Prob. 1 The same stress state as HW10 Prob. 2: $\sigma_{xx} = \sigma_x = 30$, $\sigma_{yy} = \sigma_y = -18$, $\sigma_{zz} = \sigma_z = -36$, $\sigma_{xy} = \tau_{xy} = 36$, $\sigma_{yz} = \tau_{yz} = 24$, and $\sigma_{zx} = \tau_{zx} = 12$ (All in MPa). Determine the principal strains by using two different methods.

Method 1
a) Determine the 3D strains under $x$-$y$-$z$ system using 3D Hooke’s law (for isotropic materials), Young’s modulus = 200 GPa, and Poisson’s ratio = 0.29.
b) Determine the three principal strains using the strains obtained in a).
c) Determine the direction of the first principal strain and compare with the result in HW10 Prob. 2 (c).

Method 2
d) Determine the three principal strains using the same 3D Hooke’s law as in a) and the principal stresses obtained in HW10 Prob. 2 (They are $\sigma_1 = 54.72\, Mpa$, $\sigma_2 = -24.17\, Mpa$, and $\sigma_3 = -54.53\, Mpa$).
e) Compare the results of the two methods, b) and d).

Prob. 2 The square plate shown in Fig. 1 is loaded so that the plate is in a state of plane strain ($\varepsilon_{zz} = \varepsilon_{zx} = \varepsilon_{zy} = 0$)

a) Determine the strain components of the point O for the $x$-$y$ coordinate system.
b) Determine the normal strains of the point O for the $(X, Y)$ system with a rotation $\theta = \pi/6$.
c) Determine the principal directions and the principal strains.