DAY 1 (Tuesday):

GUIDED ACTIVITIES:

1. Check that your microphone is working. Turn up the gain if necessary
2. Check that you can drive the speaker, use a low-frequency tone at low amplitude please!
3. Measure the rms noise of your microphone.

UNGUIDED ACTIVITIES (Choose 1 or more to do with a group):

1. Measure the polar pattern of our electret microphone. (The polar pattern is the sensitivity to input as a function of angle in space). The microphone should be most sensitive at 0 degrees (directly above). Our electret microphones are designed to be omni-directional – how well do your measurements agree?
2. Triangulation – synchronize your boards' clocks (using the GPS module is recommended). Now, place two microphones at different distances from a speaker. Measure the phase lag between the signal at the two microphones. Does this phase lag agree with your expectations based on the speed of sound and distance? Now with a third microphone, triangulate the location of the speaker. How close do you get?
3. Harmonics and standing waves – Get some tubes (cardboard will be fine). Find the resonance frequency of your tube. Try with both ends open versus one closed end. Does the resonant frequency agree with your expectations? Now drive a sound wave in the tube at one of the harmonics. Measure the amplitude pattern inside with a microphone and count the number of nodes. Does it agree with your expectations?

DAY 2 (Thursday):

Since we should already have the equipment working, pick one of the following longer activities:

1. Using the microphone and thin-film display, make a live audio spectrum visualizer. Use a FFT to get the spectral information, and each line of the display as your time slice.
    a. First, pick your time window and get the FFT working on that. You should ideally sample long enough to get down to 10-20 Hz.
    b. Then, interface with your ST7735R TFT display and try getting at least one visualization in real time.
    c. Finally, make your spectrogram! You can accumulate enough time slices to fill the whole screen and then flash it all at once, or for an extra challenge make a scrolling display.
2. Encoding: Pick a frequency to be your carrier (something low enough to not be annoying, please!). Figure out a way to transmit messages using sound. HINT: First make a lock-in amplifier that gets signals at your desired frequency. Then, figure out a way to encode the data.
3. Sampling and audio manipulation: Using your microphone and the keypad, code a way to record short (few second) samples of sound and then play them back through the speaker. Now, add more samples and apply some distortion or effects to them. Some simple ones are echo (adding an additional delay to the sample and playing it again, overlapped with the first) and clipping

(manipulating the sound such that the waveform hits the maximum and minimum values, creating a distorted effect).