Problems for the 1st quiz

Name:_____ Student ID:_____ Score:_____

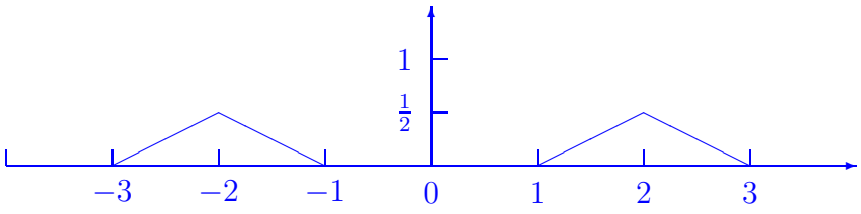
1. Let
$$\tilde{s}(t) = x(t) + jy(t) \quad \text{and} \quad s(t) = \text{Re}\{\tilde{s}(t)e^{j2\pi f_c}\},$$
where $x(t)$ and $y(t)$ are both real-valued signals.

   (a) (30%) Plot $S(f)$ if $f_c = 2$ and $\tilde{S}(f)$ is equal to
$$\tilde{S}(f) = \begin{cases} 1 - |f|, & |f| < 1; \\ 0, & \text{otherwise}, \end{cases}$$
   where $S(f)$ and $\tilde{S}(f)$ are respectively the Fourier transforms of $s(t)$ and $\tilde{s}(t)$.

   (b) (30%) What is the value of $y(t)$? Justify your answer.
   Hint: $\tilde{S}(f)$ is real and symmetric.

Solution.

(a)



(b) $y(t) = 0$ since $\tilde{s}(t)$ is real and symmetric

2. (40%) The time-averaged power spectrum density of the M-ary PSK signaling scheme is given by $2E \cdot \text{sinc}^2(fT)$, where E is the symbol energy and T is the symbol period. The null-to-null bandwidth is thus given by
$$B = \frac{2}{T} = \frac{2}{T_b \log_2(M)} = \frac{2R_b}{\log_2(M)},$$
where T_b is the equivalent time per message bit, and R_b is the transmission rate measured in message bits per second. Find the bandwidth efficiency based on null-to-null bandwidth.

   Hint: Bandwidth efficiency is measured in (bits/second)/Hz

   Solution. $\frac{1}{2}\log_2(M)$ (cf. Slide IDC1-65)