PROBLEM 1.16 DETERMINE THE STRESS MATRIX IF THE MODULUS OF ELASTICITY IS 30MPSI, POISSON'S RATIO IS 0.3, AND THE STRAIN MATRIX IS

$$[\epsilon] = \begin{bmatrix} \epsilon_x & \gamma_{xy} & \gamma_{zx} \\ \gamma_{xy} & \epsilon_y & \gamma_{yz} \\ \gamma_{zx} & \gamma_{yz} & \epsilon_z \end{bmatrix} = \begin{bmatrix} 5 & -2 & 3 \\ -2 & -3 & 1 \\ 3 & 1 & 2 \end{bmatrix} \times 10^{-4}$$

GIVEN:
1. MODULUS 30MSI
2. POISSON'S RATIO 0.3
3. STRAIN STATE GIVEN

ASSUMPTIONS:
1. ISOTROPIC, LINEAR ELASTIC MATERIAL
2.

FIND:
1. STRESS MATRIX

SOLUTION:

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{yz} \\ \gamma_{xz} \\ \gamma_{xy} \end{Bmatrix} = \begin{bmatrix} 1/E & -\nu/E & -\nu/E & 0 & 0 & 0 \\ -\nu/E & 1/E & -\nu/E & 0 & 0 & 0 \\ -\nu/E & -\nu/E & 1/E & 0 & 0 & 0 \\ 0 & 0 & 0 & 2(1+\nu)/E & 0 & 0 \\ 0 & 0 & 0 & 0 & 2(1+\nu)/E & 0 \\ 0 & 0 & 0 & 0 & 0 & 2(1+\nu)/E \end{bmatrix} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{yz} \\ \tau_{xz} \\ \tau_{xy} \end{Bmatrix}$$

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{yz} \\ \gamma_{xz} \\ \gamma_{xy} \end{Bmatrix} = \begin{bmatrix} 33.33(10^{-9}) & -10.0(10^{-9}) & -10.0(10^{-9}) & 0 & 0 & 0 \\ -10.0(10^{-9}) & 33.33(10^{-9}) & -10.0(10^{-9}) & 0 & 0 & 0 \\ -10.0(10^{-9}) & -10.0(10^{-9}) & 33.33(10^{-9}) & 0 & 0 & 0 \\ 0 & 0 & 0 & 86.67(10^{-9}) & 0 & 0 \\ 0 & 0 & 0 & 0 & 86.67(10^{-9}) & 0 \\ 0 & 0 & 0 & 0 & 0 & 86.67(10^{-9}) \end{bmatrix} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{yz} \\ \tau_{xz} \\ \tau_{xy} \end{Bmatrix}$$

$$\{\epsilon\} = [S] \cdot \{\sigma\} \Rightarrow \{\sigma\} = [S]^{-1}\{\epsilon\} = \{\sigma\} = [C]\{\epsilon\}$$

$$\sigma = \begin{Bmatrix} 18.46 \\ 0 \\ 11.54 \\ 1.154 \\ 3.46 \\ -2.31 \end{Bmatrix} \text{ksi} \qquad \epsilon = \begin{Bmatrix} 5 \\ -3 \\ 2 \\ 1 \\ 3 \\ -2 \end{Bmatrix} \times 10^{-4}$$

"Advanced Strength and Stress Analysis," 2nd ed., Budynas, Problem 1.16: Determine the stress matrix if the modulus of elasticity is 30 Msi, Poissons ratio is 0.3, and the strain matrix is [5, -2, 3; -2, -3, 1; 3, 1, 2] x10-4.

E= 3.00E+07 **nu=** 0.3

	Strain									**Stress**	
e_x			3.33E-08	-1.00E-08	-1.00E-08	0	0	0			s_x
e_y			-1.00E-08	3.33E-08	-1.00E-08	0	0	0			s_y
e_z		"="	-1.00E-08	-1.00E-08	3.33E-08	0	0	0	x		s_z
e_{zy}			0	0	0	8.67E-08	0	0			s_{zy}
e_{zx}			0	0	0	0	8.67E-08	0			s_{zx}
e_{xy}			0	0	0	0	0	8.67E-08			s_{xy}

	Stress									**Strain**	
s_x	1.8462E+04		40384615	17307692	17307692	0	0	0		5.00E-04	e_x
s_y	2.7285E-12		17307692	40384615	17307692	0	0	0		-3.00E-04	e_y
s_z	1.1538E+04	"="	17307692	17307692	40384615	0	0	0	x	2.00E-04	e_z
s_{zy}	1.1538E+03		0	0	0	11538462	0	0		1.00E-04	e_{zy}
s_{zx}	3.4615E+03		0	0	0	0	11538462	0		3.00E-04	e_{zx}
s_{xy}	-2.3077E+03		0	0	0	0	0	11538462		-2.00E-04	e_{xy}

```
>> S=[33.33 -10 -10 0 0 0
-10 33.33 -10 0 0 0
-10 -10 33.33 0 0 0
0 0 0 86.67 0 0
0 0 0 0 86.67 0
0 0 0 0 0 86.67]*1e-9

S =

  1.0e-007 *

    0.3333   -0.1000   -0.1000         0         0         0
   -0.1000    0.3333   -0.1000         0         0         0
   -0.1000   -0.1000    0.3333         0         0         0
         0         0         0    0.8667         0         0
         0         0         0         0    0.8667         0
         0         0         0         0         0    0.8667

>> C=inv(S)

C =

  1.0e+007 *

    4.0392    1.7313    1.7313         0         0         0
    1.7313    4.0392    1.7313         0         0         0
    1.7313    1.7313    4.0392         0         0         0
         0         0         0    1.1538         0         0
         0         0         0         0    1.1538         0
         0         0         0         0         0    1.1538

>> Strain=[5 -3 2 1 3 -2]*1e-4

Strain =

  1.0e-003 *

    0.5000   -0.3000    0.2000    0.1000    0.3000   -0.2000

>> Stress=C*Strain'

Stress =

  1.0e+004 *

    1.8465
    0.0002
    1.1541
    0.1154
    0.3461
   -0.2308
```