These exercises are intended to help you master and remember the material discussed in lectures and explored in labs. In future semesters, we may make some or all of these exercises required, but for now they remain optional. We suggest that you do them as we go over the material, but you may also want to use them to review concepts before the exam.

Rather than using this version directly, we suggest that you use the version without solutions to solve the problems before looking at the answers. Many studies have shown that people often trick themselves into believing that they know how to solve a problem if they are presented with the answer before they try to solve the problem themselves.

1. [L19] A magician is performing a “magic” trick in which a wand hidden in their sleeve “magically” appears in their hand when the magician gives a verbal command. Give an example of each task being performed by the magician as part of this trick.
   A. Sense: The magician senses both the position of the wand in their sleeve and the attention of the audience in order to manage the trick successfully.
   B. Compute: The magician’s brain “computes” the right speed at which to move their arm and the right time at which to close their hand in order to perform the trick.
   C. Communicate: To draw attention away from the hand that will receive the wand, the magician may wave the other hand while issuing the summoning command in order to draw the audience’s attention away from the wand as it emerges from their sleeve. Doing so is a form of communication: effectively, look over here while I retrieve the wand!
   D. Actuate: The magician has to move their arm to dislodge the wand and has to grasp the wand as it passes by their hand after emerging from their sleeve.

2. [L19] Give three examples of sensors that might be useful in digital agriculture. For each sensor, include a sentence or two explaining how that sensor can be used.
   A. Cameras can be used to monitor plant growth, to identify any large-scale plant health issues, and to estimate when to harvest certain crops.
   B. Thermometers can be used to record temperature variations to estimate water needs as well to identify any potential emergency conditions (unexpected freezes or heat waves) that necessitate immediate action.
   C. Soil water monitoring, either directly with distributed sensors or by indirectly measuring the level of the water table from the air, can help to conserve water while ensuring that plants receive an adequate supply.

3. [L19] In a sentence or two, explain why lenses are an important part of a camera.

   Lenses allow light to be collected from a wider area, enabling the camera to capture an image more quickly or to better differentiate the colors in the scene. Lenses can also be used to guide light to enable flatter camera geometry or wider image angles.

4. [L20] In a sentence or two, explain why microphones used to capture human speech and music include a filter.

   Human hearing has limited frequency range—only up to about 20 kHz for most of us. Sounds with frequencies beyond that range do not normally contribute to our hearing experience, but they can cause distortion of the sounds that we do want to hear, so removing them from the captured signal both reduces the information content of the signal and produces a signal that is more pleasurable and easier for humans to hear and understand.
5. [L20] How do sensors such as lidar and radar obtain depth information about the points in the results they produce?

These sensors send a signal (an electromagnetic wave, such as light or radio waves) in a specific frequency in a specific direction and measure the time required before they receive an echo of the signal. Given that such waves travel around the speed of light, they can then use the time taken to estimate distance to an obstacle in that direction, producing a single point in a point cloud.

6. [L20] What effect makes GPS less reliable when outdoors in urban areas?

GPS satellites may not be directly visible because of buildings, but echoed signals may be received later, artificially inflating the “distance” to the satellite and causing error in the estimated location.