



Continued from Question 1.

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2. [3 pts] [Using reference material presented here](#), define *nominal size*, *basic size* and *tolerance*, and give an example of each. Illustrate the difference between *bilateral*, *limit*, and *unilateral tolerances* with an example of a 1" diameter shaft manufactured to  $\pm 0.002$ " tolerance. ***These are non-trivial tolerancing fundamentals we need to understand and communicate clearly on detail drawings.***

nominal size:

basic size:

tolerance:

bilateral tolerance example:

limit dimension / tolerance example:

unilateral tolerance example:  
(there are two answers; list both)

***HINT: make sure all tolerance examples preserve the stated tolerance range of 0.004".***

3. [2 pts] [Using the same reference material](#), define the general terms *fit* and *allowance*, and specifically, *clearance and interference fits*. After reviewing the dimensioned shaft and bore (i.e. precision hole) illustrations presented in the reference material, sketch and limit dimension a shaft and bore example of each type of fit using the information noted below.

fit:

allowance:

clearance fit (assume  $\frac{1}{2}$ " nominal shaft manufactured to  $+0.000$ " /  $-0.002$ " tolerance,  $0.010$ " allowance (i.e. min. clearance), and bore precision of  $\pm 0.001$ "; *hint: bore precision is the tolerance range within which the bore can be repeatedly produced*):

***clearance fit: a fit in which one part fits easily into another with a resulting clearance gap***

**SHAFT:  $\varnothing 0.500$   
 $\varnothing 0.498$**

**BORE:  $\varnothing 0.512$   
 $\varnothing 0.510$**

**[KEY CONCEPT:  $0.010$ " MIN. CLEARANCE REQUIRES MIN. BORE SIZE OF  $\varnothing 0.510$ ]**

interference fit (assume  $\frac{3}{4}$ " nominal shaft manufactured to  $+0.002$ " /  $-0.000$ " tolerance,  $0.010$ " allowance (i.e. max. interference), and bore precision of  $\pm 0.001$ "; *hint: bore precision is the tolerance range within which the bore can be repeatedly produced*):

4. [1 pt] [Using the same reference material](#), illustrate the difference between datum dimensioning versus chain dimensioning by labeling the following two examples. ***The datums used for dimensioning are critical for properly communicating our design intent for each part feature. Simply throwing the required dimensions on a part drawing is not enough.***



5. Take time to understand why the following items are essential for every detail drawing we make, and use this checklist for each detail drawing created for this course.
- a. **Dimensions necessary to locate every feature on the part during manufacturing.** It only takes one missing dimension to halt progress on a part and waste valuable time (that you pay for) when the manufacturer has to contact the part designer/drawer for this information. It also makes you look incompetent. (*Mike's Rule #1 for Competent Engineers: always try to avoid looking dumb ☺.*)
  - b. **Tolerances for every dimension on the drawing.** Since a tolerance defines the allowable range of error, a dimension without a tolerance is useless and signifies any size is okay; that's rarely the designer's intent. Every dimension must have a tolerance. (*Reference Rule #1 above.*)
  - c. **Units specification.** When you receive parts that are scaled wrong by a factor of 25.4, yet still have to pay for them, others may laugh, but you won't. (*Rule #1 owns all.*)
  - d. **Material specification.** A part made from the wrong material will either be too weak or too strong. Too weak will obviously result in failure and too strong means you paid more for the part than necessary (*which again makes you look dumb since you already forgot Rule #1 ☺*).
  - e. **Quantity of parts to be made.** Aside from the obvious reason why part quantity is imperative to note on detail drawings, part quantity will *largely* impact individual part cost.
  - f. **Surface finish specifications for every surface.** In addition to feature tolerance, this is other information we care about when manufacturing parts. Like smaller tolerances, better surface finishes cost a lot more, so make sure they are justified. Failure to note this information results in finishes that are too coarse or too fine. Too coarse may not function properly in use and too fine means you (again) paid *significantly* more for the part than necessary for it to do its required job. (*Rule #1 strikes again.*)
  - g. **Appropriate hole and thread notes.** Parts typically attach to others via holes and fasteners, so it is imperative to specify these correctly (*which is not trivial*).
  - h. **Unique part name or part number.** The part name is important because it is referenced in the bill of materials and will be discussed with the manufacturer. Referring to a part as “the small one with four holes in one end and a slot in the other...” is unprofessional and will inevitably lead to mistakes. (*Rule #1 never sleeps.*)
  - i. **Names of designer and drawer.** The designer's and drawer's names must be on each drawing (detail & assembly) so everyone knows who to contact if there are problems. *Although a checker's name is not typically listed on each drawing, each drawing you make is a legal document and as such, requires proofing by an independent party. Too much is on the line to not ask someone who is intelligent and reliable to proof your drawings, so choose wisely!*
  - j. **Additional notes about breaking sharp corners (i.e. deburring), etc.** Debur notes are important because you don't want to incur injury assembling newly manufactured parts and you don't want a customer to get hurt using your product. A drawing note like “*debur all edges*” is adequate to ensure the manufacturer removes sharp edges that can cut your skin. *Every time a cutting tool is used (i.e. on a milling machine, lathe, bandsaw, drill press, sheetmetal shear, etcetera) a sharp edge will result that requires debur instructions, so include them every time.*

6. [2 pts] Define *accuracy* and *precision* (i.e. explain the difference) and illustrate your understanding by labeling the circular targets using the following description letters:
- accurate and precise
  - accurate but not precise
  - precise but not accurate
  - inaccurate and imprecise

accuracy:

precision:



7. [1 pt] Illustrate your understanding of accuracy and precision by describing the following measurement results using the same description letters as the previous problem. Actual part size is 1.250".

1.210"	1.255"	1.281"	1.251"
1.230"	1.245"	1.282"	1.252"
1.270"	1.253"	1.281"	1.251"
1.290"	1.247"	1.282"	1.250"

8. The purpose of a bill of materials (BOM) is to show all components of a finished product (both purchased & manufactured items). ***For EML2322L a BOM should contain the following info: part numbers, quantities, descriptions and unique item numbers that match the corresponding balloons on the accompanying assembly drawing(s).*** (Note that a BOM does not contain material or cost information, as these belong in the individual part detail drawing(s) and the project budget summary, respectively.) Take time to review the example assembly drawings and BOMs shown on the course website under the [Design Project Report Examples link](#):

**[BOM Example 1 \(\\*\\*\\*\) excellent example of a proper BOM for EML2322L \(\\*\\*\\*\)](#)**

***Refer to this information when creating the BOM required for the course project.***

9. ***The primary purpose of a tolerance table on a detail drawing is to un-clutter the drawing for the person making the part. If a detail drawing has more than 3 dimensions, a tolerance table should be used.*** Take time to examine a tolerance table and understand how it is used. Look at [this example of the shaft clamp bracket from lab without a tolerance table](#) to appreciate how much clutter a tolerance table can remove from a part drawing.

10. [4 pts] [Using the provided reference material for significant figures](#) identify the number of significant figures in the following numbers and write the answers to the right of each one:

- A. 3.0800 \_\_\_\_\_
- B. 0.00418 \_\_\_\_\_
- C.  $7.09 \times 10^{-5}$  \_\_\_\_\_
- D. 91.600 \_\_\_\_\_
- E. 0.003005 \_\_\_\_\_
- F.  $3.200 \times 10^9$  \_\_\_\_\_
- G. 250 \_\_\_\_\_
- H. 780,000,000 \_\_\_\_\_

11. [5 pts] How many millimeters are in an inch? How many inches are in a millimeter? How many feet are in a meter? How many Newtons are in a pound? How many pounds are in a kilogram? Use a calculator and report answers to three significant figures. ***These are basic unit conversions you should know from memory. From this day forward, you should not need to rely on your calculator for these basic unit conversions, as we look foolish in front of our bosses, co-workers and customers when we can't perform ballpark conversions in our heads without a calculator.***

Using rounded approximations (i.e. NO CALCULATOR), approximately what size does a 4" diameter cylinder measure in millimeters? Approximately how thick is a 6mm plate in inches? If a piece of pipe measures 3-1/2 meters in length, approximately how long is that in feet? If a part's mass measures 20 kilograms, approximately how heavy is it in pounds? If a part weighs 20 pounds, what is its approximate mass in kilograms? ***Success in industry requires the ability to perform accurate analyses when necessary and ballpark estimates that are within 20% of the actual answer, quickly.***

**COMPUTE THESE  
USING A CALCULATOR:**

- 1 inch = \_\_\_\_\_ mm
- 1 mm = \_\_\_\_\_ in
- 1 m = \_\_\_\_\_ ft
- 1 lb = \_\_\_\_\_ N
- 1 kg = \_\_\_\_\_ lb

**ESTIMATE THESE WITHOUT  
USING A CALCULATOR:**

- 4 in  $\approx$  \_\_\_\_\_ mm
- 6 mm  $\approx$  \_\_\_\_\_ in
- 3.5 m  $\approx$  \_\_\_\_\_ ft
- 20 kg  $\approx$  \_\_\_\_\_ lb
- 20 lb  $\approx$  \_\_\_\_\_ kg