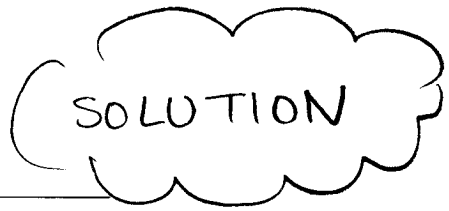
ME 355 Manufacturing Processes
Winter 2006, Kumar
MIDTERM EXAM #1

January 27, 2006
Time: **50 minutes**
Maximum points: **100**



Name: _____

Student No: _____

Notes

1. This exam is **CLOSED BOOK** and **CLOSED NOTES**. *There are a total of six pages, including the cover page. There are 20 questions, each worth 5 points. Please make sure you have the complete exam before you begin.*

2. Please be brief and to the point.
3. Do not turn this page until the bell rings.

Good Luck!

Give a short answer to the following questions within the space provided. Draw a sketch to support your answer wherever possible.

1. What is concurrent engineering?

See page 29 of text.

The key concept is that in concurrent engineering the product design, materials selection, and the manufacturing process design are conducted simultaneously, in an integrated manner,

2. What is the difference between accuracy and precision of a measurement?

accuracy: how close is a measurement to the true value

precision: how repeatable is the measurement.

3. What is the difference between an assignable error and a random error? Give an example of each.

assignable error; when a cause can be identified, and the error can be quantified. Example: temperature difference between calibration and actual measurement with a caliperse.

Random error; can not be quantified / accounted for.
Ex; human error.

4. Define true strain. How is it different from engineering strain?

$$\epsilon_{true} = \int_{l_0}^{l_0+\Delta L} \frac{dl}{l} = \ln \frac{(l_0+\Delta L)}{l_0}$$

$$\epsilon_{eng} = \frac{\Delta L}{l_0}$$

5. What is adhesion? What surface properties play a major role in determining the extent of adhesion developed between the surfaces?

The force needed to seperate two surfaces in contact with each other is a measure of adhesion between the two surfaces. This force depends on the strength of bonds established at the molecular level. Cleanliness of surfaces, and chemical compatibility of the materials affect the extent of adhesion developed.

6. What is a ceramic? Give an example. What unique characteristic of ceramics makes them useful as a class of materials?

Ceramic is usually an oxide, nitride, or carbide of a metal.

Ex: SiO_2, WC etc.

Ceramics have exellent properties at high temperatures — thus they are a unique set of materials for high temp. applications.

7. Give two examples each of a) a ferrous material; b) a non-ferrous material, and c) a thermoplastic material.

a) ferrous : materials with iron; cast iron, stainless steel, etc.

b) non-ferrous: materials without iron: Cu, Al, Mg etc. and their alloys.

c) PE, PP, PC, ABS etc.

8. What is the function of lubricants in metal working operations? Give two examples of lubricants.

lubricant functions : reduce friction; also reduce adhesion between workpiece and tool thus reducing die wear.

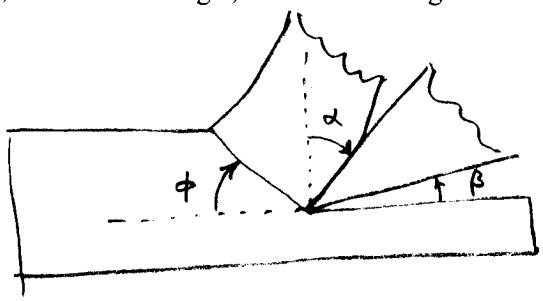
examples: Silicon oil, graphite, MoS_2, dry soap etc.

9. You need to establish the stress-strain behavior of a material in tension as well as in compression. Which test—tension or compression—will require a higher capacity test machine? Why?

Compression test. Several reasons:

1) specimen area increases in compression → requiring higher loads to reach breaking stress.
2) compression suppresses crack propagation → may delay fracture
3) often compressive strengths are higher than tensile strengths.

10. Make a sketch of ideal orthogonal cutting with a positive rake angle. Mark the rake angle, the clearance angle, and the shear angle.



α: rake angle

β: clearance angle

ϕ: shear angle.

11. Describe two different kinds of chips produced in machining, and state the conditions under which they are produced.

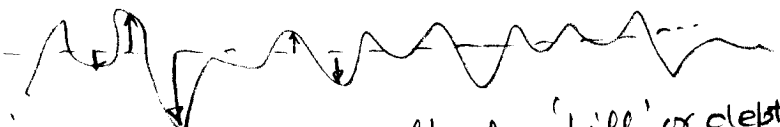
Continuous chips: ductile materials

short, broken chips: when cutting materials with low ductility, or cutting free-machining materials.

Process variables e.g. cutting speed, rake angle can affect the kind of chip produced.

12. What is the difference between surface roughness and surface integrity?

Surface roughness



$$Ra = \frac{\Sigma y_i}{n}$$ where y = height of a 'hill' or depth of a valley relative to a mean surface.

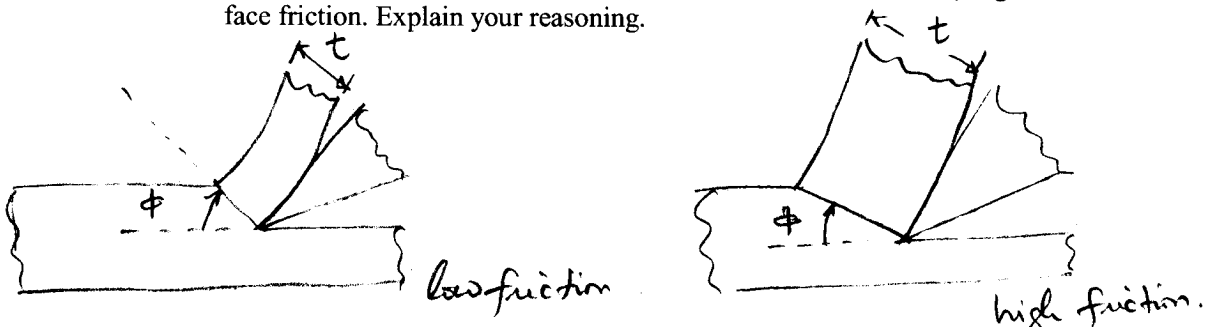
n = no. of measurements.

Ra is a measure of how smooth a surface is.

Surface integrity embodies the desired properties of a surface in a given application. These may include presence of cracks, surface strength, fatigue strength, etc.

As friction increases, the shear angle decreases, leading to a thicker chip. This is a result of the process seeking to minimize the energy spent in the cutting operation.

13. Make a sketch of ideal orthogonal cutting with a positive rake angle. Show the shear angle and chip thickness for **a)** low tool-face friction and **b)** high tool-face friction. Explain your reasoning.



14. Taylor equation for tool life is:

$V t^n = C$

Where V is the cutting speed in feet per min, t is tool life in min. and C is a constant. The exponent n and C are empirically determined.

If n = 0.25 and C = 1000 fpm, what should be the cutting speed V for a life of one hour?

$V t^{.25} = 1000 \quad ; \quad t = 60 \text{ min}.$

$\Rightarrow V = 359 \text{ ft/min}.$

15. If the life of an HSS cutting tool is 60 minutes at the recommended cutting speed, what will the life be at **a)** 25 %, and **b)** 50 % higher speed?

Assume n = 0.1

$$\frac{t_{25\%}}{t_0} = \frac{1}{(1.25)^{(1/.1)}} = .107 \Rightarrow t_{25\%} = 6.44 \text{ min}.$$

$$\frac{t_{50\%}}{t_0} = \frac{1}{(1.5)^{1/.1}} = .017 \Rightarrow t_{50\%} = 1.04 \text{ min}.$$

16. State at least three effects that temperature rise due to friction can have on the machining process.

- lower the tool life
- lead to poor dimensional control of the workpiece.
- BUE can form at certain speeds leading to poor surface finish.

17. State at least three factors that can affect the tool wear on a lathe.

1. Cutting speed
2. feed rate
3. depth of cut

others : lubrication, workpc. material, etc.

18. List three of the key wear mechanisms and give an example for each.

Adhesive wear : when a pressure-welded "junction" is stronger than one of the bodies, and rips out a particle when the bodies slide. This is most common type of wear.
examples : car tire wear, Journal bearing wear, pencil wear, etc.

Abrasive wear : caused by a hard particle abrasion. ex; sand blasting

Surface fatigue : surface cracks leading to removal of a particle from surface - ex. in ball bearings.

19. Define homologous temperature.

$$T_{hom} = \frac{T\ (^\circ K)}{T_m\ (^\circ K)}$$

20. Give two examples of processing conditions that can lead to a residual stress. Discuss the possible (favorable or unfavorable) consequence of residual stress in your examples.

Welding → leads to distorsions (unfavourable)

Shot peening → leads to compressive residual stresses that increase the surface fatigue life (favorable)