EML2322L – MAE Design and Manufacturing Laboratory

FASTENERS & THREADING (HW #3)

Name: ____ **Lab Period (i.e. W2-3):** ______

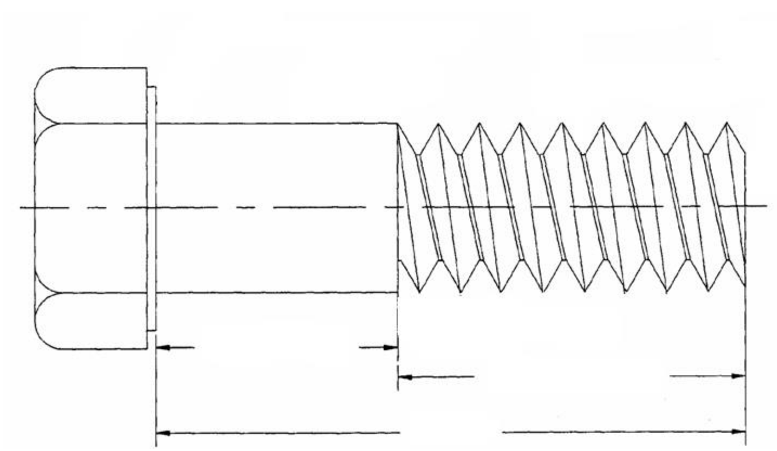
Assigned Roster Number (i.e. XYZ): ____________ **Grader's Initials:** ______

References: *Fasteners and Threading Course Notes, Tap Drill Chart.pdf*

Description: This assignment highlights fastener concepts you need to know for parts and drawings you create for the course project as well as when working in industry. Refer to the lecture notes on fasteners & threading and the drill & tap chart handout to complete this assignment. If extra room is needed to answer any of the questions, use the back side of each page. Questions from the lecture notes list the corresponding pages where the answers can be found. **WORK INDIVIDUALLY TO ANSWER THESE QUESTIONS** (if you need assistance after reading the lecture notes, ask a TA or the course instructor). Messy work or answers not hand written on these assignment pages and stapled together will be penalized 25%. Please write your correct lab period and roster number on the cover page.

1. [p.3] What is the functional difference between a bolt and a screw?

2. [pp.6-7] On the following illustration of a fastener, clearly label the head, bearing surface, shank, thread crest, thread root, thread point, pitch, grip length, thread length & overall length.



3. [p.7] Regardless of country of origin, what are the two varieties of fastener threads available?

4. [pp.9-11] How are the threads on all quality fasteners made and why are they made this way? *Hint: die or lathe cut threads create stress risers resulting in weak threads that fail prematurely.*

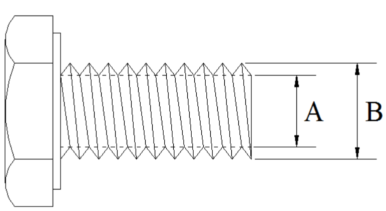
5. [p.12] What is the sole purpose of a fastener?

6. [pp.12-13] Why should fastener threads never be placed in shear? How should engineers prevent relative sliding of parts fastened to each other?

7. [p.14] What keeps a fastener tight or secure? What does not?

8. [pp.7-8] For the same size fastener, is a coarse thread stronger than a fine thread? *Most fasteners are made from high strength alloy steels with threads that are rolled after heat treatment to obtain the strength required to function effectively. Typical fastener failures occur under excessive tensile load by breaking at the minor diameter (since this is the weakest area of the fastener's geometry). Therefore, whichever thread has the larger minor diameter will be stronger.* For each case (i.e. coarse and fine thread), dimension the major and minor thread diameters with actual values off the tap drill chart and highlight the area of the fastener that would fail in the scaled view. Use these illustrations to answer the original question by explaining which fastener thread has a greater cross sectional area *(CSA)*.

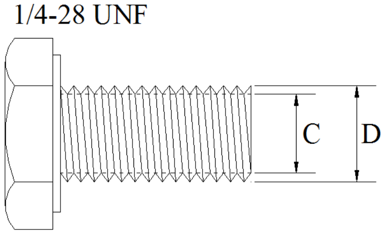
1/4-20 UNC



A =

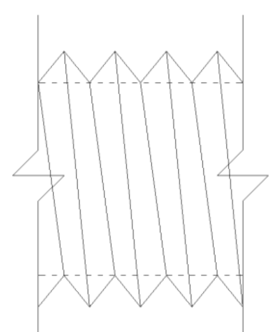
B =

1/4-28 UNF



C =

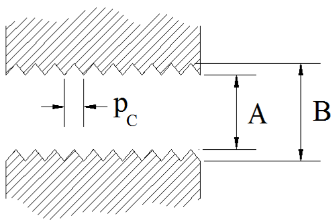
D =



SCALED VIEW

9. [pp.7-8] For the same size threaded hole in a soft material like aluminum, is a coarse thread stronger than a fine thread? Assume the same number of engaged threads. *Typical female thread failures occur under excessive tensile load by shearing the cross-sectional area (CSA) of the threads at the major thread diameter. Therefore, whichever thread has the larger thread pitch and smaller minor diameter will have greater shear area and thus be stronger.* For each case (i.e. coarse and fine thread) dimension the major and minor thread diameters and pitch with the correct values off the tap drill chart and highlight the area(s) where the failure would occur. Show which thread has greater CSA. Use these illustrations to answer the original question.

1/4-20 UNC

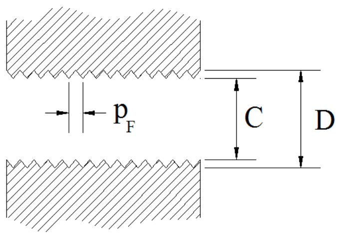


A =

B =

p_C =

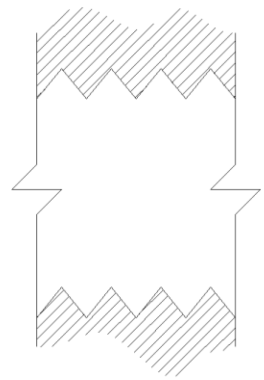
1/4-28 UNF



C =

D =

p_F =



SCALED VIEW

10. [pp.13-15] Read the over-tightening versus under-tightening example presented in the notes. What is the ultimate tensile strength (UTS) of the 3/8-24 fastener? How many 12,000 lb load cycles can the fastener endure before failure if stressed, "torqued" or "preloaded" to 40% of its UTS? How many cycles can the same fastener tolerate if torqued to 60% of its UTS? Approximately how many more stress cycles did the *properly torqued* 3/8" fastener sustain before failure? What does this indicate about our need to not only select proper size fasteners, but also to explicitly denote torque specifications on <u>all</u> fasteners used in our assemblies?

   A. ultimate tensile strength (UTS) of 3/8-24 fastener used in the example:
   B. # of 12,000 lb cycles a 3/8-24 fastener torqued to 40% of its UTS can withstand:
   C. # of 12,000 lb cycles a 3/8-24 fastener torqued to 60% of its UTS can withstand:
   D. approx. increase in # of stress cycles (i.e. # of cycles @ 60% / # of cycles @ 40%):
   E. conclusion:

11. [p.15] What is the equation used to calculate required fastener torque as a function of desired preload and bolt size? Calculate the tightening torques for the following fasteners: a grade 5, ¼-20 fastener, a grade 8, ¼-20 fastener and a grade 8, ¼-28 fastener. ***Explain how fastener grade and TPI affect the required preload.***

    equation:

<u>*Grade 5, ¼-20*</u>	<u>*Grade 8, ¼-20*</u>	<u>*Grade 8, ¼-28*</u>
σ_y = *85,000 psi*	σ_y =	σ_y =
σ_t = *76,500 psi*	σ_t =	σ_t =
A_t = *0.0318* in^2	A_t =	A_t =
F_i = *2,433 lbf*	F_i =	F_i =
T = 122 lb-in = 10.2 lb-ft	***T =***	***T =***

    trends:

12. What does the shank diameter of a 3/8-16 fastener used in an aluminum workpiece measure? *Hint: shank size is not a function of workpiece material type.*

    shank diameter of a 3/8-16 fastener:

13. How much (total) clearance does a close fit hole for a 1/4″ bolt leave? How much radial clearance would the same fit leave? Similarly, how much total and radial clearance does a free fit hole for a 5/16″ bolt leave? ***Radial clearance is defined as half the total clearance.***

    total (1/4" close fit): ***0.007″***　　total (5/16″ free fit):
    radial (1/4" close fit): ***0.0035″***　　radial (5/16″ free fit):

14. Select the appropriate tap drill size for tapping a ¼-20 thread in an aluminum workpiece. Select the appropriate tap drill size for tapping a ¼-28 thread in a steel workpiece.

    drill size for tapping ¼-20 in aluminum: ***Ø 0.201″***
    drill size for tapping ¼-28 in steel:

15. How many threads per inch (TPI) does a ½" UNF fastener have? What does the thread pitch of a ½" UNF fastener measure? Repeat for a ½" UNC fastener. How are TPI & thread pitch related?

    TPI (1/2" UNF): ***20***　　TPI (1/2" UNC):
    thread pitch (1/2" UNF): ***0.050"***　　thread pitch (1/2" UNC):
    TPI and thread pitch relationship:

16. Which of the following would qualify as industry standard clearance holes for 3/8″ fasteners: 0.370″, 0.375″, 0.380″, 0.386″, 0.390″, 0.397″, 0.400″, 0.500″? Circle your answer(s).

17. Specify the appropriate drill size for tapping an M6x1.0 thread in aluminum. Specify the appropriate drill size for tapping an M6x0.75 thread in a steel workpiece.

    M6x1.0 in aluminum: ***Ø 5.00 mm***
    M6x0.75 in steel:

18. When mounting a part to a robot using ¼″ fasteners, what size clearance hole should be specified in the mounting bracket if (A) positioning accuracy is important (in which case a milling machine would be used) or (B) quick manufacturing time is important (in which case a drill press would be used)?

    (A) ***Ø 0.257″***
    (B)

19. Study the example hole note for specifying (2) holes to be drilled and tapped for 1/2″ threads thru an aluminum workpiece. List the correct hole note for specifying (3) 1/2″ fastener threads 1.0″ deep in a steel workpiece. *Hint #1: the type of thread (coarse or fine) is dictated by the type of material being threaded (weaker or stronger). Hint #2: blind holes must be tap drilled approximately one major fastener diameter deeper than the required thread depth.*

hole note specifications:	***1/2″ threads in aluminum:***	***1/2″ threads in steel:***
Ø tap drill diameter + depth;	***Ø 27/64″ THRU;***	
thread specification + depth;	***1/2-13 UNC THRU;***	
quantity of holes desired	***2 PLACES***	

20. Study the example hole note for specifying (2) holes to be drilled and tapped for 10mm threads 20mm deep in a brass workpiece. List the correct hole note for specifying (3) 10mm fastener threads 25mm deep in an iron workpiece. *Hint #1: the type of thread (coarse or fine) is dictated by the type of material being threaded (weaker or stronger). Hint #2: blind holes must be tap drilled approximately one major fastener diameter deeper than the required thread depth.*

hole note specifications:	***10mm threads in brass:***	***10mm threads in iron:***
Ø tap drill diameter + depth;	***Ø 8.50, 30 DEEP;***	
thread specification + depth;	***M10x1.50, 20 DEEP;***	
quantity of holes desired	***2 PLACES***	