

Syllabus
Oakland University, School of Engineering and Computer Science,
Department of Mechanical Engineering, 2018 Winter Semester
Metal Forming Processes – ME5900 course, 4 credits, Dodge Hall 236

Instructor: Associate Professor Sergey F. Golovashchenko, PhD.

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Days/ Time of the class: Monday and Wednesday 5:30-7:17p.m.

Office hours in EC318: Monday 4:30- 5:15p.m. and Wednesday 7:30-8:15pm.

Final exam – April 19th, 7-10pm.

Course material:

Textbooks

Part 1: Sheet Metal Forming: Fundamentals by T.Altan and A.E. Tekkaya (ISBN-13: 978-1-61503-842-8).

Part 2: Sheet Metal Forming: Processes and Applications by T.Altan and A.E. Tekkaya (ISBN-13: 978-1-61503-844-2).

In addition to the course textbooks, other course materials (to be handed out by the instructor) will include journal/conference papers, handouts from other textbooks, and notes from personal experience in industry.

Course description:

Study of metal forming processes with substantial emphasis on sheet metal forming. The major emphasis of this course is on understanding limitations of the processes, die design, sheet metal formability, and understanding the results of numerical simulation. Topics include: introduction to plasticity, testing sheet metal properties, understanding of shearing, drawing, flanging, hemming, tube nosing and flaring operations, sheet and tube hydroforming, and hot forming processes. Significant amount of time will be dedicated to construction of stamping dies and discussion of presses capabilities.

Learning outcomes: students will be able to use analytical and experimental methods characterizing material behavior in metal forming processes, understand limitations of sheet metal stamping operations and understand fundamentals of stamping die design.

Grading:

Homework -10%; Participation – 5%; Project – 25%;

Midterm exam- 25%; Final exam- 35%.

Eating and usage of cell phones during the lecture is not welcomed by the instructor. Cell phones must be in the silent mode.

Lectures and Homework: typical lectures will be based upon the course textbook (textbook is Sheet Metal Forming Fundamentals by T.Altan and A.E. Tekkaya) other textbooks, journal and conference papers, and personal industrial experience of the instructor. Homework will be assigned from the textbook and from other materials

reviewed during the lectures. Late homework will not be accepted. The project will be based upon the topic agreed between the student and instructor.

Course objectives

Objective	ABET classification
List and describe relevant professional terminology related to technology and equipment for metal forming	A, E, F, H
Use force equilibrium, yield criteria, deformation compatibility, stress-strain relationship, and fracture criteria to solve problems of metal stamping	A, C, E, H, I
Explain material flow and interaction with the die in metal stamping processes. Discuss the factors which influence quality of manufactured parts in stamping processes	A, E, K
Define the basic operating principles of stamping presses and stamping dies as well as their classifications and applications	A, E, K
Based upon analysis of acting forces in metal stamping, describe basic principles of stamping die design and guidelines to select the appropriate metal stamping equipment	A, C, E, K
Demonstrate basic sheet metal stamping processes in the lab. Analyze experimental results based upon analytical models discussed in the course	A, B, E, K
Locate, analyze and critique technical papers related to metal stamping	A, F, G, K

Lecture 1 (January 3rd, 2018) –Introduction. Metal Forming Processes in Manufacturing. Classification of Metal Forming Processes. Sheet Metal Forming as a System; Blank Preparation; Deep Drawing; Trimming and Piercing; Bending, Flanging and Hemming. Production of sheet metal. Sheet metal properties. Fundamentals of theory of plasticity.

Lecture 2 (January 8th, 2018) – Fundamentals of theory of sheet metal forming. Major assumptions made for analytical models and finite element analysis for sheet metal forming. Tensile test. Prediction of fracture in metal forming.

Lecture 3 (January 10th, 2018) – Formability tests in sheet metal forming. Bulging test, drawing test, stretching of sheared surface, and hole expansion test. Measurement of strains.

January 15th – MLK day

Lecture 4 (January 17th, 2018) – Friction and lubrication for sheet metal forming. Factors affecting friction. Friction tests in sheet metal forming.

Lecture 5 (January 22nd, 2018) – Mechanics of shearing processes. Blanking, Trimming, Piercing, Lancing, Shaving and Fine Blanking. Important parameters of the shearing processes.

Lecture 6 (January 24th, 2018) - Effects of shearing processes on further metal forming operations. Methods of testing sheared surface stretchability. Innovative method of robust shearing. Die wear in shearing processes.

Lecture 7 (January 29th, 2018) - Design of the dies for blanking, trimming, piercing, lancing and fine blanking processes. Equipment for shearing processes. Calculation of shearing force.

Lecture 8 (January 31st, 2018) – Mechanics of sheet metal bending. Major assumptions for sheet metal bending analysis. Limiting factors. Springback. Methods to overcome springback.

Lecture 9 (February 5th, 2018) – Stretch bending processes. Flanging operation. Design of bending and flanging dies. Methods of preventing splits and wrinkles in stretch flanging and shrink flanging processes. Hemming operation. Limiting factors. Table top hemming and roller hemming. Roll forming.

Lecture 10 (February 7th, 2018) – Deep Drawing of Round Cups. Limiting factors. Analysis of stresses and strains in cup drawing processes. Redrawing processes. Ironing process.

Lecture 11 (February 12th, 2018) – Laboratory demonstrations of the tensile test, bulging test, bending operation, and shearing operation with various cutting clearances.

Lecture 12 (February 14th, 2018) - Midterm exam

Winter recess – February 17th - February 25th, 2018.

Lecture 13 (February 26th, 2018) – Methods of adjusting material flow into the die cavity. Drawbead analysis.

Lecture 14 (February 28th, 2018) – Drawing of box shaped parts. Drawing of automotive panels.

Lecture 15 (March 5th, 2018) – Sheet hydroforming. Tube hydroforming. Limitations of the hydroforming processes. Equipment for hydroforming.

Lecture 16 (March 7th, 2018) - Formability analysis. Forming Limit Diagram. Experimental methods of measuring strains in formed blank. Working with results of numerical simulation to adjust the material flow.

Lecture 17 (March 12th, 2018) – Hot forming of sheet metal parts. Hot stamping of boron steel. Processes of Superplastic Forming, Quick Plastic Forming and Warm Forming. Intermediate heat treatments to improve formability of sheet metal. Pulsed forming processes: explosive forming, electromagnetic forming and electrohydraulic forming.

Lecture 18 (March 14th, 2018) - Principles of Sheet Forming Presses. Characteristics of presses. Die changing system. Mechanical Press designs.

Lecture 19 (March 19th, 2018) – Properties and material structure of sheet steels and aluminum alloys broadly used in automotive industry.

Lecture 20 (March 21st, 2018) – Die materials, their surface treatment and heat treatment.

Lecture 21 (March 26th, 2018) – Hydraulic presses. Drive systems. Characteristics of hydraulic presses. Die cushions. Multipoint die cushion systems. Safety rules at stamping plants.

Lecture 22 (March 28th, 2018) – Servo presses. Advantages and perspectives.

Lecture 23 (April 2nd, 2018) – Project work

Lecture 24 (April 4th, 2018) – Project work

Lecture 25 (April 9th, 2018) – Project work

Lecture 26 (April 11th, 2018) – Projects review

Lecture 27 (April 16th, 2018) – Course review

Final exam – April 19th 7-10pm – to be confirmed.