ECS 332: In-Class Exercise # 5

Instructions

1. Separate into groups of no more than three persons.
2. **The group cannot be the same as any of your former groups.**
3. Only one submission is needed for each group.
4. 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.
5. **Do not panic.**

Date: 11 / 10 / 2017			
Name	ID (last 3 digits)		
Prapun	**5**	**5**	**5**

1. Consider the impulse train $g(t)$ shown on the left in Figure 1. Plot its Fourier transform $G(f)$ from $f=-2$ to $f=2$. Explanation is not required for this question.

[See 4.46 in the lecture notes.]

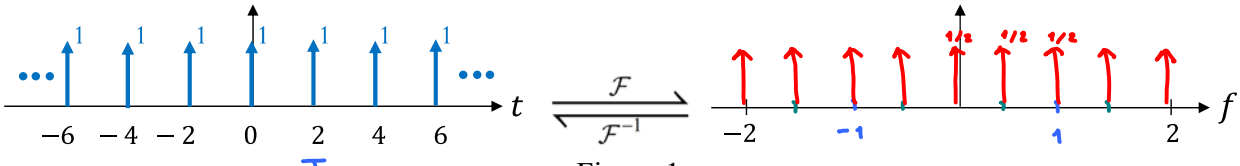


Figure 1

T_0

$f_0 = \frac{1}{2}$

2. Consider a "square" wave (a train of rectangular pulses) $r(t)$ shown in Figure 2.

Its value periodically alternates between A and 0 with period T_0. Suppose $A = 2$.

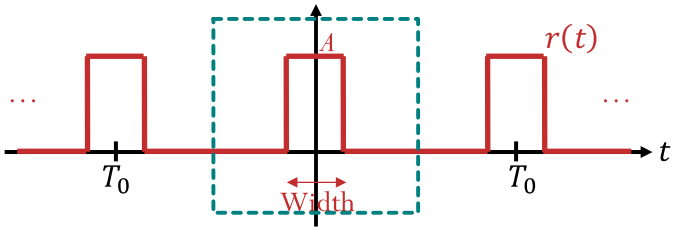


Figure 2

The Fourier series expansion of $r(t)$ is given by $\sum_{k=-\infty}^{\infty} c_k e^{j2\pi(kf_0)t}$ where $f_0 = 1/T_0$.

See recipe 4.44 on p. 56 of the lecture notes

$c_k = \frac{1}{T_0} R_{T_0}(kf_0)$

d

a. Suppose the duty cycle is 50%. Find c_0 and c_2.

1/2

$\frac{1}{2} \times 2 = c_0 =$ 1, $c_2 =$ 0

$c_0 = \frac{1}{T_0} R_{T_0}(0) = \langle r(t) \rangle$

See the last sentence on p. 59 of the lecture notes.

$R_{T_0}(0)$ = area under one rectangular function

= width × A

= d × T_0 × A

b. Suppose the duty cycle is 20%. Find c_0 and c_5.

1/5

$\frac{1}{5} \times 2 = c_0 =$ 0.4, $c_5 =$ 0

$c_0 = \frac{1}{T_0} R_{T_0}(0) = d \times A$

ECS 332: In-Class Exercise # 6

Instructions

1. Separate into groups of no more than three persons.
2. **The group cannot be the same as any of your former groups.**
3. Only one submission is needed for each group.
4. **Do not panic.**

Date: 18 / 10 / 2017			
Name	ID (last 3 digits)		
Prapun	**5**	**5**	**5**

1. Consider the rectangular pulse train $r(t)$ shown in Figure 1.

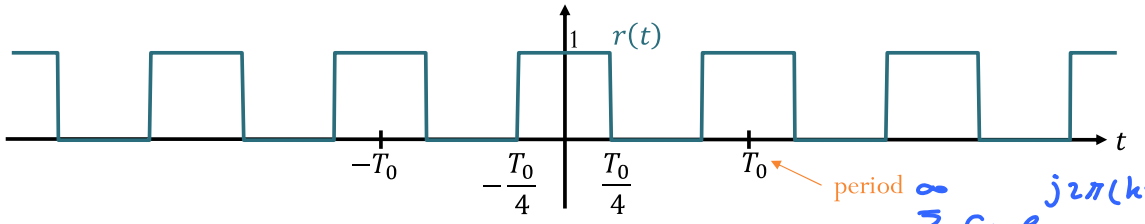


Figure 1

$r(t) = \sum_{k=-\infty}^{\infty} c_k e^{j2\pi(kf_0)t}$

a. Using Fourier series expansion, we can write $r(t)$ in the form

$$\cdots \boxed{\frac{-1}{3\pi}} e^{j2\pi(-3f_0)t} + \boxed{0} e^{j2\pi(-2f_0)t} + \boxed{\frac{1}{\pi}} e^{j2\pi(-f_0)t} + \boxed{\frac{1}{2}} + \boxed{\frac{1}{\pi}} e^{j2\pi(f_0)t} + \boxed{0} e^{j2\pi(2f_0)t} + \boxed{\frac{-1}{3\pi}} e^{j2\pi(3f_0)t} + \cdots$$

(c_0, c_1, c_2, c_3)

where $f_0 = \frac{1}{T_0}$.

same, same, same

Write the appropriate coefficients in the boxes above.

$r(t) = c_0 + \sum_{k=1}^{\infty} a_k \cos(2\pi(kf_0)t)$

b. Using another form of Fourier series expansion, we can write $r(t)$ in the form

$$\boxed{\frac{1}{2}} + \boxed{\frac{2}{\pi}} \cos(2\pi(f_0)t) + \boxed{0} \cos(2\pi(2f_0)t) + \boxed{\frac{-2}{3\pi}} \cos(2\pi(3f_0)t) + \boxed{0} \cos(2\pi(4f_0)t) + \cdots$$

(c_0, a_1, a_2, a_3, a_4)

Write the appropriate coefficients in the boxes above.

2. Consider the rectangular pulse train $r(t)$ shown in Figure 2.

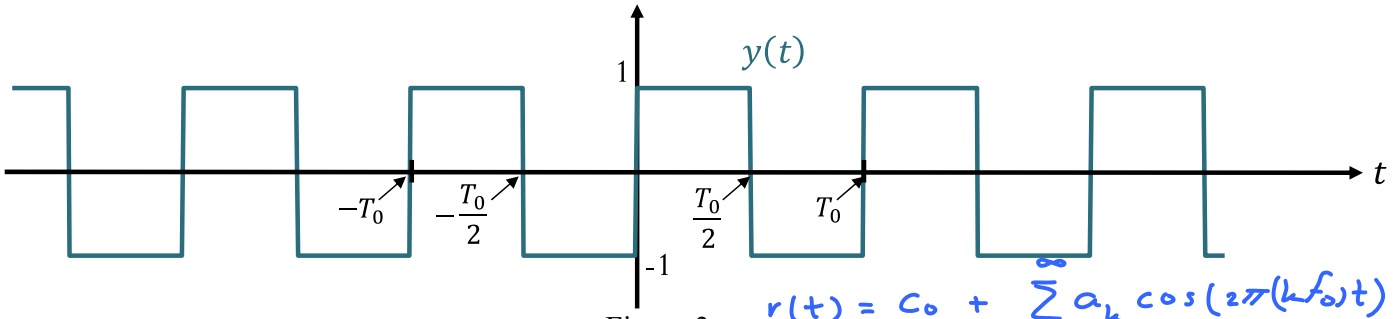


Figure 3

$r(t) = c_0 + \sum_{k=1}^{\infty} a_k \cos(2\pi(kf_0)t)$

a. Observe that $y(t) = \alpha + \beta r(t - \gamma T_0)$. Find the constants α, β, and γ.

$y(t) = \alpha + \beta r(t - \gamma T_0)$

$= (\alpha + \beta c_0) + \sum_{k=1}^{\infty} \beta a_k \cos(2\pi(kf_0)(t - \frac{T_0}{4}))$

$= 2\pi k f_0 t - 2\pi k f_0 \frac{T_0}{4}$

$\alpha = \underline{-1}$, $\beta = \underline{2}$, $\gamma = \underline{\frac{1}{4}}$

b. $y(t)$ can be written in the form

$$\boxed{0} + \boxed{\frac{4}{\pi}} \sin(2\pi(f_0)t) + \boxed{0} \sin(2\pi(2f_0)t) + \boxed{\frac{4}{3\pi}} \sin(2\pi(3f_0)t) + \boxed{0} \sin(2\pi(4f_0)t) + \cdots$$

Write the appropriate coefficients in the boxes above.

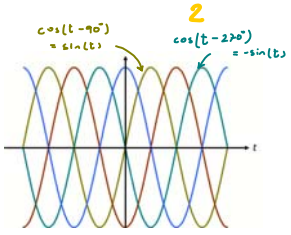
$\alpha + \beta c_0 = -1 + 2 \times \frac{1}{2}$

$= \beta a_1 \cos(2\pi f_0 t - \frac{\pi}{2})$

$= 2 \times \frac{2}{\pi} \times \sin(2\pi f_0 t)$

$= \beta a_3 \cos(2\pi(3f_0)t - 3\frac{\pi}{2})$

$= 2 \times (\frac{-2}{3\pi})(-\sin(2\pi(3f_0)t))$



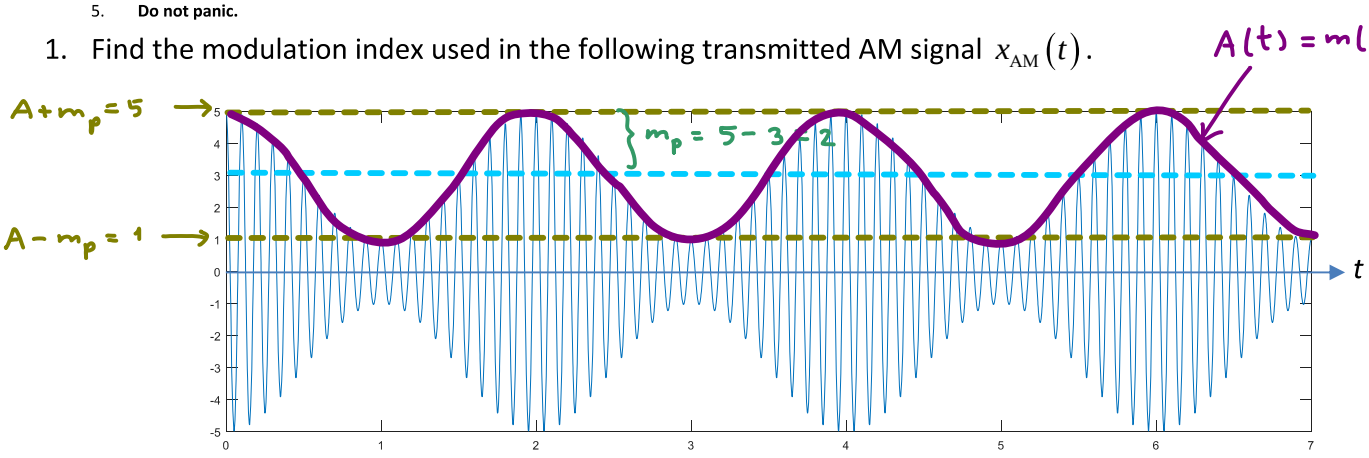
ECS 332: In-Class Exercise # 7

Instructions

1. Separate into groups of no more than three persons.
2. **The group cannot be the same as any of your former groups.**
3. Only one submission is needed for each group.
4. 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.
5. **Do not panic.**

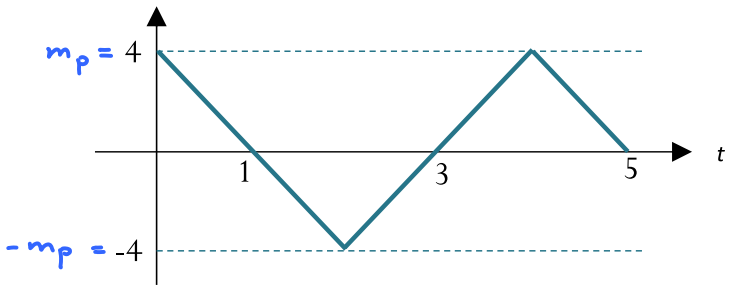
Date: 20 / 10 / 2017			
Name	ID (last 3 digits)		
Prapun	**5**	**5**	**5**

1. Find the modulation index used in the following transmitted AM signal $x_{\text{AM}}(t)$.



$A = \frac{(A+m_p)+(A-m_p)}{2} = \frac{5+1}{2} = 3$ $\quad \mu = \frac{m_p}{A} = \frac{2}{3} \approx 66.67\%$.

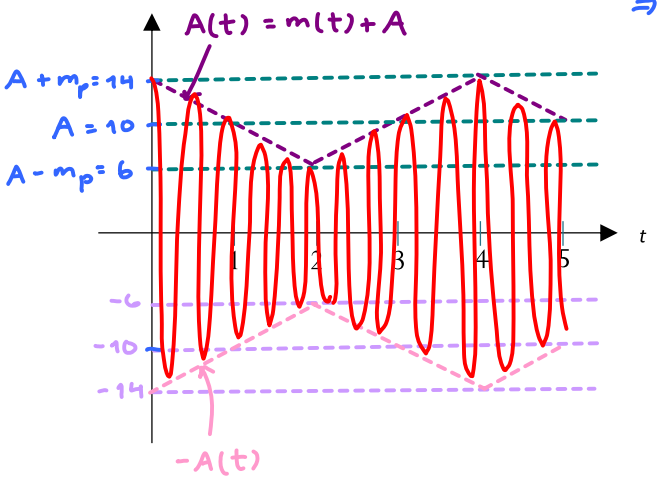
2. Suppose $m(t)$ is plotted below.

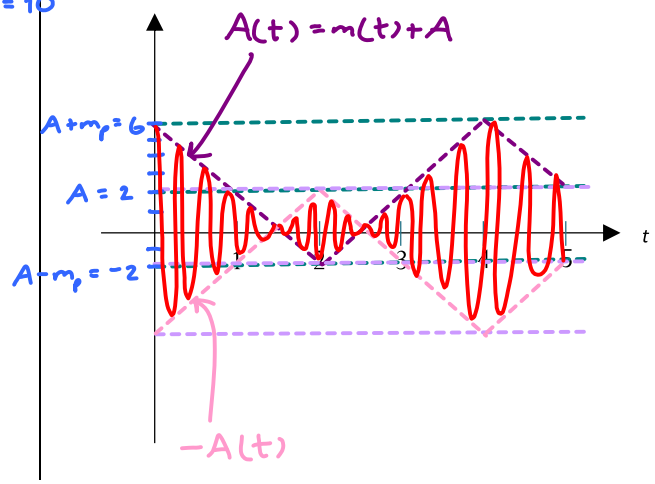


Assume that the carrier frequency f_c is large (enough). Plot the corresponding AM signal $x_{\text{AM}}(t)$.

(a) when the modulation index is 40% $= 0.4 = \frac{m_p}{A} = \frac{4}{A} \Rightarrow A = 10$

(b) when the modulation index is 200% $= 2 = \frac{m_p}{A} = \frac{4}{A} \Rightarrow A = 2$





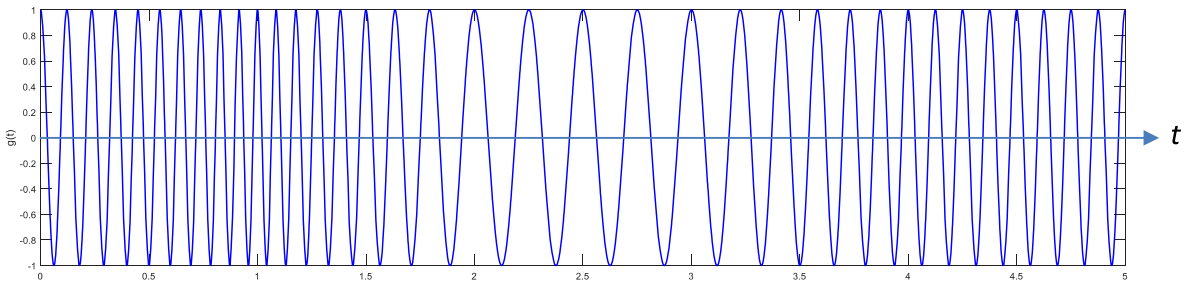
ECS 332: In-Class Exercise # 8

Instructions

1. Separate into groups of no more than three persons.
2. **The group cannot be the same as any of your former groups.**
3. Only one submission is needed for each group.
4. 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.
5. **Do not panic.**

Date: 03 / 11 / 2017			
Name	ID (last 3 digits)		
Prapun	5	5	5

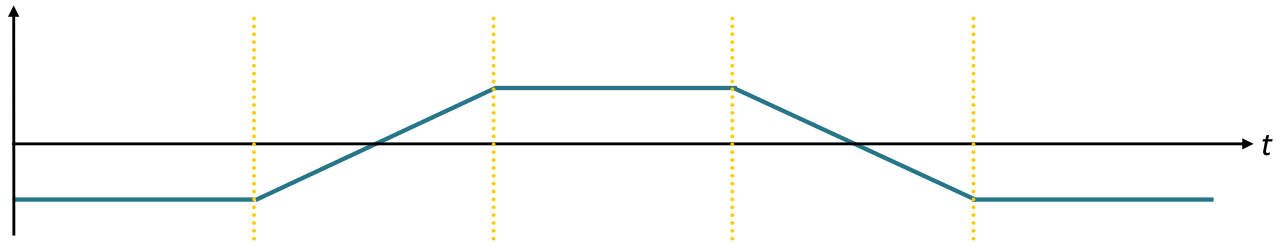
1. Look at the plot of a generalized cosine function $g(t)$ below.



During each of the time intervals below, the frequency is either "constant", "increasing", or "decreasing". Choose the appropriate frequency behavior during each interval.

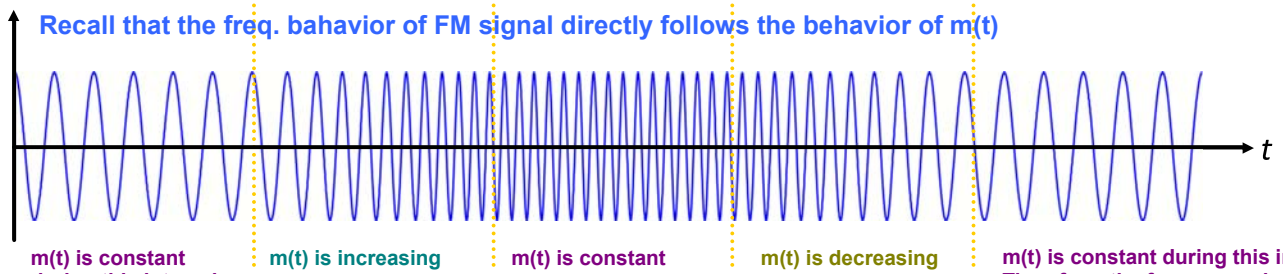
	Time Interval	Frequency Behavior ("constant", "increasing", or "decreasing"?)
(a)	$0 < t < 1$	increasing Note that the number of cycles during the interval [0,0.5) is less than the number of cycles during the interval [0.5,1)
(b)	$1 < t < 2$	decreasing
(c)	$2 < t < 3$	constant
(d)	$3 < t < 4$	increasing
(e)	$4 < t < 5$	constant

2. Suppose $m(t)$ is plotted below.



Sketch the corresponding FM signal $x_{\text{FM}}(t)$. Make sure that the frequency behavior is illustrated clearly.

Recall that the freq. bahavior of FM signal directly follows the behavior of m(t)



m(t) is constant during this interval. Therefore, the frequency should be constant during this interval.
m(t) is at its min value during this interval. Therefore, the freq. shoud be lowest in this interval.

m(t) is increasing during this interval. Therefore, the frequency should be increasing during this interval.

m(t) is constant during this interval. Therefore, the frequency should be constant during this interval.
m(t) is at its max value during this interval. Therefore, the freq. shoud be highest in this interval.

m(t) is decreasing during this interval. Therefore, the frequency should be decreasing during this interval.

m(t) is constant during this interval. Therefore, the frequency should be constant during this interval.
m(t) is at its min value during this interval. Therefore, the freq. shoud be lowest in this interval. Note that the freq. should be the same as during the first interval.

ECS 332: In-Class Exercise # 9

Instructions

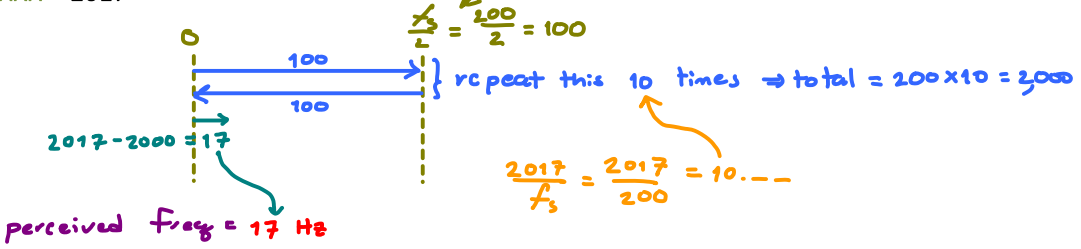
1. Separate into groups of no more than three persons.
2. **The group cannot be the same as any of your former groups.**
3. Only one submission is needed for each group.
4. Write down all the steps that you have done to obtain your answers. You may not get full credit even when your answer is correct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

Date: 15 / 11 / 2017			
Name	ID (last 3 digits)		
Prapun	**5**	**5**	**5**

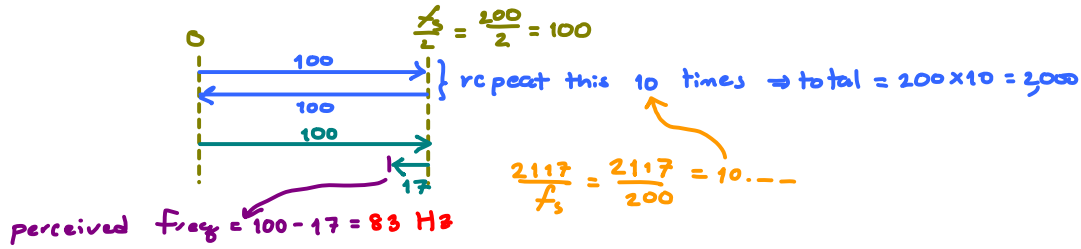
1. Suppose we input $\cos(2\pi(XXXX)t)$ into `plotspect` with sampling rate f_s = 200 samples/sec.

   Find the perceived frequency (the freq. that `plotspect` sees) when

   a) XXXX = 2017



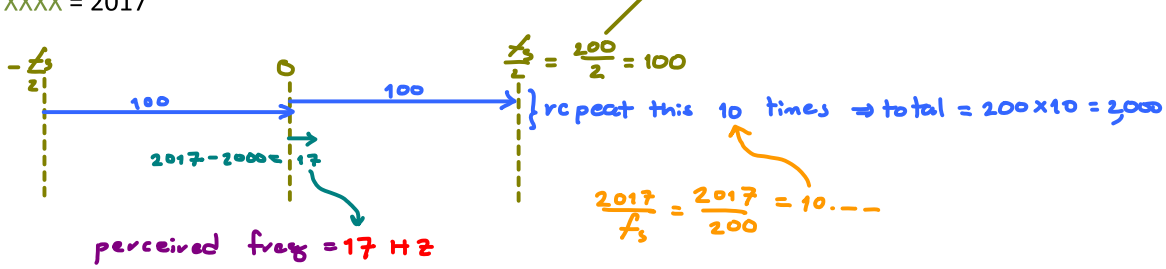
   b) XXXX = 2117



2. Suppose we input $e^{j(2\pi(XXXX)t)}$ into `plotspect` with sampling rate f_s = 200 samples/sec.

   Find the perceived frequency (the freq. that `plotspect` sees) when

   a) XXXX = 2017



   b) XXXX = 2117