1/Starting with the stress tensor given in Problem 2.1 from Budynas, 2nd ed.

$$[\sigma] = \begin{bmatrix} 0 & -30 & 25 \\ -30 & -40 & -15 \\ 25 & -15 & 10 \end{bmatrix} MPa$$

The stress cube was first rotated 45° about the x-axis and then -45° about the z-axis. The resulting stress tensor is

$$[\sigma]_{x'y'z'} = \begin{bmatrix} -11.46 & 15.00 & 9.82 \\ 15.00 & -18.54 & 45.18 \\ 9.82 & 45.18 & 0 \end{bmatrix} MPa$$

Given the material is steel (E=200GPa, υ=0.3), determine the initial engineering strain tensor and the engineering strain tensor after transformation.

SOLUTION:

```
>> Sig=[0 -40 10 -15 25 -30]'*1e6
Sig =
         0
  -40000000
   10000000
  -15000000
   25000000
  -30000000

>> Sig_xyz=[-11.46 -18.54 0 45.18 9.82 15]'*1e6
Sig_xyz =
  -11460000
  -18540000
         0
   45180000
    9820000
   15000000
```

```
>> Scomp=[1/200e9 -.3/200e9 -.3/200e9 0 0 0;
        -.3/200e9 1/200e9 -.3/200e9 0 0 0;
        -.3/200e9 -.3/200e9 1/200e9 0 0 0;
         0 0 0 2*(1+.3)/200e9 0 0;
         0 0 0 0 2*(1+.3)/200e9 0;
         0 0 0 0 0 2*(1+.3)/200e9]

Scomp =  1.0e-010 *
   0.0500   -0.0150   -0.0150         0         0         0
  -0.0150    0.0500   -0.0150         0         0         0
  -0.0150   -0.0150    0.0500         0         0         0
        0         0         0    0.1300         0         0
        0         0         0         0    0.1300         0
        0         0         0         0         0    0.1300

>> e=Scomp*Sig
e =  1.0e-003 *
   0.0450
  -0.2150
   0.1100
  -0.1950
   0.3250
  -0.3900
```

$$[\varepsilon]_{eng} = \begin{bmatrix} 45 & -390 & 325 \\ -390 & -215 & -195 \\ 325 & -195 & 110 \end{bmatrix} \mu\varepsilon \quad [\varepsilon] = \begin{bmatrix} 45 & -195 & 162 \\ -195 & -215 & -98 \\ 162 & -98 & 110 \end{bmatrix} \mu\varepsilon$$

```
>> e_xyz=Scomp*Sig_xyz
e_xyz =  1.0e-003 *
  -0.0295
  -0.0755
   0.0450
   0.5873
   0.1277
   0.1950
```

$$[\varepsilon_{x'y'z'}]_{eng} = \begin{bmatrix} -30 & 195 & 128 \\ 195 & -76 & 587 \\ 128 & 587 & 45 \end{bmatrix} \mu\varepsilon \quad [\varepsilon_{x'y'z'}] = \begin{bmatrix} -30 & 98 & 64 \\ 98 & -76 & 294 \\ 64 & 294 & 45 \end{bmatrix} \mu\varepsilon$$