PNA B
Problem Set 1

1A. Contrast is defined as the simple subtractive difference in signal between two features, e.g., |White Matter – Gray Matter| signal. Using the canonical equation describing signal intensity in a spin echo MRI study, $SI = kM\rho(1 - e^{-tr/T1})e^{-te/T2}$, find the combination of *tr* and *te* that yields the maximum contrast. Assume that the values for T1 and T2 are as shown below and that the proton density, ρ. is the same for both tissues:

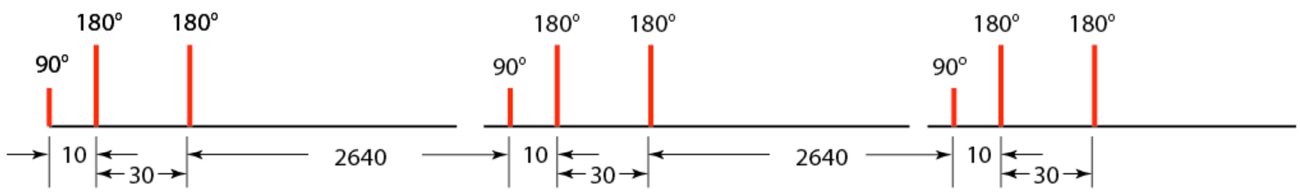
	T1	T2
Gray Matter	1300 ms	70 ms
White Matter	1500	85
CSF	2300	200

1B. Find a second maximum where the contrast is inverted (gray matter > white matter vs. white matter > gray matter)

1C. Make a plot of the combinations of tr and te where the signals from these tissues are isointense.

2A. Use matlab to make graphs of the longitudinal and transverse magnetization for gray matter and white matter that take place with the following RF pulse train:

repeat 3 times: [90° - 10 ms – 180° - 30 ms – 180° - 2640 ms]



Assume that the sample starts at magnetic equilibrium (fully magnetized).

2B. Do the same with this RF sequence (btw – this is a "FLAIR" sequence):

repeat 3 times: [180° - 1500 ms – 90° - 30 ms – 180° - 4500 ms]

This plot for a [90° - 1500 ms] sequence may help you get started:

```
T1g = 1300; % Set grey matter T1
T2g = 70;   % white matter T1
tr = 1500;
step = 4; % I have decided to go in 4 ms steps
% in this loop, create an array of time, Mz and Mxy
for T = 0:step:3*tr    % go for three tr's
    t = mod(T,tr);  % modulus function counts from 0 to tr
    Mz = 1-exp(-t/T1g); % longitudinal magnetization
    Mxy = (1-exp(-tr/T1g)) * exp(-t/T2g);    % why?
    i = T/step + 1; % array indexing must be integers from 1
    S(i,:) = [T, Mz, Mxy];
end
% make separate plots of Mz and Mxy
subplot(2,1,1);
plot(S(:,1),S(:,2)); % time vs. Mz
subplot(2,1,2);
plot(S(:,1),S(:,3)); % time vs Mxy
```