

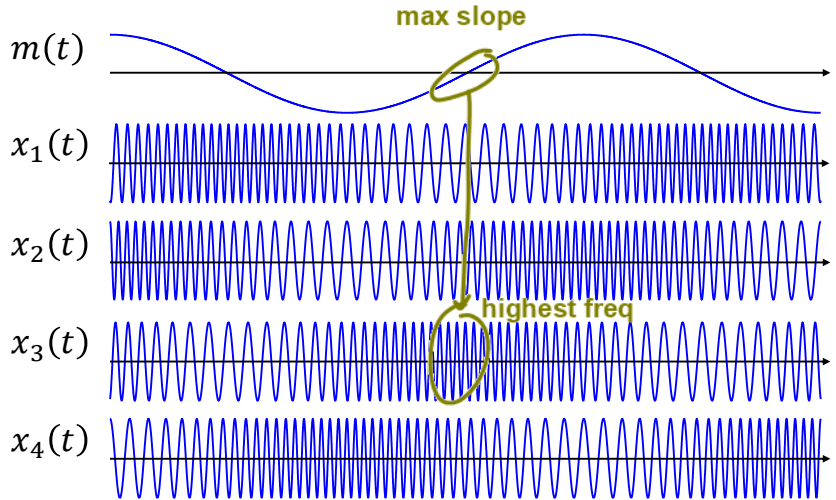
ECS 332: In-Class Exercise # 16

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.**

Date: 07 / 11 / 2018			
Name			ID (last 3 digits)
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1. Consider five plots below. The top one is the baseband message signal $m(t)$ that is used in the modulation to create the PM signal. Identify which plot is $x_{PM}(t)$.



$x_{PM}(t) : \underline{x_3(t)}$

2. Consider an FM signal $x_{FM}(t) = A \cos\left(\frac{8\pi}{3}t^3 - 8\pi t^2 + 16\pi t - \frac{8\pi}{3}\right)$ defined between time $t = 0$ to $t = 2$.

- a. Let $f(t)$ be its instantaneous frequency. Find $f(1)$.

$$f(t) = \frac{1}{2\pi} \theta'(t) = \frac{1}{2\pi} (8\pi t^2 - 16\pi t + 16\pi) = 4t^2 - 8t + 8$$

$$f(1) = 4 - 8 + 8 = 4$$

Alternatively, $\frac{d}{dt} \theta(t) = 8\pi t^2 - 16\pi t + 16\pi$

$$\frac{1}{2\pi} \frac{d}{dt} \theta(t) = 4t^2 - 8t + 8$$

- b. (Optional) Suppose the message is $m(t) = 2t^2 - 4t + 1$. Find the carrier frequency f_c and the constant k_f .

$f_c = \underline{6}$ and $k_f = \underline{2}$

$$f(t) = f_c + k_f m(t) = f_c + k_f (2t^2 - 4t + 1) = 4t^2 - 8t + 8$$

$$\frac{f_c + k_f}{2} = 8 \Rightarrow f_c = 6$$

$$2k_f = 4 \Rightarrow k_f = 2$$

Alternatively, inside cos it should be $2\pi f_c t + \beta + 2\pi k_f \int m(t) dt$

$$= 2\pi \left(\frac{2}{3} t^3 k_f - 2k_f t^2 + (k_f + f_c)t \right) + \beta$$

$$= 2\pi \left(\frac{4}{3} t^3 - 4t^2 + (2 + f_c)t \right) - \frac{8\pi}{3}$$

\downarrow $k_f = 2$ \downarrow $k_f = 2 \Rightarrow 2 + f_c = 8 \Rightarrow f_c = 6$
same