Prob. 11.2

(a) Write out the compliance matrix **S** of Eqn. 11.3 for polycarbonate using data in the Module on Material Properties.

Digits:=4;with(linalg);

S:=matrix(6,6,[[1/E, -nu/E, -nu/E, 0, 0, 0], [-nu/E,1/E, -nu/E, 0,0 ,0],

[-nu/E, -nu/E, 1/E, 0,0 ,0],[0,0,0, 1/G,0 ,0], [0,0,0, 0,1/G,0], [0,0,0,0 ,0, 1/G]]);

$$
S := \begin{vmatrix}
\dfrac{1}{E} & -\dfrac{\nu}{E} & -\dfrac{\nu}{E} & 0 & 0 & 0 \\
-\dfrac{\nu}{E} & \dfrac{1}{E} & -\dfrac{\nu}{E} & 0 & 0 & 0 \\
-\dfrac{\nu}{E} & -\dfrac{\nu}{E} & \dfrac{1}{E} & 0 & 0 & 0 \\
0 & 0 & 0 & \dfrac{1}{G} & 0 & 0 \\
0 & 0 & 0 & 0 & \dfrac{1}{G} & 0 \\
0 & 0 & 0 & 0 & 0 & \dfrac{1}{G}
\end{vmatrix}
$$

unprotect(E); E:=2.7e9; G:=.97e9; nu:=.42;

$$E := .27 \ 10^{10}$$

$$G := .97 \ 10^{9}$$

$$\nu := .42$$

S2:=map(eval,S);

$$
S2 := \begin{vmatrix}
.3704 \ 10^{-9} \, , & -.1556 \ 10^{-9} \, , & -.1556 \ 10^{-9} \, , & 0 \, , & 0 \, , & 0 \\
-.1556 \ 10^{-9} \, , & .3704 \ 10^{-9} \, , & -.1556 \ 10^{-9} \, , & 0 \, , & 0 \, , & 0 \\
-.1556 \ 10^{-9} \, , & -.1556 \ 10^{-9} \, , & .3704 \ 10^{-9} \, , & 0 \, , & 0 \, , & 0 \\
0 \, , & 0 \, , & 0 \, , & .1031 \ 10^{-8} \, , & 0 \, , & 0 \\
0 \, , & 0 \, , & 0 \, , & 0 \, , & .1031 \ 10^{-8} \, , & 0 \\
0 \, , & 0 \, , & 0 \, , & 0 \, , & 0 \, , & .1031 \ 10^{-8}
\end{vmatrix}
$$

(b) Use matrix inversion to obtain the stiffness matrix **D.**

unprotect(D);D:=inverse(S2);

$$D := \begin{vmatrix} .6901 \ 10^{10}\,, & .5000 \ 10^{10}\,, & .5000 \ 10^{10}\,, & 0\,, & 0\,, & 0 \\ .5000 \ 10^{10}\,, & .6902 \ 10^{10}\,, & .5000 \ 10^{10}\,, & 0\,, & 0\,, & 0 \\ .5000 \ 10^{10}\,, & .5000 \ 10^{10}\,, & .6901 \ 10^{10}\,, & 0\,, & 0\,, & 0 \\ 0\,, & 0\,, & 0\,, & .9699 \ 10^{9}\,, & 0\,, & 0 \\ 0\,, & 0\,, & 0\,, & 0\,, & .9699 \ 10^{9}\,, & 0 \\ 0\,, & 0\,, & 0\,, & 0\,, & 0\,, & .9699 \ 10^{9} \end{vmatrix}$$

(c) Use matrix multiplication to obtain the stresses needed to induce the strains

epsilon:=matrix(6,1,[.02,0,.03,.01,.025,0]);

$$\varepsilon := \begin{vmatrix} .02 \\ 0 \\ .03 \\ .01 \\ .025 \\ 0 \end{vmatrix}$$

sigma=evalm(D &* epsilon);

$$\sigma = \begin{vmatrix} .2880 \ 10^{9} \\ .2500 \ 10^{9} \\ .3070 \ 10^{9} \\ .9699 \ 10^{7} \\ .2425 \ 10^{8} \\ 0 \end{vmatrix}$$