \qquad \tau_n = \sqrt{|\underset{\sim}{\rho_n}|^2 - \sigma_n^2}$$

$$\epsilon_{xy} = \frac{1}{2}\gamma_{xy} \qquad \epsilon_{nn} = \underset{\sim}{N}^T\underset{\sim}{\epsilon}\underset{\sim}{N} \qquad \epsilon_{sn} = \underset{\sim}{S}^T\underset{\sim}{\epsilon}\underset{\sim}{N}$$

$$\sigma_n = \frac{\sigma_{xx}+\sigma_{yy}}{2} + \left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)\cos 2\alpha + \tau_{xy}\sin 2\alpha$$

$$\epsilon_{volum.} = \epsilon_{xx}+\epsilon_{yy}+\epsilon_{zz} = \frac{1-2\nu}{E}tr(\underset{\sim}{\sigma})$$

$$\tau_n = -\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)\sin 2\alpha + \tau_{xy}\cos 2\alpha$$

$$\epsilon_{x'x'} = \frac{\epsilon_{xx}+\epsilon_{yy}}{2} + \left(\frac{\epsilon_{xx}-\epsilon_{yy}}{2}\right)\cos 2\theta + \epsilon_{xy}\sin 2\theta$$

$$\sigma_e^3 - I_1\sigma_e^2 + I_2\sigma_e - I_3 = 0 \qquad \epsilon_e^3 - J_1\epsilon_e^2 + J_2\epsilon_e - J_3 = 0$$

$$I_1 = tr(\underset{\sim}{\sigma}) \qquad I_3 = \det(\underset{\sim}{\sigma}) \qquad J_1 = tr(\underset{\sim}{\epsilon}) \qquad J_3 = \det(\underset{\sim}{\epsilon})$$

$$I_2 = \left|\begin{array}{cc}\sigma_{xx} & \tau_{xy}\\ \tau_{xy} & \sigma_{yy}\end{array}\right| + \left|\begin{array}{cc}\sigma_{xx} & \tau_{xz}\\ \tau_{xz} & \sigma_{zz}\end{array}\right| + \left|\begin{array}{cc}\sigma_{yy} & \tau_{yz}\\ \tau_{yz} & \sigma_{zz}\end{array}\right|$$

$$J_2 = \left|\begin{array}{cc}\epsilon_{xx} & \epsilon_{xy}\\ \epsilon_{xy} & \epsilon_{yy}\end{array}\right| + \left|\begin{array}{cc}\epsilon_{xx} & \epsilon_{xz}\\ \epsilon_{xz} & \epsilon_{zz}\end{array}\right| + \left|\begin{array}{cc}\epsilon_{yy} & \epsilon_{yz}\\ \epsilon_{yz} & \epsilon_{zz}\end{array}\right|$$

$$\sigma_{1,3} = \frac{\sigma_{xx}+\sigma_{yy}}{2} \pm \sqrt{\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

$$\epsilon_{1,3} = \frac{\epsilon_{xx}+\epsilon_{yy}}{2} \pm \sqrt{\left(\frac{\epsilon_{xx}-\epsilon_{yy}}{2}\right)^2 + \epsilon_{xy}^2}$$

$$\tau_{max} = \left|\frac{\sigma_1-\sigma_3}{2}\right| = \sqrt{\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

$$\gamma_{max} = |\epsilon_1-\epsilon_3| = 2\sqrt{\left(\frac{\epsilon_{xx}-\epsilon_{yy}}{2}\right)^2 + \epsilon_{xy}^2}$$

$$\underset{\sim}{\sigma} = \underset{\sim}{\sigma}_h + \underset{\sim}{\sigma}_d \qquad tr(\underset{\sim}{\sigma}_d) = 0 \qquad \underset{\sim}{\sigma}_h = \left[\begin{array}{ccc}p & 0 & 0\\ 0 & p & 0\\ 0 & 0 & p\end{array}\right] \qquad \underset{\sim}{\sigma}_d = \left[\begin{array}{ccc}\sigma_{xx}-p & \tau_{xy} & \tau_{xz}\\ \tau_{xy} & \sigma_{yy}-p & \tau_{yz}\\ \tau_{yz} & 0 & \sigma_{zz}-p\end{array}\right]$$

$$\sigma_x = \frac{N}{S} + \frac{M_z y}{I_z} - \frac{M_y z}{I_y} \qquad \tau_{xy} = \frac{QM_s}{tI_z} \qquad \tau = \frac{T\rho}{J}$$