```
% GaussJordanRREF.m
%   "Gauss-Jordan Reduced Row Echelon Form"

clear all; clearvars; close all; clc;
format long;


% Constants
A = [15600, 18760, 17610, 19170];
B = [7540,   2750, 14630,   610];
C = [20140, 18610, 13480, 18390];
t = [0.07074, 0.07220, 0.07690, 0.07242];

c = 299792.458; % "Speed of Light" [km/sec]

MatrixA = [2*(A(2)-A(1)) 2*(B(2)-B(1)) 2*(C(2)-C(1)) -2*(c^2)*(t(2)-t(1));
           2*(A(3)-A(1)) 2*(B(3)-B(1)) 2*(C(3)-C(1)) -2*(c^2)*(t(3)-t(1));
           2*(A(4)-A(1)) 2*(B(4)-B(1)) 2*(C(4)-C(1)) -2*(c^2)*(t(4)-t(1))];

Matrixb = [-(A(1)^2-A(2)^2) - (B(1)^2-B(2)^2) - (C(1)^2-C(2)^2) + (c^2)*(t(1)^2-t(2)
^2);
           -(A(1)^2-A(3)^2) - (B(1)^2-B(3)^2) - (C(1)^2-C(3)^2) + (c^2)*(t(1)^2-t(3)
^2);
           -(A(1)^2-A(4)^2) - (B(1)^2-B(4)^2) - (C(1)^2-C(4)^2) + (c^2)*(t(1)^2-t(4)
^2)];

GJRREF = rref([MatrixA Matrixb])

%{
GJRREF =

   1.0e+04 *

   0.000100000000000                   0                   0  -0.001074917788137
-0.004173829537023
                   0   0.000100000000000                   0   0.062367719529478
-0.001878593770368
                   0                   0   0.000100000000000   8.378880714248918
0.610180417737350

%}

%{
% Equation 4.38 (#1):  Substitute x,y,z to obtain quadratic formula of
%   one (1) variable d
% f1 = (x-A(1))^2 + (y-B(1))^2 +(z-C(1))^2 - (c*(t(1)-d))^2

x =     10.74917788137 * d +  -41.73829537023;
y =   -623.67719529478 * d +  -18.78593770368;
```

```
z = -83788.80714248918 * d + 6101.80417737350;
%}

%{
*** Use Matlab "Symbolic" Toolbox (*** Command Window)
>> clear all; clearvars; close all; clc;
>> format long
>> syms d
>> c = 299792.458; % "Speed of Light" [km/sec]
>> f1 = ( ((10.74917788137 * d +  -41.73829537023) - 15600)^2 + ...
          ((-623.67719529478 * d +  -18.78593770368) - 7540)^2 + ...
          ((-83788.80714248918 * d + 6101.80417737350) - 20140)^2 - ...
          (c * (0.07074 - d))^2 )
>> vpa(expand(f1))       % Displays Quardratic Eqn with real coefficients
                         %   instead of ratios

% Quadratic Eqn in terms of d:
-82854564582.531752408189817691143*d^2
    + 15077167846.761892504574543743006*d
    + 49119806.640944939363509095287271
%}

% Two (2) Solutions:
%d1 = ( -b + sqrt(b^2 - 4ac) ) / (2a)
d1 = ( (-15077167846.761892504574543743006 + sqrt(15077167846.761892504574543743006^2 ↙
- 4*(-82854564582.531752408189817691143)*(49119806.640944939363509095287271))) / (2 * ↙
(-82854564582.531752408189817691143) ) )

%d2 = ( -b - sqrt(b^2 - 4ac) ) / (2a)
d2 = ( (-15077167846.761892504574543743006 - sqrt(15077167846.761892504574543743006^2 ↙
- 4*(-82854564582.531752408189817691143)*(49119806.640944939363509095287271))) / (2 * ↙
(-82854564582.531745337631705576475) ) )

%{
x1 =     10.74917788137 * d1 +  -41.73829537023
y1 =   -623.67719529478 * d1 +  -18.78593770368
z1 = -83788.80714248918 * d1 + 6101.80417737350

x2 =     10.74917788137 * d2 +  -41.73829537023
y2 =   -623.67719529478 * d2 +  -18.78593770368
z2 = -83788.80714248918 * d2 + 6101.80417737350

% 1st Solution (*** Verifies GPS Receiver Location via
%                       Quadratic Eqn and Quadratic Formula)
x1 = -41.772709570831225
y1 = -16.789194106527130
z1 = 6.370059559223346e+03

% 2nd Solution (*** NOT RELEVANT ***)
```

```
x2 = -39.747837348160374
y2 = -1.342741443606676e+02
z2 = -9.413624553735761e+03
%}
```