EECS 361
Homework #3

1. Section 2.6 Participation activities
2.6.1: Energy or power signals?
2.6.2: Energy or power or neither?
2.6.3: Power and energy in sums of signals

2. (Concepts: signal power and energy)
Find the power and energy in $x(t) = 0.707\ \text{rect}\left(\frac{t-10}{4}\right)$

3. (Concepts: signal power and energy)
Determine if each of the following signals is a power signal, an energy signal or neither

a. $x_1(t) = 10(u(t)-u(t-6))$

b. $x_2(t) = -20\sin(100t-0.785)$

4. (Concept: Energy per bit)
In binary phase shift keying (BPSK) modulation a "1" bit is transmitted as $A\cos(2\pi f_c t)$ for a bit time T_b and a "0" bit sent as $-A\cos(2\pi f_c t)$ for a bit time T_b . Assume A = 100mV, a carrier frequency of f_c=100GHz, and a bit rate of 10Gb/s, find the energy used to transmit a bit, E_b. Hint: $f_c\ T_b$ is an integer, i.e., f_c * T_b=k where k is an integer.

5. (Concept: signal power of a radio frequency (RF) signal)
Find the power in $x_{RF}(t) = 10\cos(2\pi f_m t)\cos(2\pi f_c t)$; f_m = message frequency, f_c = carrier frequency.
Hint: $\cos(\alpha)\cos(\beta) = \frac{1}{2}(\cos(\alpha+\beta)+\cos(\alpha-\beta))$

6. Section 3.1 Participation activities
3.1.1: Properties of square function.
3.1.2: Linear or not?
3.1.5: Is the system time invariant?

7. (Concepts: Linearity and time invariance)
Specify if the following systems are linear and or time invariant.

a. $y(t) = 3x(t) - 1\ 1$

b. $y(t) = x^2(t)$

c. $y(t) = \int_{t-2}^{t+2} x(\tau)\, d\tau$

d. $y(t) = x(t) - 2x(t-1)$

e. $y(t) = tx^2(t)$

8. (Concept: Signal power)
Which of these signals have finite power.
a. $x_1(t) = \sin(10\,t)$
b. $x_2(t) = \text{rect}(t)$
c. $x_3(t) = u(t)$

9. (Concept: Signal energy)
Find the energy of $x(t) = 2*\text{rect}(t-0.5) - 1.0\ \text{rect}\left(\frac{t-2}{4}\right)$.
Hint: Plot x(t) and $x^2(t)$.

10. (Concept: Example of specific nonlinear systems generating new frequencies)
a. Let $y(t) = x^2(t)$. For $x(t)=A\cos(2\pi f_m t)$ find y(t). What frequencies are present in y(t)?
b. Let $z(t)=x^3(t)$. For $x(t)=A\cos(2\pi f_m t)$ find z(t). What frequencies are present in z(t)?
Hint: Trig identities:
$\cos^2\alpha = \frac{1}{2}(1 + \cos 2\alpha)$ and $\cos^3\alpha = \frac{1}{4}(3\cos\alpha + \cos 3\alpha)$