

**2.810 Manufacturing Processes and Systems**  
**Practice Quiz #1**

Open book, open notes, computers with internet off

Time: 80 minutes

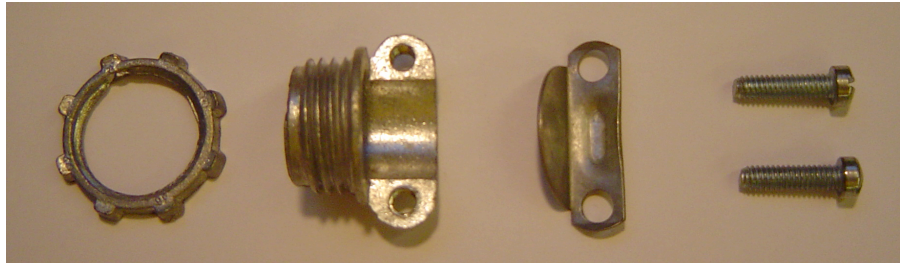
Name: \_\_\_\_\_

Problems:

1. How were these parts made? (XX points)
2. Process plan for bike chain puller body (XX points)  
+ Extra credit question (XX points)
3. Injection molding (XX points)
4. Micro turning lathe (XX points)
5. Injection molding redesign (XX points)

**1. How were these parts made? (XX points)**

Examine the electrical connector that you were given. For each of the four part types, identify the materials, the primary processes, and the secondary processes (if any) used to manufacture it. Be sure to list the reasons why you decided upon the materials and manufacturing processes that you listed. You may draw on the picture below to point out features or details that you are referring to.



1

2

3

4

Part	Material(s)	Reasons
1		
2		
3		
4		

Part	Process(es)	Reasons
1		
2		
3		
4		

## 2. Process plan for bike chain puller body (XX points)

The bike chain puller “tool body” shown on the following page can be made from hexagonal steel stock by machining. Assume it has already been cut and machined to length. Please write down the process steps to make the features listed below and called out on the drawing:

1. three lands of different widths,
2. radiused slot,
3. hole in base.

For each feature, identify the machines, tools, and fixtures needed for each operation, and the sequence of operations required. For each feature that you machine, sketch a simple schematic showing your set-up, namely the positions of the part, fixture, and tool. Your sketch should also show the orientation of the part. Point out any part of a feature that is particularly difficult to make. Use the blank process plan sheet that is provided.

**You do not need to estimate times. You only need to write a process plan.**

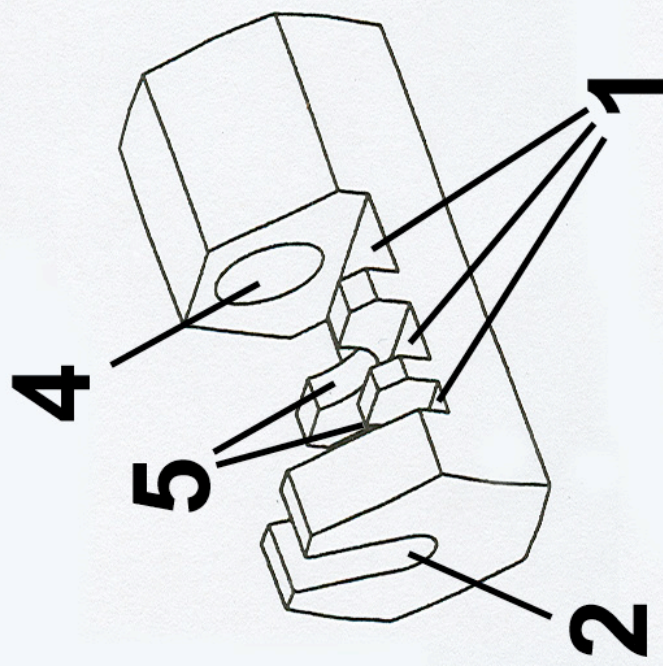
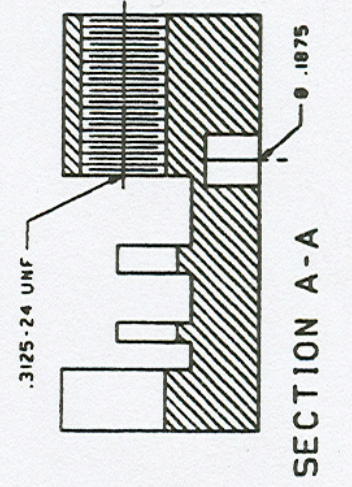
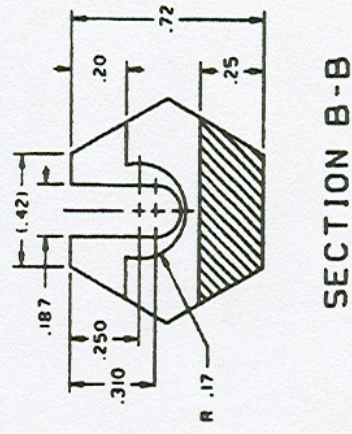
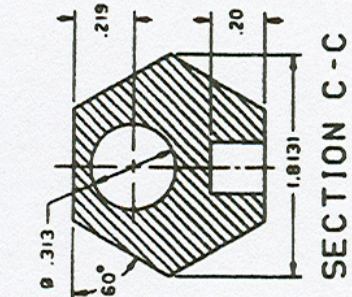
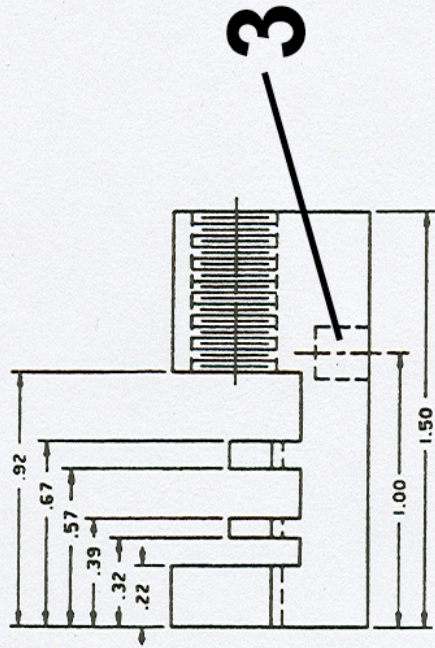
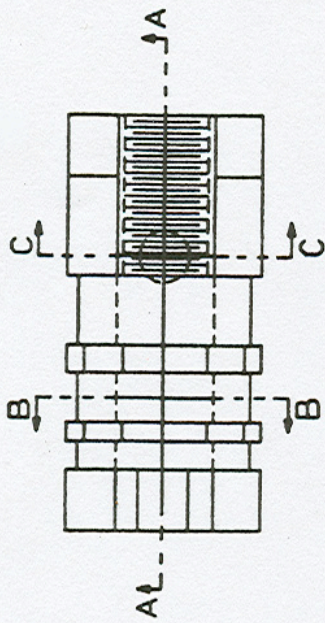
All dimensions are in inches. Unless otherwise indicated, tolerances are  $\pm 0.005$  inches. Please state all assumptions clearly.

### Extra credit (XX points)

a) Write down the process steps to make the following features:

4. horizontal threaded hole,
5. radiused profile on ridges between lands.

b) Estimate the time to machine feature 1.

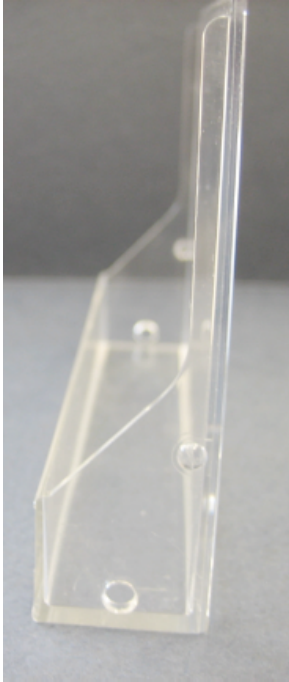




#	Machine	Tool	Operation	Fixture	Sketch

### 3. Injection molding (XX points)

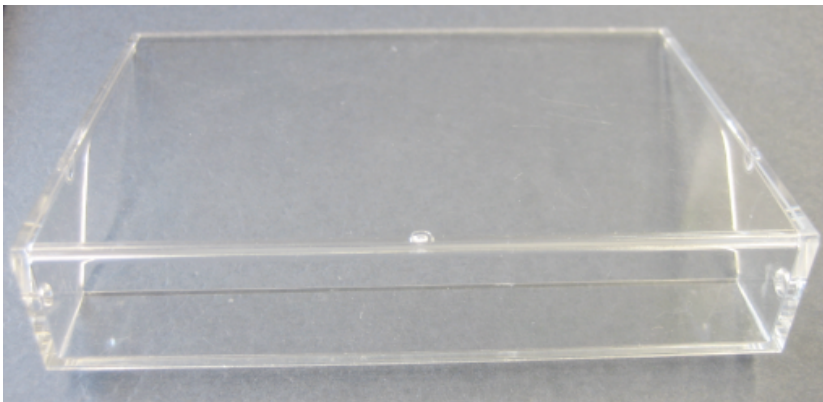
Look at this tape cassette case carefully. You only need to consider the top cover, shown in pictures 1 and 3. Estimate some basic parameters about the nature of the manufacturing process used to make this part.



Picture 1. Top cover.



Picture 2. Cassette case with top open.



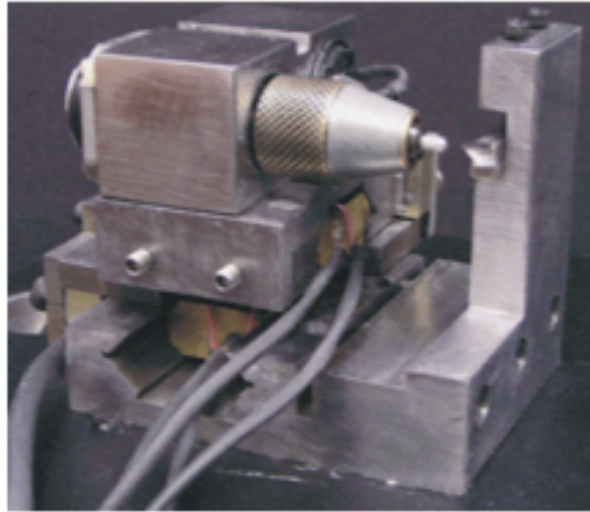
Picture 3. Top cover.

- a) Estimate the clamping force (in pounds force), if the dimensions  $L \times W \times H$  are 4 in  $\times$  2.625 in  $\times$  0.75 in.

b) Estimate the cooling time (in seconds), if the thickness of the plastic is  $1/8$  in.

c) Make a sketch of the tooling needed to make this part. Point out the gate location and the special tooling features required, if any.

#### 4. Micro turning lathe (XX pts)



#### Micro turning lathe

Dimensions  $W \times D \times H = 65 \times 44 \times 45 \text{ mm}^3$

Mass  $m = 150 \text{ g}$

Rotational speed  $n_{\max} = 10,000 \text{ min}^{-1}$

DC motor  $P_s = 1.6 \text{ W}$

Consider the micro-turning lathe shown above. This lathe is capable of turning an  $L = 1 \text{ mm}$  long aluminum needle with a diameter of  $d = 65 \mu\text{m}$  using a polycrystalline diamond, PCD, tool. The spindle speed was  $n = 10,000 \text{ rev}\cdot\text{min}^{-1}$  resulting in a cutting speed of  $v_c = 2 \text{ m/min}$  while the feed was  $f = 0.12 \mu\text{m}$  and the depth of cut  $a_p = 2 \mu\text{m}$ . The electrical power required for this machine is  $65 \text{ W}$ .

a) Estimate the material removal rate in  $\text{cm}^3/\text{sec}$ .

b) Estimate the electrical energy used per unit volume of material removed (in  $\text{kJ}/\text{cm}^3$ ) and unit mass removed (in  $\text{J}/\text{kg}$ ).

c) How does this “energy intensity” compare with more conventional machining, which is generally in the range of 1 – 10  $\text{MJ}/\text{kg}$  removed?

### 5. Injection molding redesign (XX pts)

A flat rectangular part with dimensions  $L \times W \times H$  is successfully injection molded at temperature  $T$  and filling velocity  $V$  through a single end gate. A modified design of this part has decreased each dimension by 30%. It is planned to mold this part at the same temperature and velocity. A manufacturing engineer suggests that you may run the risk of a short-shot. Do you agree? Please justify your answer with an analysis.

