EECS 360
Discrete Fourier Transform

Using the FFT algorithm in Matlab answer the given questions concerning the following discrete time signals:

$x_a(n)$	=	$10 \sin Bn$	$0 \le n \le 255$ $B = 0.049087$
$x_b(n)$	=	$10 \sin Bn$	$0 \le n \le 200$ $B = 0.049087$
$x_c(n)$	=	0	$n=0$
	=	$10\left(1 - \frac{\lvert n - 32\rvert}{32}\right)$	$n = 1, \ldots 64$
	=	0	$n = 65, \ldots 127$
$x_d(n)$	=	0	$n = 0$
	=	$10\left(1 - \frac{\lvert n - 32\rvert}{32}\right)$	$n = 1, \ldots 64$
	=	0	$n = 65, \ldots 255$
$x_e(n)$	=	0	$n = 0$
	=	$10\left(1 - \frac{\lvert n - 16\rvert}{16}\right)$	$n = 1, \ldots 33$
	=	0	$n = 33, \ldots 127$
$x_f(n)$	=	0	$n=0$
	=	10	$n = 1, 49$
	=	0	$n = 50, \ldots 63$

Class 1: Use the FFT program to calculate the FFT of $x_a(n)$, $x_b(n)$, $x_c(n)$, $x_d(n)$, $x_e(n)$, and $x_f(n)$ and plot the magnitude of the resulting FFTs.

Class 2: Explain the difference between the FFT's of $x_a(n)$ and $x_b(n)$.

Class 3: Explain the differences between the FFT's of $x_c(n)$ and $x_d(n)$.

Class 4: Explain the differences between the FFT's of $x_c(n)$ and $x_e(n)$.

Class 5: If the sampling rate is 10,000 samples/sec., how long is the time record of $x_c(n)$ in seconds, what is the frequency resolution of the FFT in Hz, what is the highest frequency present in the FFT in Hz? Re-lable your graph of the magnitude of the FFT for $x_c(n)$ in Hz in assuming a sampling rate of 10,000 samples/sec.

Class 6: Form product of the FFT of $x_f(n)$ with itself, i.e.,

$$Y(m)=FFT[x_f(n)\,]FFT[x_f(n)]$$. Then take the inverse FFT of $Y(m)$.

a) Use Matlab conv function to find the discrete convolution of $x_f(n)$ with $x_f(n)$.
b) Comment on the relationship between the result of the inverse FFT of $Y(m)$ and the discrete convolution of $x_f(n)$ with $x_f(n)$ found using conv.
c) Pad $x_f(n)$ with N_{pad} zeros and then form product of the FFT of padded version of $x_f(n)$ with itself, i.e., $Y(m)=FFT[x_f(n)]\ FFT[x_f(n)]$. Then take the inverse FFT of $Y(m)$. Use a value of N_{pad} such that the inverse FFT of $Y(m)$ is the same the discrete convolution of $x_f(n)$ with $x_f(n)$ found using conv, i.e., the same as the result for part a).