

PRINT NAME _____

Instructions:

- One 8 $\frac{1}{2}$ " x 11" sheet of notes is allowed and must be turned in with the exam.
- You may use a pencil, eraser, and straight edge.
- No electronic devices may be used.
- Try to pace yourself. Look over the entire exam and work on the things you know you can do first. If you get stuck on something, move on !
- Good Luck !!

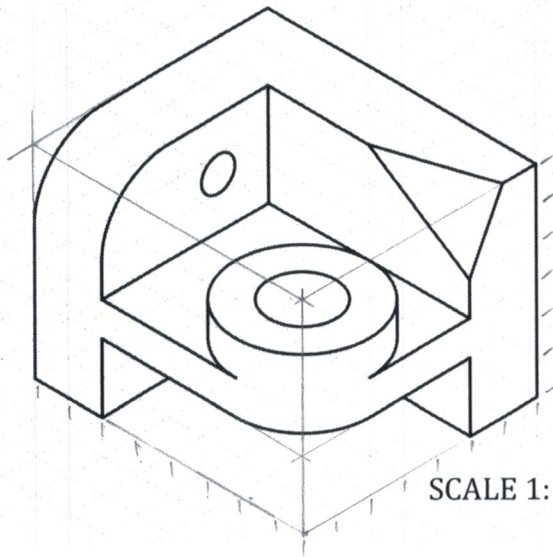
| Section | Score | Points Possible | Points Earned |
|---------|--|-----------------|---------------|
| I | Sketching – Orthographic Projection & Dimensioning | 15 | |
| II | Sketching – Isometric | 10 | |
| III | Sketching – Advanced Iso/Ortho | 15 | |
| IV | Sketching – Section View and Hole Callouts | 15 | |
| V | Sketching – Auxiliary View | 10 | |
| VI | Fits and Tolerances | 15 | |
| VII | Tolerance Stack Analysis | 10 | |
| VIII | Threaded Fasteners | 10 | |
| Total | | 100 | /100 |

By my signature below, I hereby testify that I have neither given nor received any assistance on this exam and I have obeyed the Honor Code (an engineering student will not lie, cheat, or steal, or tolerate those who do). All work on this exam is my own. I have not and will not discuss this exam with any other student or prospective student.

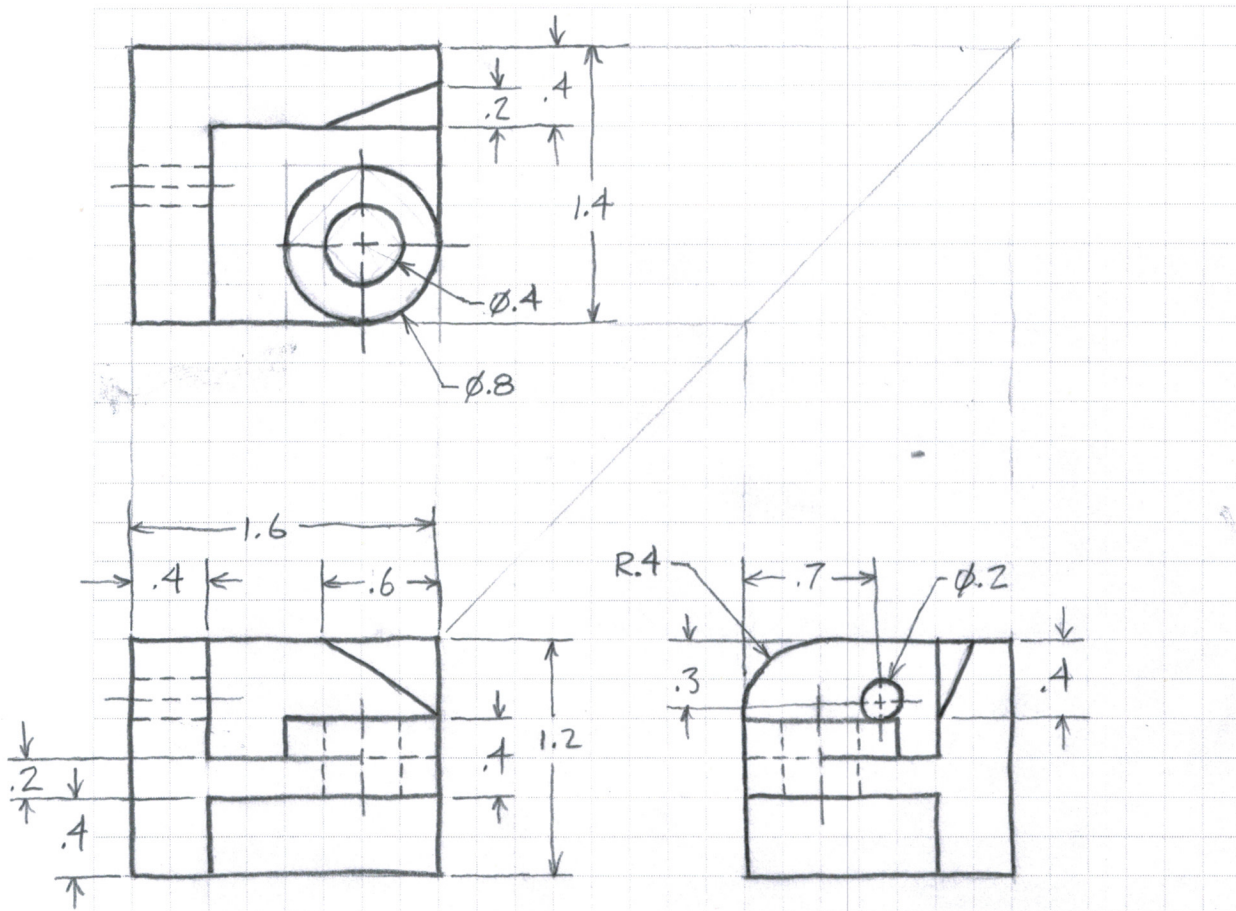
Signature: _____ Date: _____

I Orthographic Projection and Dimensioning (15 pts)

Create a fully-dimensioned orthographic sketch of the following object. Use 3rd angle projection and include front, top, and right-side views. Note: all holes are thru-holes.

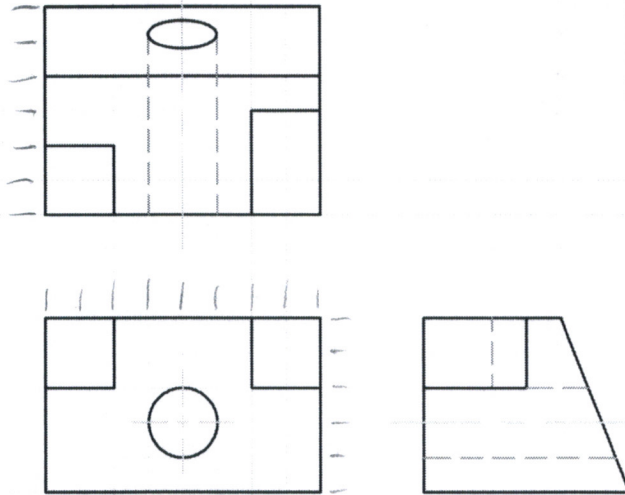


SCALE 1:1 Each grid is 1/5"

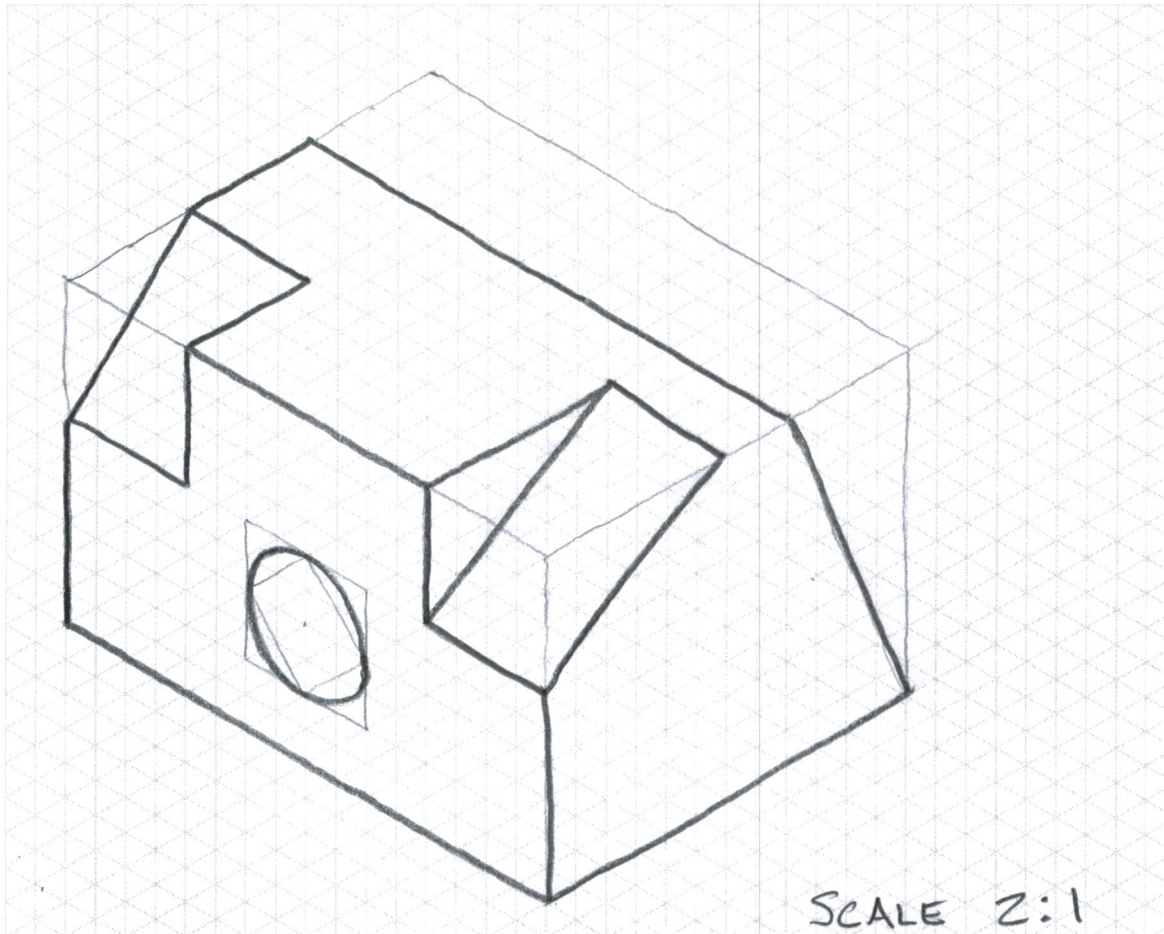


II Isometric Sketching (10 pts)

Create an Isometric sketch of the following object, which is shown using 3rd angle projection. No dimensions are required.



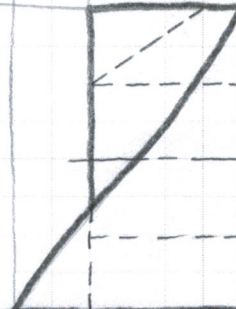
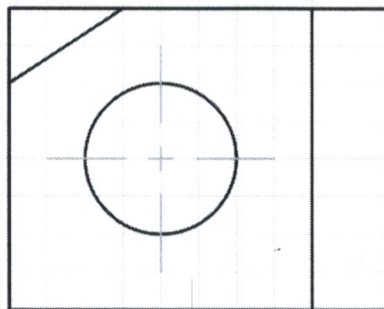
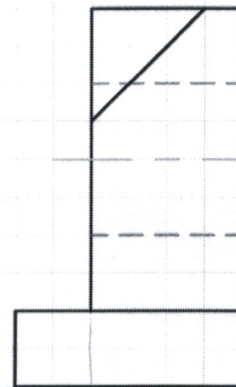
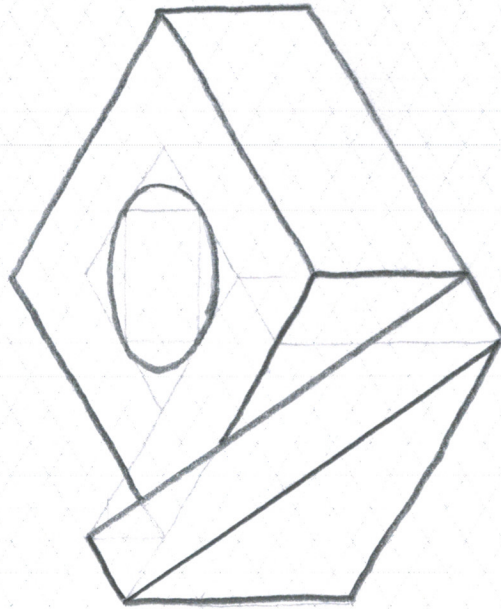
SCALE 1:1



SCALE 2:1

III Advanced Sketching (15 pts)

Given top and right-side views of the following object, in 3rd angle projection, sketch the front view and an isometric view. No dimensions are required.

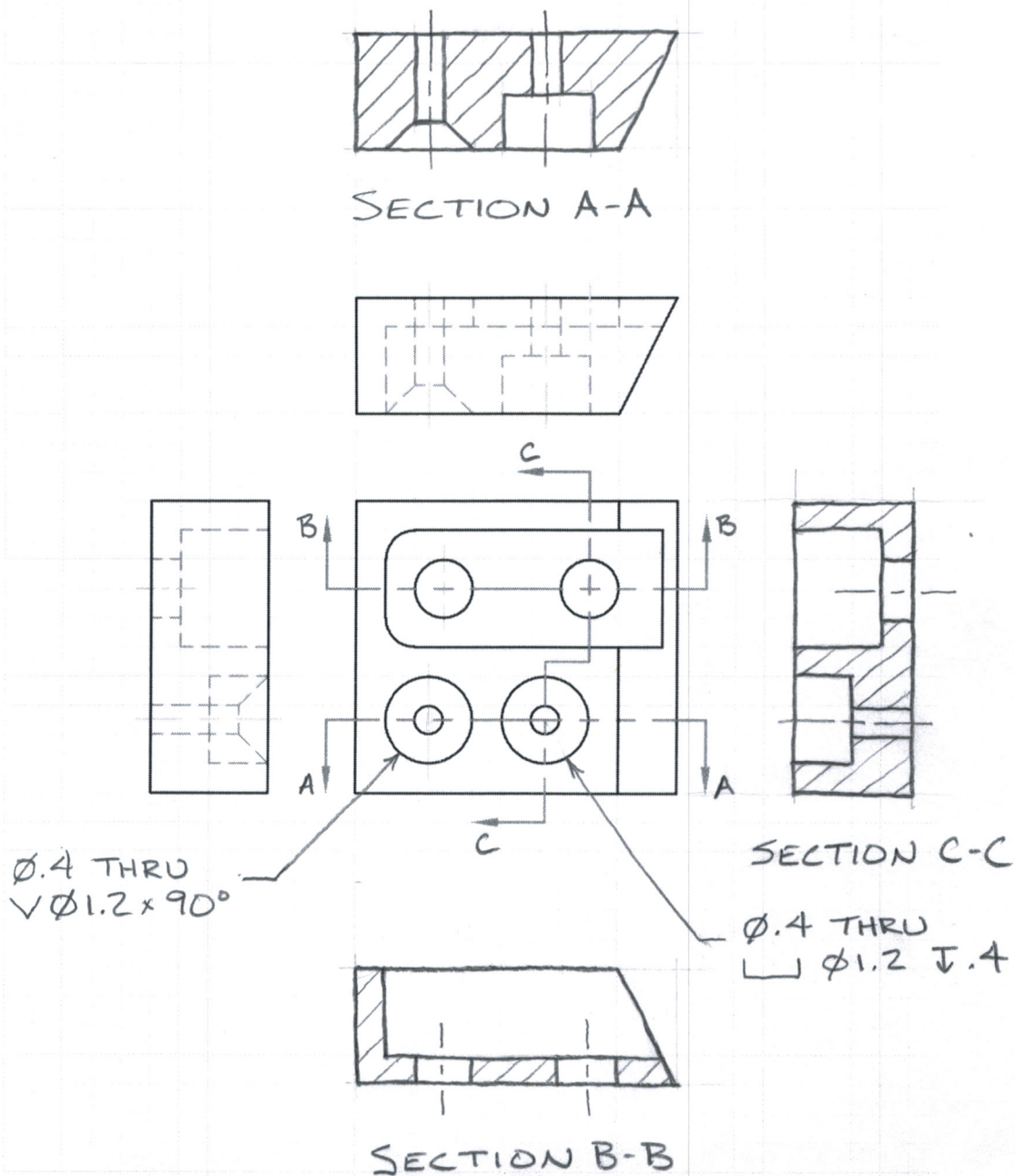


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IV Section View and Hole Callouts (15 pts)

Given the following orthographic views in third angle projection, draw three section views, based on the provided cutting plane lines. Add appropriate callouts for the machined (counterbored/countersunk) holes.

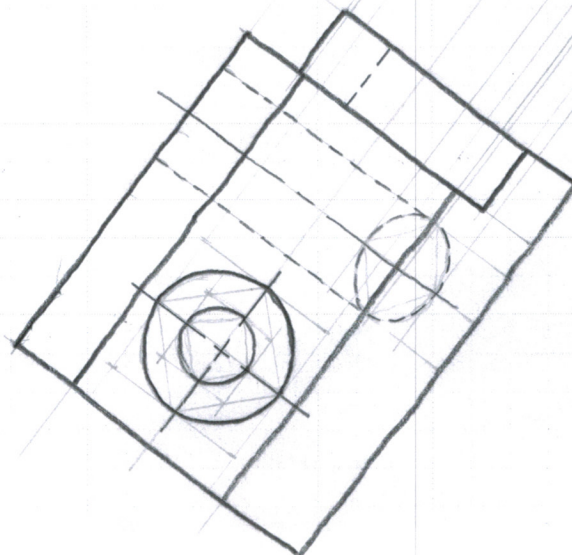
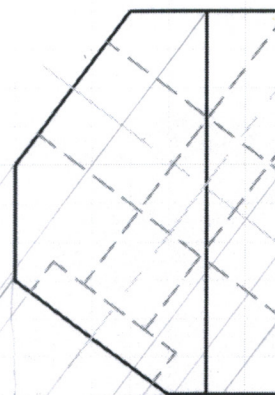
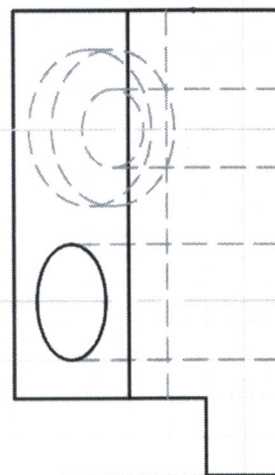
SCALE 1:2 (each grid is 1/5")



V Auxiliary View (10 pts)

Given the following orthographic views in third-angle projection, create a *full* auxiliary view to show the true shape of the counterbored hole. No dimensions are required.

SCALE 1:5

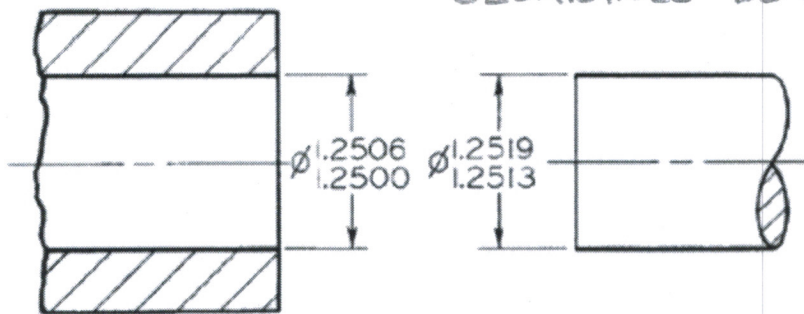


VI Fits and Tolerances (15 pts)

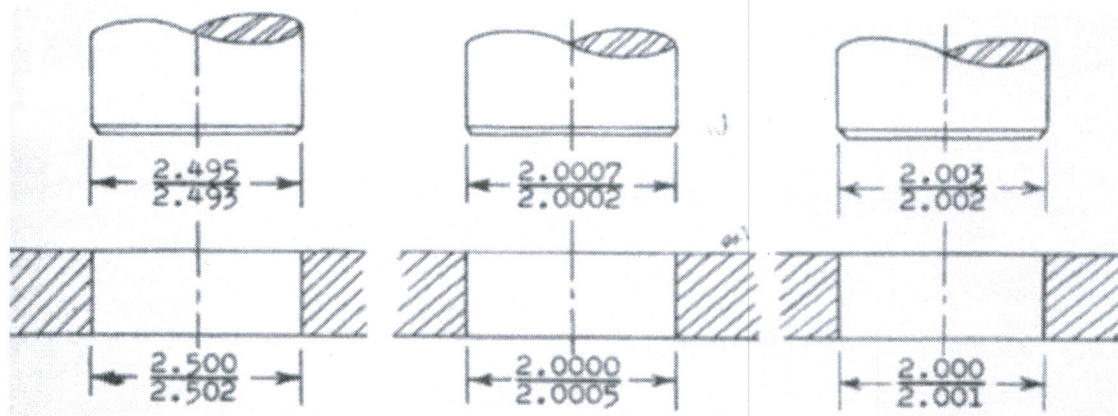
Given the dimensions as shown in the below figure, determine:

- the tolerance of the hole $1.2506 - 1.2500 = .0006$
- the tolerance of the shaft $1.2519 - 1.2513 = .0006$
- allowance = MIN CLEARANCE = $1.2500 - 1.2519 = -.0019$
- maximum clearance $1.2506 - 1.2513 = -.0007$
- Define what fit is the assembly and explain why.

INTERFERENCE FIT: THE SHAFT IS ALWAYS LARGER THAN THE HOLE (MIN & MAX CLEARANCE BOTH NEGATIVE).



Determine the type of fit in the following example:



CLEARANCE
FIT

TRANSITION
FIT

INTERFERENCE
FIT

VII Tolerance Stack Analysis (10 points)

Both parts of this question refer to the blocks assembled in the figure below. The values of the labeled dimensions are shown in the table below. The last two columns are for your use, but are not graded.

Part 1:

Determine the following for the gap labeled G2 using a Worst Case Analysis. All units are in mm.
(place answer in boxes for c-f):

- (3 pts) Loop Diagram (show below)
- (2 pts) Gap Equation (show below)
- (0.5 pts) Nominal Gap Value
- (0.5 pts) Gap Tolerance (+/-)
- (0.5 pts) Max Gap and
- (0.5 pts) Min Gap.

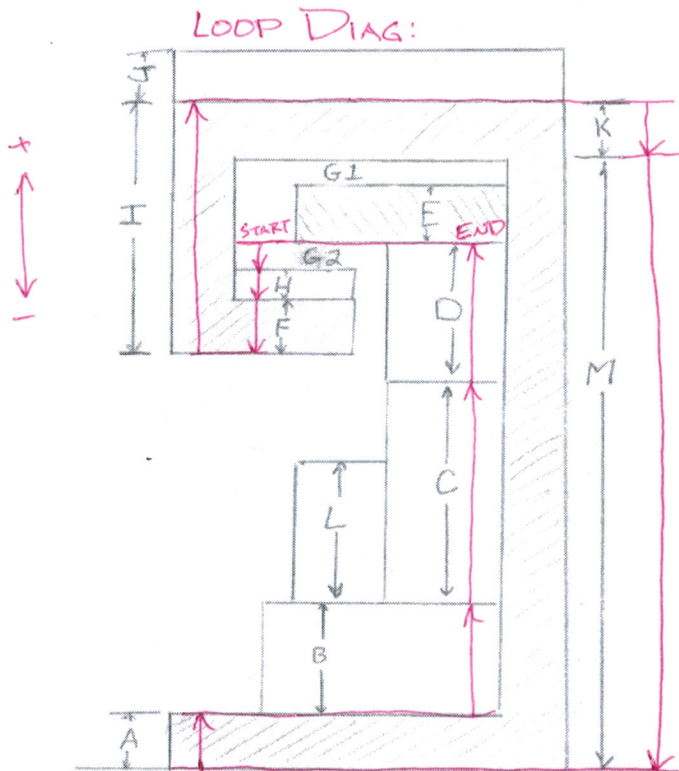
| |
|------|
| 1.75 |
| ±.76 |
| 2.51 |
| .99 |

| | Nominal Height | Tolerance | Adjusted Nominal | Adjusted Tolerance |
|---|----------------|-------------|------------------|--------------------|
| A | 2 | ±0.1 | + 2 | ±.1 |
| B | 4 | ±0.07 | + 4 | ±.07 |
| C | 8 | ±0.1 | + 8 | ±.1 |
| D | 5 | ±0.1 | + 5 | ±.1 |
| E | 2 | +0.1 / -0.0 | | |
| F | 2 | ±0.08 | - 2 | ±.08 |
| H | 1 | ±0.01 | - 1 | ±.01 |
| I | 9 | +0.2 / -0.0 | + 9.1 | ±.1 |
| J | 2 | ±0.1 | | |
| K | 2 | ±0.05 | - 2 | ±.05 |
| L | 5 | ±0.1 | | |
| M | 21.5 | +0.0 / -0.3 | - 21.35 | ±.15 |

Part 2:

(3 pts) Assuming that parts D and H are made in house, how would you modify the nominal values and tolerances of one (or both) of those parts to get the gap to be between 0.5 and 2.0, inclusive? Place your answers in the table to the right.

| | Recommended Nominal | Recommended Tolerance |
|---|---------------------|-----------------------|
| D | 4.5 | ±.09 |
| H | 1 | ±.01 |



$$-G_2 - H - F + I - K - M + A + B + C + D = 0$$

GAP EQN:

$$G_2 = A + B + C + D - F - H + I - K - M$$

PART 2:

HAVE $1.75 \pm .76$

WANT $1.25 \pm .75 = G_2$

TO MAKE THE GAP SMALLER,
MAKE D SMALLER OR H BIGGER.

CHOOSE $D = 4.5$ $H = 1$

ALSO, REDUCE TOL BY .01

CHOOSE $D \pm .09$

VIII Threaded Fasteners

1. (4 pts) Determine the minimum tap drill depth for a 1/2-13 coarse threaded tapped hole by using a 7-thread tapered chamfer tap, given that the desired thread engagement length must be 1.0 inches.

MIN THREAD DEPTH: 1 INCH
 TAP CHAMFER: 7/13 INCH
 + EXTRA THREAD: 1/13 INCH

$$1\frac{8}{13} \text{ INCH} \approx 1.615 \text{ INCH MIN}$$

2. (3 pts) Identify the different components of each thread note:

M10 x 1.5 - 4h6h - LH
THRU

M: METRIC
 10: 10 MM MAJ DIA
 1.5: 1.5 MM PITCH
 4h6h: TOLERANCE
 LH: LEFT-HAND THREAD
 THRU: THREADS SHOULD
 EXTEND THROUGH PART

#6 - 32 UNC - 2B - RH
∇0.75

#6: NOMINAL SIZE
 32: 32 THREADS/INCH
 UNC: UNIFIED COARSE THREAD
 2: THREAD CLASS (NORMAL)
 B: INTERNAL THREAD
 RH: RIGHT-HAND
 ∇0.75: MIN THREAD DEPTH 0.75 IN.

3. (3 pts) Write the thread note for a 7/16 fine thread. What is the pitch?

7/16 - 20 UNF

PITCH IS $\frac{1}{20}$ INCH

(External Threads) Approximate Minor diameter = $D - 1.0825P$

P = Pitch

| Nominal Size, in. | Basic Major Diameter (D) | Course UNC | | Fine UNF | | Extra Fine UNEF | |
|----------------------|-----------------------------------|------------------|-------------------|------------------|-------------------|--------------------|-------------------|
| | | Thds. Per in. | Tap Drill Dia. | Thds. Per in. | Tap Drill Dia. | Thds. Per in. | Tap Drill Dia. |
| #0 | 0.060 | ... | ... | 80 | 3/64 | ... | ... |
| #1 | 0.0730 | 64 | 0.0595 | 72 | 0.0595 | ... | ... |
| #2 | 0.0860 | 56 | 0.0700 | 64 | 0.0700 | ... | ... |
| #3 | 0.0990 | 48 | 0.0785 | 56 | 0.0820 | ... | ... |
| #4 | 0.1120 | 40 | 0.0890 | 48 | 0.0935 | ... | ... |
| #5 | 0.1250 | 40 | 0.1015 | 44 | 0.1040 | ... | ... |
| #6 | 0.1380 | 32 | 0.1065 | 40 | 0.1130 | ... | ... |
| #8 | 0.1640 | 32 | 0.1360 | 36 | 0.1360 | ... | ... |
| #10 | 0.1900 | 24 | 0.1495 | 32 | 0.1590 | ... | ... |
| #12 | 0.2160 | 24 | 0.1770 | 28 | 0.1820 | 32 | 0.1850 |
| 1/4 | 0.2500 | 20 | 0.2010 | 28 | 0.2130 | 32 | 7/32 |
| 5/16 | 0.3125 | 18 | 0.257 | 24 | 0.272 | 32 | 9/32 |
| 3/8 | 0.3750 | 16 | 5/16 | 24 | 0.332 | 32 | 11/32 |
| 7/16 | 0.4375 | 14 | 0.368 | 20 | 25/64 | 28 | 13/32 |
| 1/2 | 0.5000 | 13 | 27/64 | 20 | 29/64 | 28 | 15/32 |
| 9/16 | 0.5625 | 12 | 31/64 | 18 | 33/64 | 24 | 33/64 |
| 5/8 | 0.6250 | 11 | 17/32 | 18 | 37/64 | 24 | 37/64 |
| 11/16 | 0.675 | ... | ... | ... | ... | 24 | 41/64 |
| 3/4 | 0.7500 | 10 | 21/32 | 16 | 11/16 | 20 | 45/64 |