PROBLEM:

It might be difficult to see why the derivative of the phase would be the instantaneous frequency. The following experiment provides a clue.

(a) Use the following parameters to define a "chirp" signal:

$$\begin{aligned}\omega_1 &= 2\pi(1) \text{ rad/sec} \\ \omega_2 &= 2\pi(9) \text{ rad/sec} \\ T_2 &= 2 \text{ sec}\end{aligned}$$

In other words, determine α and β in equation (**??**) to define $x(t)$ so that it sweeps the specified frequency range.

(b) Now make a plot of the signal synthesized in part (a). Pick a time sampling interval that is small enough so that the plot is very smooth. Put this plot in the middle panel of a 3×1 subplot, i.e., `subplot(3,1,2)`.

(c) It is difficult to verify whether or not this chirp signal will have the correct frequency content. However, the rest of this problem is devoted to an experiment that will demonstrate that the derivative of the phase is the "correct" definition of instantaneous frequency. First of all, make a plot of the instantaneous frequency $f_i(t)$ (in Hz) versus time.

(d) Now generate and plot a 4 Hz sinusoid. Put this plot in the upper panel of a 3×1 subplot, i.e., `subplot(3,1,1)`.

(e) Finally, generate and plot an 8 Hz sinusoid. Put this plot in the lower panel of a 3×1 subplot, i.e., `subplot(3,1,3)`.

(f) Compare the three signals and comment on the frequency content of the chirp. Concentrate on the frequency of the chirp in the time range $1.6 \leq t \leq 2$ sec. Which sinusoid matches the chirp in this time region? Compare the expected $f_i(t)$ in this region to 4 Hz and 8 Hz.