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Problem 1: 2.20 from the text

```
%Find Symbolic Rotation Matrix
syms phi th psi %create sybolic variables for phi, theta, and psi
Rz_phi = [...
    cos(phi)    sin(phi)    0;...
    -sin(phi)   cos(phi)    0;...
    0           0           1]; %from XYZ to X'Y'Z'

Rx_th = [...
    1       0           0;...
    0       cos(th)    sin(th);...
    0       -sin(th)   cos(th)]; %from X'Y'Z' to X"Y"Z"

Rz_psi = [...
    cos(psi)    sin(psi)    0;...
    -sin(psi)   cos(psi)    0;...
    0           0           1]; %from X"Y"Z" to xyz

R = Rz_psi*Rx_th*Rz_phi %find overall rotation matrix

%Evaluate R at given angles
R_eval = eval(subs(R,[phi, th, psi], [pi/6, pi/4, -pi/3]))

%Find coordinates in XYZ of point r = -5i + 3j in xyz
r_xyz = [-5; 3; 0];
r_XYZ = R_eval.'*r_xyz
```

```
R =

[   cos(phi)*cos(psi) - cos(th)*sin(phi)*sin(psi), cos(psi)*sin(phi) +
 cos(phi)*cos(th)*sin(psi), sin(psi)*sin(th)]
[ - cos(phi)*sin(psi) - cos(psi)*cos(th)*sin(phi),
 cos(phi)*cos(psi)*cos(th) - sin(phi)*sin(psi), cos(psi)*sin(th)]
[                                sin(phi)*sin(th),
         -cos(phi)*sin(th),          cos(th)]


R_eval =

    0.7392   -0.2803   -0.6124
    0.5732    0.7392    0.3536
```

```
    0.3536   -0.6124    0.7071
```

```
r_XYZ =

   -1.9763
    3.6192
    4.1225
```

Problem 2

```
RV = calc_R('z', 40);
RE = calc_R('x', 20);
RN = calc_R('y', 10);

R = RN*RE*RV;
a_env = [0; 0.5; -2]; %all times g
a_ENV = R.'*a_env
```

```
a_ENV =

   -1.0011
    0.6527
   -1.6798
```

Problem 3

```
X_prime = [1 0 0];
x = [-50 20 0];
phi = acos(dot(X_prime,x)/(norm(X_prime)*norm(x)))*180/pi;
R_Zprime = calc_R('z', phi);
r_B_A = [-50 20 0];
r_C_A = [-50 0 40];
ABC_perp_p = cross(r_B_A, r_C_A);
ABC_perp_pp = R_Zprime*ABC_perp_p.';
Z_pp = [0;0;1];
theta = acos(dot(ABC_perp_pp,Z_pp)/
(norm(ABC_perp_pp)*norm(Z_pp)))*180/pi;
R_Xpp = calc_R('x',theta);
R = R_Xpp*R_Zprime
r_O_A = R*[-50;0;0]
```

```
R =

   -0.9285    0.3714         0
   -0.1564   -0.3910    0.9070
    0.3369    0.8422    0.4211
```

```
r_O_A =

   46.4238
    7.8192
  -16.8430
```

Problem 4

```
R_Z = calc_R('z',40);
theta = acos((cosd(43.96))/cosd(40))*180/pi;
R_Yp = calc_R('y', theta);
R = R_Yp*R_Z
```

```
R =

    0.7198    0.6040   -0.3421
   -0.6428    0.7660         0
    0.2621    0.2199    0.9397
```

Problem 5

```
R1 = calc_R('z', atan(3/2)*180/pi);
R2 = calc_R('y', 45);
R3 = R1.';
r_CA_IV = [0;2;1];
r_CA = R1'*R2'*R3'*r_CA_IV;
r_A = [3;0;0];
r_C = r_A + r_CA
```

```
r_C =

    3.1219
    2.1828
   -0.4696
```

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