ME 3217 – Metal Cutting Principles

Credits and Contact Hours: 3 Credits. Two 50 minute lectures and one 2 hour lab per week.

Instructors: Bi Zhang

Textbook: *Manufacturing Engineering and Technology*, 3rd edition, by S. Kalpakjian, Addison-Wesley Publishing Company, 1993

Specific Course Information:

a. Catalog Description: Examination of metal cutting processes including turning, shaping, drilling, grinding. Mechanics of two and three dimensional cutting. Principles and mechanisms of wear. Tool materials. Theoretical prediction of surface finish. Chemistry of cutting fluids. Laboratory period includes operation of machine tools. Experimental determination of cutting energies forces, stresses and strains. The interrelationship between these and practical metal cutting conditions.

b. Prerequisites: None
Corequisites: CE 3110

c. Required, Elective or Selected Elective: Elective

Specific Goals:

a. Course Outcomes:
After completing ME 3217 students should understand:

1. Merchant force circle, calculations of cutting force, shear force, friction force, and normal force.
2. Specific energy in machining; power dissipation; power for cutting, shearing and friction.
3. 2-D vs 3-D cutting; cutting ratio; determination of shear strain, effective rake angle, shear angle and friction angle;
4. Built-up edge formation mechanisms; tool wear mechanisms; chemical affinity; prediction of cutting zone temperature, cutting tool life, surface finish;
5. Cutting tool materials; determination of tool-workpiece material combination; tool material selection.
6. Determination of material removal rate and machining time; selection of machining conditions for turning, milling, grinding, drilling, etc.
7. Machine tool structures; suppression of machining chatter and vibrations; machining economics, machining automation.
8. Selection of machining processes; determination of undeformed chip thickness for milling and grinding.

b. Relationship of Course Outcomes to Criterion 3 Student Outcomes:

a) an ability to apply knowledge of mathematics, science, and engineering:
The course requires application of mechanics to metal cutting processes. Problems focus on the physics and the principles involved in metal cutting.

b) an ability to design and conduct experiments, as well as analyze and interpret data:
Each student conducts four lab experiments. They collect, analyze and interpret experimental data. The Tool Wear experiment requires the students to compare their results with published values and prepare a formal lab report.

c) an ability to design a system, component, or process to meet desired needs: *not applicable*

d) an ability to function on multi-disciplinary teams:
Students are given opportunities to work in small groups in each lab. The teams are not necessarily composed of members from outside of Mechanical Engineering, but the students do experience team interactions and dynamics.

e) an ability to identify, formulate, and solve engineering problems:
Students identify and formulate metal cutting problems and solve them using the knowledge acquired from this course.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively:
Four written laboratory reports are submitted during the course. Each laboratory report is evaluated on its technical content and its presentation.

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context:
Students learn manufacturing engineering and technology developed in competing nations, such as Germany and Japan.

i) a recognition of the need for, and an ability to engage in life-long learning:
The course stresses that since new manufacturing technologies are constantly developed, there is a need to engage in life-long learning to remain current with the rapid progress in manufacturing engineering.

j) a knowledge of contemporary issues:
As novel manufacturing knowledge and cutting edge technologies are constantly introduced into the course, students can learn and gain knowledge of contemporary issues, and apply these issues to the future work.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students gain fundamental knowledge and principles involved in material removal processes and apply fundamentals to practical metal cutting operations.

Topics Covered:

- Fundamentals of metal cutting
- Cutting tool materials and cutting fluids
- Cutting processes for producing round shapes
- Cutting processes for producing various shapes
- Machining centers and machine tool structures
- Abrasive processes and finishing operations
- Non-traditional machining processes
- Automation of manufacturing processes