Instructions: This homework assignment covers **Chapter 6** of the course notes. On each part, there is opportunity for partial credit, so show all of your work and explain all of your reasoning. No work/no explanation means no credit even if your answer is correct. If you use R to answer any part or to check your work, please include all code and output as attachments. Do not just write out the code you used.

1. A microdrill is a precision drill for small-diameter holes. An article in *Journal of Engineering Manufacture* described a study to examine the performance of a microdrill when holes are drilled into a brass alloy (CuZn38). A sample of $n = 50$ drills was used. On each one, the researchers recorded

$$X = \text{number of holes a drill machines before it breaks.}$$

Here are the data from the study:

11	14	20	23	31	36	39	44	47	50
59	61	65	67	68	71	74	76	78	79
81	84	85	89	91	93	96	99	101	104
105	105	112	118	123	136	139	141	148	158
161	168	184	206	248	263	289	322	388	512

For example, the observation "11" means the drill machined 11 holes successfully before it broke.

(a) Based on the information above, what do you think the population is? There is no "right" answer here, but there are certainly good and bad answers.
(b) Prepare a histogram of the data. Based on the shape of the histogram, what continuous probability distribution might be a reasonable model to describe the population? Explain your reasoning.
(c) Calculate an estimate of μ, the population mean number of holes a drill machines before it breaks. Calculate an estimate of the population standard deviation σ.

2. The World Health Organization uses a normal distribution with mean $\mu = 125$ and standard deviation $\sigma = 15$ to model X, the systolic blood pressure (SBP, measured in mmHg), for all American males aged 18 and over.

(a) Approximately how many individuals are in this population? Use Google or ChatGPT to answer this.
(b) Use R to graph the $\mathcal{N}(125, 15^2)$ population pdf. Use the 68-95-99.7% rule to form intervals 1, 2, and 3 standard deviations from the mean. Interpret.
(c) Calculate the proportion of individuals in this population whose SBP is larger than 130 mmHg.
(d) We have a random sample of $n = 40$ individuals from this population. What is the probability the sample mean SBP is larger than 130 mmHg? Why is this answer so different from your answer in part (c)?

3. Hollow pipes are to be used in an electrical wiring project. In testing "1-inch" (inside diameter) pipes, the data below (next page) were collected by a design engineer. These are $n = 25$ measurements of X, the outside diameter of this type of pipe (in inches).

1.312	1.270	1.331	1.370	1.330
1.254	1.340	1.320	1.343	1.332
1.379	1.357	1.264	1.332	1.307
1.257	1.275	1.302	1.296	1.321
1.344	1.308	1.303	1.268	1.343

The manufacturer of this pipe claims the mean outside diameter is $\mu = 1.300$ inches. This is in the design specifications for this pipe and is meant to describe the entire population of pipes of this type the manufacturer produces. *Is the sample above consistent with this claim?* This is what we will investigate in this question.

(a) Find the sample mean $\overline{x}$ and the sample standard deviation s for the data above. Make sure you identify the units attached to each number.
(b) Calculate the value of

$$t = \frac{\overline{x} - \mu}{s/\sqrt{n}}$$

under the assumption the manufacturer's claim is correct.
(c) If the manufacturer's claim is correct, then the value of t you calculated in part (b) comes from a $t(24)$ distribution if the population distribution for the pipe's outside diameter is normal. Therefore, use R to plot the $t(24)$ pdf and locate on the horizontal axis where the value of t falls.
(d) Did the value of t fall in the center of the $t(24)$ distribution, say, close to 0? This is what we would expect if the manufacturer's claim is true (because you calculated t under this assumption). Or, did it fall out in one of the tails of the distribution? Note that

- values of t far out in the right tail would be more consistent with $\mu > 1.300$ inches.
- values of t far out in the left tail would be more consistent with $\mu < 1.300$ inches.

What is your assessment of the manufacturer's claim?
(e) The $t(24)$ distribution arises in part (c) when the population distribution of the outside diameter is normal. Are the data above well described by a normal distribution? Use a normal qq plot to answer this question.