

ME 678 Mechanics of Sheet Metal Forming (3-0-0-6)

Description of Material properties: Tensile test, effect of properties on forming. Sheet deformation processes: Uni-axial tension, general sheet forming processes, yielding, flow rule, work hardening hypothesis, work of plastic deformation, isotropic and anisotropic yield functions, Bauschinger effect modeling, effective stress and strain. Sheet deformation in plane stress: strain distributions, strain diagram, deformation modes, effective stress-strain laws, principal tensions. Stamping analysis: 2-D and 3-D model of stamping, stretch and draw ratios in stamping. Load instability and tearing: uniaxial tension of perfect strip and imperfect strip, tensile instability in stretching continuous sheet. Sheet formability: Forming limit curve – concept and evaluation, formability tests, theoretical prediction, factors affecting FLC. Sheet bending: Variables in bending a continuous sheet, equilibrium conditions, material models, bending without tension, springback. Analysis of circular shells: equilibrium equations, Models for forming axisymmetric shells. Cylindrical deep drawing: Drawing the flange, cup height, redrawing cylindrical cups, wall ironing of deep drawn cups. Stretching circular shells: Analysis of bulging with fluid pressure, stretching over punch. Combined bending and tension of sheet. Governing differential equations for finite element formulation. Recent advances: Hydroforming, tailor welded blanks, friction stir welding of sheets.

Textbooks/References:

- [1] D. Banabic, Sheet metal forming processes Constitutive modeling and numerical simulation, Springer-Verlag Berlin Heidelberg, 2010
- [2] Z. Marciniak, J. L. Duncan, S. J. Hu, Mechanics of sheet metal forming, Elsevier, Butterworth-Heinemann, 2002
- [3] R. H. Wagoner, J. L. Chenot, Fundamentals of metal forming, John Wiley and Sons, 1997
- [4] W. F. Hosford, R. M. Caddell, Metal forming Mechanics and Metallurgy, Printice-Hall, 2007
- [5] J. Chakrabarty, Theory of Plasticity, McGraw Hill, 1998.
- [6] D. W. A. Rees, Basic engineering plasticity, Elsevier, 2006