```
clear;
clc;

filename = 'BMEG_330_April_2_OOP_4_FILTERED.csv';
headerLines = 24;
g_to_mps2 = 9.81;
sampleRate = 10000;
dt = 1 / sampleRate;

%% Filter
cutoffFreq = 50;
filterOrder = 4;
[b, a] = butter(filterOrder, cutoffFreq/(sampleRate/2), 'low');

%% Load data
opts = detectImportOptions(filename, 'NumHeaderLines', headerLines);
data = readtable(filename, opts);

time = data{:,1};
acc_raw = data{:,2:10};
acc_mps2 = acc_raw * g_to_mps2;

%% Filter
acc_filtered = filtfilt(b, a, acc_mps2);

% Centre of Gravity: COGX, COGY, COGZ
COG = acc_filtered(:, 1:3);

% Anterior: ANTY, ANTZ
ANT = [acc_filtered(:,4), acc_filtered(:,5)];

% Lateral: LATX
LAT = acc_filtered(:,6);

% Superior: SUPX, SUPY
SUP = [acc_filtered(:,8), acc_filtered(:,9)];

%% Plot
figure;
subplot(4,1,1)
plot(time, COG)
title('Center of Gravity (COG) Acceleration')
xlabel('time (s)'); ylabel('acceleration (m/s^2)')
legend({'COGX','COGY','COGZ'}, 'Location','eastoutside')

subplot(4,1,2)
plot(time, ANT)
title('Anterior Acceleration')
xlabel('time (s)'); ylabel('acceleration (m/s^2)')
```

```
legend({'ANTY','ANTZ'}, 'Location','eastoutside')

subplot(4,1,3)
plot(time, LAT)
title('Lateral Acceleration')
xlabel('time (s)'); ylabel('acceleration (m/s^2)')
legend({'LATX'}, 'Location','eastoutside')

subplot(4,1,4)
plot(time, SUP)
title('Superior Acceleration')
xlabel('Time (s)'); ylabel('acceleration (m/s^2)')
legend({'SUPX','SUPY'}, 'Location','eastoutside')

sgtitle('Test 6: Acceleration of Sensors - downward offset')

%% find peak linear acceleration
peakLinearX = max(abs([COG(:,1); LAT; SUP(:,1)]));
peakLinearY = max(abs([COG(:,2); ANT(:,1); SUP(:,2)]));
peakLinearZ = max(abs([COG(:,3); ANT(:,2)]));

fprintf('\nPeak Linear Acceleration\n');
fprintf('X-direction: %.2f m/s²\n', peakLinearX);
fprintf('Y-direction: %.2f m/s²\n', peakLinearY);
fprintf('Z-direction: %.2f m/s²\n', peakLinearZ);

%% find rotational acceleration along the axis
% estimating distances (m) of sensors from COG
r_sup_cog = 0.10;
r_ant_cog = 0.12;

% a_x ( difference in Z accel between SUP and COG)
a_x = (SUP(:,2) - COG(:,2)) / r_sup_cog;

% a_y ( difference in Z accel between ANT and COG)
a_y = (ANT(:,2) - COG(:,3)) / r_ant_cog;

% a_z ( difference in Y accel between SUP and COG)
a_z = (SUP(:,1) - COG(:,1)) / r_sup_cog;

peakaX = max(abs(a_x));
peakaY = max(abs(a_y));
peakaZ = max(abs(a_z));

fprintf('\nRotational Acceleration\n');
fprintf('About X-axis: %.2f rad/s²\n', peakaX);
fprintf('About Y-axis: %.2f rad/s²\n', peakaY);
fprintf('About Z-axis: %.2f rad/s²\n', peakaZ);
```

```
%% Max linear acceleration and its direction
% linear acceleration vectors from COG
accVecs = COG;

% magnitudes at each point
accMags = vecnorm(accVecs, 2, 2);

% location of maximum magnitude
[peakLinearMag, idxMaxAcc] = max(accMags);

% direction as unit vector
maxAccDir = accVecs(idxMaxAcc, :) / peakLinearMag;

fprintf('\nmaximum Linear Acceleration: %.2f m/s²\n', peakLinearMag);
fprintf('unit vector: [%.3f, %.3f, %.3f]\n', maxAccDir);

%% max rotational acceleration
rotVecs = [a_x, a_y, a_z];
rotMags = vecnorm(rotVecs, 2, 2);
[peakRotMag, idxMaxRot] = max(rotMags);
maxRotDir = rotVecs(idxMaxRot, :) / peakRotMag;

fprintf('\nMax rotational acceleration: %.2f rad/s²\n', peakRotMag);
fprintf('rotation axis (unit vector): [%.3f, %.3f, %.3f]\n', maxRotDir);

%% force tranmission plot and rotational acceleration plot
mass = 80;
forceVecs = mass * COG;
forceMags = vecnorm(forceVecs, 2, 2);
rotVecs = [a_x, a_y, a_z];
rotProj = rotVecs * maxRotDir';
figure;

subplot(2,1,1)
plot(time, forceMags)
title('Force Transmission')
xlabel('time (s)'); ylabel('Force (N)')

subplot(2,1,2)
plot(time, rotProj)
title('Rotational Acceleration (About max rotation axis)')
xlabel('time (s)'); ylabel('Angular Acceleration (rad/s²)')

sgtitle('Trial 6: Force and Rotational Acceleration along True Direction')

%% max force transmission
[maxForce, idxMaxForce] = max(forceMags);
fprintf('\nMaximum force transmission: %.2f N\n', maxForce);
```