ECS 332: In-Class Exercise # 14 - Sol

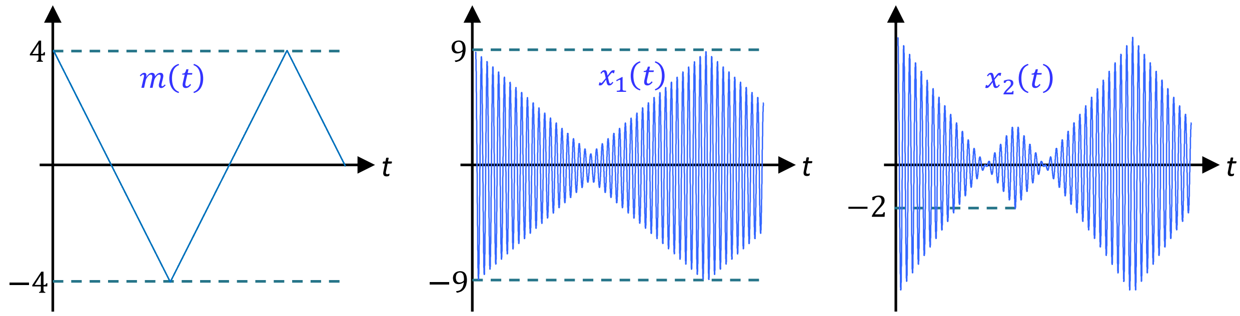
Date: 2 5 / 1 0 / 2019

Name	ID (last 3 digits)		
Prapun	5	5	5

Instructions

1. Separate into groups of no more than three students each. **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.

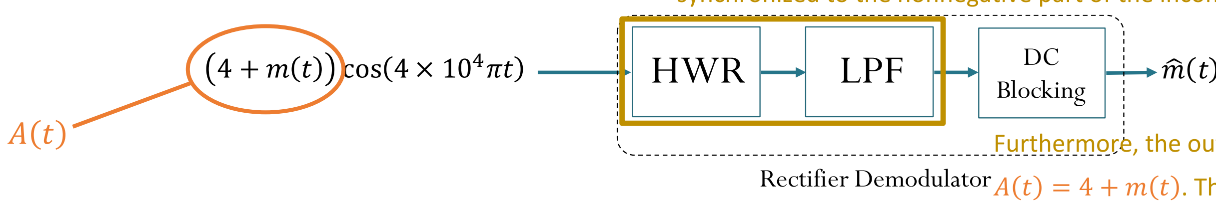
Suppose $m(t)$ is a periodic triangular wave with average power $\langle m^2(t)\rangle = \frac{16}{3}$.

Calculate the corresponding value of the power efficiency for each case.

$x_{AM}(t)$	A	μ	Power Efficiency
$x_1(t)$	5	80%	$\text{Eff} = \dfrac{\frac{P_m}{2}}{\frac{A^2}{2}+\frac{P_m}{2}} = \dfrac{1}{\frac{A^2}{P_m}+1} = \dfrac{1}{\frac{5^2}{16/3}+1} = \dfrac{16}{91} \approx 0.1758 = 17.58\%$
$x_2(t)$	2	200%	$\text{Eff} = \dfrac{\frac{P_m}{2}}{\frac{A^2}{2}+\frac{P_m}{2}} = \dfrac{1}{\frac{A^2}{P_m}+1} = \dfrac{1}{\frac{2^2}{16/3}+1} = \dfrac{4}{7} \approx 0.5714 = 57.14\%$

2. [ENRPr] Consider a rectifier demodulator shown below:

In class, we have shown that, if $A(t)$ is always nonnegative, this combination is equivalent to a switching demodulator whose ON time is synchronized to the nonnegative part of the incoming sinusoidal signal.



Furthermore, the output is $\frac{g}{\pi}A(t)$. Here, $A(t) = 4 + m(t)$. Therefore, the output of this part is $\frac{4g}{\pi} + \frac{g}{\pi}m(t)$.

Assume that $m(t)$ has 0 average and that it is band-limited to $B = 5$ kHz.

The frequency response of the LPF is $H_{LPF}(f) = \begin{cases} g, & |f| \le B, \\ 0, & \text{otherwise.} \end{cases}$

Assume that $m(t) \ge -4$ at all time.

Find the value of the gain g which makes $\hat{m}(t) = m(t)$:

$g = $ π

Finally, the DC blocking box removes the DC component. Here, because we assume that $\langle m(t)\rangle = 0$, the DC component is

$$\left\langle \frac{4g}{\pi} + \frac{g}{\pi}m(t) \right\rangle = \frac{4g}{\pi} + \frac{g}{\pi}\langle m(t)\rangle = \frac{4g}{\pi}.$$

So,

$$\hat{m}(t) = \frac{4g}{\pi} + \frac{g}{\pi}m(t) - \frac{4g}{\pi} = \frac{g}{\pi}m(t).$$

To make $\hat{m}(t) = m(t)$, we need $g = \pi$.