

## Assignment 5.

Latest due date: Sunday, February 24th

**Note:** please make sure to **include all figures and final results** in the **PDF report!**

1. Prove each of the following on paper - no computer:
  - $\cos(\theta) = \frac{1}{2}(e^{i\theta} + e^{-i\theta})$ . Give a similar expression for  $\sin(\theta)$ .
  - $z\bar{z} = |z|^2$  where  $z$  complex. Note that  $|z|$  denotes the amplitude or length of  $|z|$ .
  - Given complex numbers  $x$  and  $y$  prove that  $|\frac{x}{y}| = \frac{|x|}{|y|}$  and also that the angle of the polar form of  $\angle(\frac{x}{y})$  is equal to  $\angle x - \angle y$ . Note:  $\angle$  denotes the phase or angle.
  
2. (a) Plot in matlab the following signal,  $s = \sin(80\pi t) + 0.5 \sin(180\pi t)$ , for 500 time points in the time interval  $t = [0, 0.5]$ . Make sure to label your x-axis with "Time (seconds)" and your y-axis with "Amplitude" and provide this plot in your report.
- (b) Write an algorithm which will compute the corresponding 500 (complex) modes  $X$  for your signal  $s$ . Include in your report a plot of the amplitude  $x = |X|$  of these modes vs frequencies<sup>1</sup> (you do that in matlab plot using the command: `plot([0:2:1000-2],x)`). Title your x-axis as "Frequencies (Hz)" and y-axis as "Amplitude".
- (c) Print out in your report the first 10 complex modes  $X$  (not amplitudes) and last 10 complex modes. Compare them and discuss your observations.
- (d) Based on your observations from above how many of the frequencies or "modes" should you really need? Is there a way to save space in other words?

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<sup>1</sup>Note: here  $T = .5$  and frequency  $f = 1/T = 2$ .