EES 351: In-Class Exercise # 17

Date: 6 / 11 / 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. **ENRE** (Explanation is not required for this exercise.)
4. 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
5. **Do not panic.**

1. In QAM system, the transmitted signal is of the form

$$x_{\text{QAM}}(t) = m_1(t)\sqrt{2}\cos(2\pi f_c t) + m_2(t)\sqrt{2}\sin(2\pi f_c t).$$

Here, we want to express $x_{\text{QAM}}(t)$ in the form

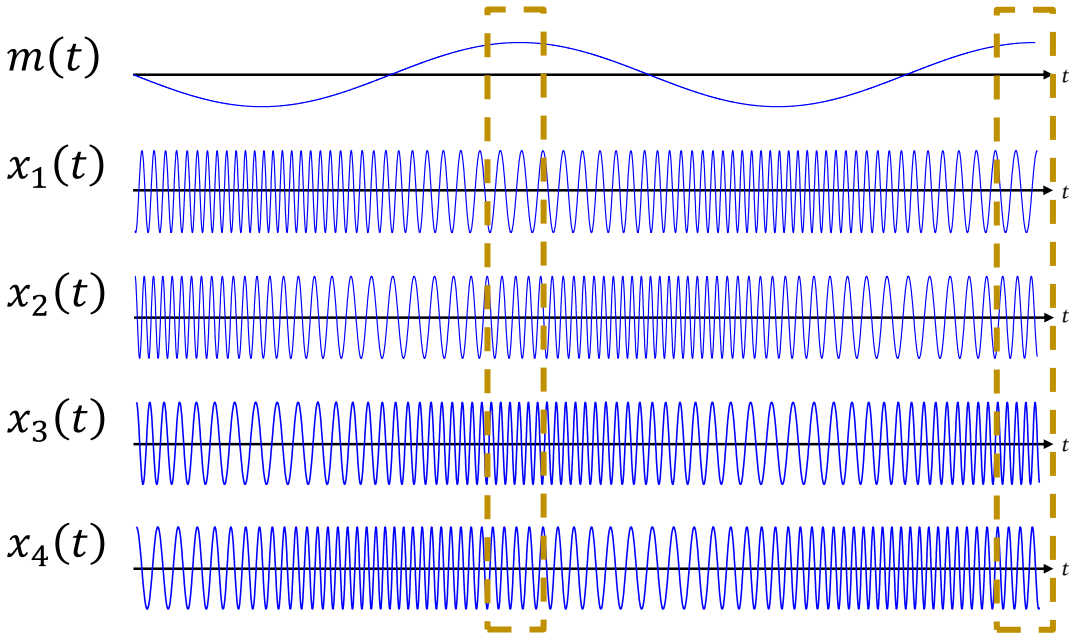
$$x_{\text{QAM}}(t) = \sqrt{2}E(t)\cos(2\pi f_c t + \phi(t)),$$

where $E(t) \geq 0$ and $\phi(t) \in (-180^\circ, 180^\circ]$.

This problem assumes the messages are piecewise constant. Their values during three time intervals are listed below. Find the values of $E(t)$ and $\phi(t)$ during the corresponding time intervals.

Intervals	$m_1(t)$	$m_2(t)$	$E(t)$	$\phi(t)$	$m_1 - jm_2$
$0 \leq t < 1$	3	3	$3\sqrt{2}$	$-45°$	$3 - 3j = 3\sqrt{2}\angle -45°$
$1 \leq t < 2$	0	–3	3	$90°$	$3j = 3\angle 90°$
$2 \leq t < 3$	–4	3	5	$-143.13°$	$-4 - 3j \approx 5\angle -143.13°$

2. Consider five plots below. The top one is the baseband message signal $m(t)$ that is used in the modulation to create an FM signal. Identify which plot is $x_{\text{FM}}(t)$.



$x_{\text{FM}}(t)$: $x_3(t)$

The "frequency" of the FM signal should follow the value of $m(t)$.
For example, the time when $m(t)$ has highest value should correspond to the time when FM signal has the highest frequency.