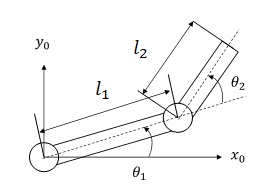
**Mid-term – Part 1 Written Section (Closed Book) – 60-minute time limit**

**Instructions:** Complete your answers in the space below (do not use back of paper).

**Student Name** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Final Score** out of 50: \_\_\_\_\_\_\_\_

1. Fill in the blanks for the following – some blanks may be 2 worded ones (10 points)
   1. \_\_\_\_\_\_\_\_\_ is the international standard to represent alpha-numeric characters
   2. A \_\_\_\_\_\_\_\_\_ emulator is used to establish serial communications
   3. \_\_\_\_\_\_\_\_\_ is used to permanently hold device information like identifiers (like device ID)
   4. RAM holds temporary information whereas \_\_\_\_\_\_\_\_\_\_\_\_\_ stores more permanent information like read/write instructions.
   5. A \_\_\_\_\_\_\_\_ is information, typically in the form of bytes to read and/or write instructions
   6. Little Endian means that the \_\_\_\_\_\_\_ significant bits are stored in the first byte, and the higher ones in the second byte.
   7. \_\_\_\_\_\_\_\_\_\_\_ is often employed to verify packets were correctly transferred between devices
   8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a standard notation for labeling and locating a robot’s reference frames
   9. The \_\_\_\_\_\_\_\_\_\_\_\_ transformation matrix maps reference frames to in a robot
   10. The \_\_\_\_\_\_\_\_\_ frame is the transformation from the robot’s base (origin) to the robot’s end-effector frame
2. The ASCII decimal value for the uppercase character G is 71. Sketch what should be seen on the scope when G is transmitted serially at 4800 bits/second. Annotate your photo clearly showing the spacing between any HI and LO voltage values and the timing in seconds between any widths. (10-points)
3. What is Little Endian? Provide an example using a Hex value 16-bit number (i.e. 2-bytes). Show the calculations (decimal, hexadecimal, and binary) to demonstrate Little Endian representation (10-points)
4. For the 2-link planar manipulator sketched below derive (show calculations and/or derivations)



* 1. The Denavit-Hartenberg parameter table (2.5-points)
  2. Forward kinematic equations for end point locations and based on the link lengths and and their angles and (2.5-points)
  3. The tool frame (5-points)
  4. Derive the inverse kinematics equation for the second angle such that (10-points):