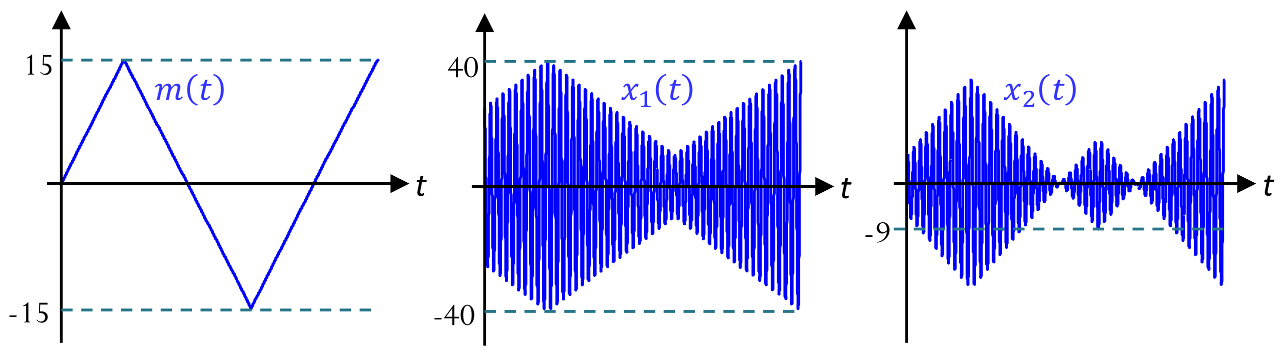
ECS 332: In-Class Exercise # 13

Date: **26** / **10** / 2018	ID (last 3 digits)		
Name			
Prapun	**5**	**5**	**5**

Instructions

1. Separate into groups of no more than three persons. **The group cannot be the same as any of your former groups after the midterm.**
2. Write down all the steps that you have done to obtain your answers. You may not get full credit even when your answer is correct without showing how you get your answer.
3. **Do not panic.**

1. Continue from the previous in-class exercise. We considered AM transmission of the message $m(t)$ shown on the left below.



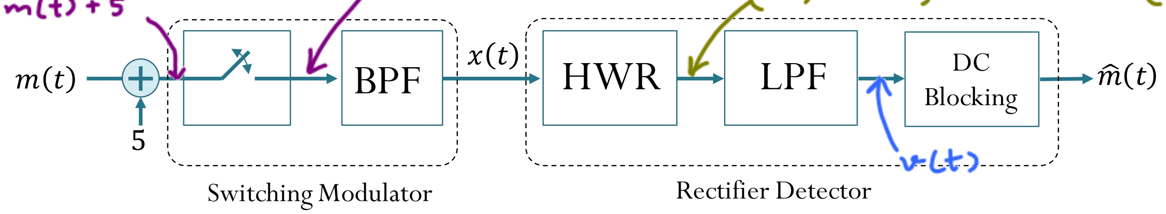
The middle and the rightmost plots show two AM signals $x_1(t)$ and $x_2(t)$ produced by using two different values of modulation index. During the previous in-class exercise, we have calculated the values of A and μ. They are summarized in the table below.

Suppose $m(t)$ is periodic with average power $\langle m^2(t)\rangle = 75$ (P_m). Calculate the corresponding value of the power efficiency for each case.

p.75 of the lecture note

$x_{AM}(t)$	A	μ	Power Efficiency $= \frac{\frac{1}{2}P_m}{\frac{1}{2}P_m+\frac{1}{2}A^2} = \frac{P_m}{A^2+P_m}$
$x_1(t)$	25	60%	$= \frac{75}{25^2+75} = \frac{75}{700} = \frac{3}{28} \approx 0.1071$
$x_2(t)$	6	250%	$= \frac{75}{6^2+75} = \frac{75}{111} = \frac{25}{37} \approx 0.6757$

2. [ENRPr] Consider an AM system shown below:



$m(t)+5$; $(m(t)+5)\left(\frac{1}{2}+\frac{2}{\pi}\cos(2\pi f_c t) - \frac{2}{3\pi}\cos(2\pi(3f_c)t)+\dots\right)$; $(\alpha+\beta m(t))\cos(2\pi f_c t)\left(\frac{1}{2}+\frac{2}{\pi}\cos(2\pi f_c t)+\dots\right)$; $v(t)$

The switching box is operating at frequency $f_c = 200$ kHz with duty cycle 50%. Assume $m(t)$ is band-limited to $B = 5$ kHz. The frequency response of the BPF and LPF are

$$H_{BPF}(f) = \begin{cases} 4, & |f \pm f_c| \le B, \\ 0, & \text{otherwise.} \end{cases} \quad \text{and } H_{LPF}(f) = \begin{cases} g, & |f| \le B, \\ 0, & \text{otherwise.} \end{cases}$$

$4(m(t)+5)\left(\frac{2}{\pi}\cos(2\pi f_c t)\right)$

(a) (Optional) The modulator gives $x(t) = (\alpha + \beta m(t))\cos(2\pi f_c t)$: $\alpha =$ **$40/\pi$** and $\beta =$ **$8/\pi$**

(b) Assume that $\alpha + \beta m(t)$ is greater than 0 at all time. Find the value of the gain g which makes $\hat{m}(t) = m(t)$: $g =$ **$\pi^2/8$**

$v(t) = (\alpha + \beta m(t))\frac{1}{2} \times \frac{2}{\pi} g = g\frac{\alpha}{\pi} + g\frac{\beta}{\pi} m(t)$

$\hat{m}(t) = g\frac{\beta}{\pi} m(t) \Rightarrow$ want $g\frac{\beta}{\pi} = 1 \Rightarrow g = \frac{\pi}{\beta}$