EES 351: In-Class Exercise # 13

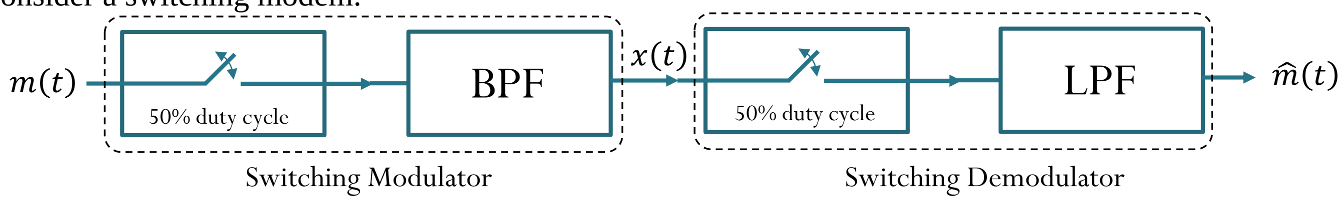
Date: 21 / 10 / 2020			
Name	ID (last 3 digits)		

Instructions

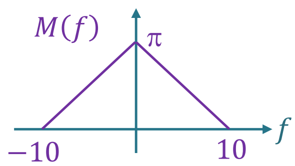
1. Work alone or in a group of no more than three students. **The group cannot be the same as any of your former groups after the midterm.**
2. Only one submission is needed for each group.
3. You have two choices for submission:
   (a) Online submission via Google Classroom
   - PDF only.
   - Only for those who can directly work on the posted files using devices with pen input.
   - Paper size should be the same as the posted file.
   - No scanned work, photos, or screen capture.
   - Your file name should start with the 10-digit student ID of one member. (You may add the IDs of other members, exercise #, or other information as well.)

   (b) Hardcopy submission
4. **Do not panic.**

1. Consider a switching modem:

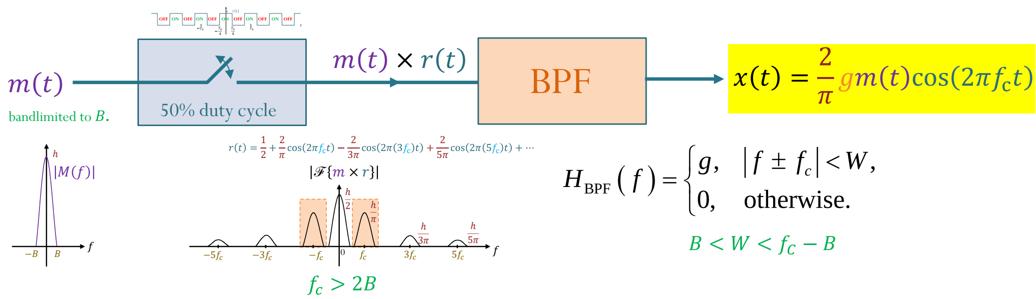


The ON times of both switching boxes are set to be the same as the nonnegative part of $\cos(60\pi t)$. $M(f)$ is plotted below. The frequency responses of the filters are also specified.



$$H_{\text{BPF}}(f) = \begin{cases} 2, & |f \pm 30| < 15, \\ 0, & \text{otherwise.} \end{cases} \qquad H_{\text{LPF}}(f) = \begin{cases} 3, & |f| < 14, \\ 0, & \text{otherwise.} \end{cases}$$

(a) Find $x(t)$. (The final answer can contain $m(t)$. There is no need to find the expression for $m(t)$.)



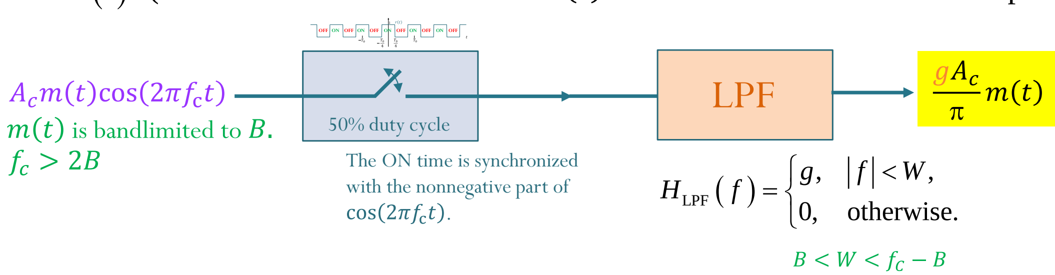
$$x(t) = \frac{2}{\pi} g\, m(t)\cos(2\pi f_c t)$$

$$H_{\text{BPF}}(f) = \begin{cases} g, & |f \pm f_c| < W, \\ 0, & \text{otherwise.} \end{cases}$$

Here, $B = 10$, $f_c = 30$, $g = 2$, and $W = 15$. First, we need to check two conditions:
(1) $f_c = 30$ and $2B = 20$; so, $f_c > 2B$.
(2) $B = 10$, $W = 15$, and $f_c - B = 20$; so, $B < W < f_c - B$.
From the two conditions above, we can conclude easily that

$$x(t) = \frac{2}{\pi} g m(t)\cos(2\pi f_c t) = \frac{2}{\pi}(2) m(t)\cos(2\pi(30)t) = \frac{4}{\pi} m(t)\cos(60\pi t).$$

(b) Find $\hat{m}(t)$. (The final answer can contain $m(t)$. There is no need to find the expression for $m(t)$.)



$$H_{\text{LPF}}(f) = \begin{cases} g, & |f| < W, \\ 0, & \text{otherwise.} \end{cases}$$

Here, $B = 10$, $f_c = 30$, $g = 3$, $W = 14$, and $A_c = \frac{4}{\pi}$. First, we need to check two conditions:
(1) $f_c = 30$ and $2B = 20$; so, $f_c > 2B$.
(2) $B = 10$, $W = 14$, and $f_c - B = 20$; so, $B < W < f_c - B$.

From the two conditions above, we can conclude easily that

$$\hat{m}(t) = \frac{g A_c}{\pi} m(t) = \frac{3 \times \frac{4}{\pi}}{\pi} m(t) = \frac{12}{\pi^2} m(t).$$