Forming technology and machines

Bulk Forming

General description of forming techniques

1. Define material forming
2. List volume- and sheet metal forming technologies
3. Describe the main classes of manufacturing processes
4. Describe the categorization of forming processes
5. Describe the effect of forming on the mechanical properties
6. Describe the basic cost analysis of production using an example

Strain- and stress state; material law

1. Describe the definitions of true and engineering strain and stress terms
2. Describe the measures of strain and its properties
3. Describe the use of volume constancy
4. Define the strain state
5. Define the equivalent strain
6. Describe strain rate state and the equivalent strain rate
7. Define the stress state
8. Define the scalar invariants of the stress tensor
9. Describe the determination of principal stresses by Mohr's circle method
10. Describe the calculation of equivalent stress
11. Define the von Mises yield criteria and explain its application
12. Describe the von Mises material law
13. Define the plastic modulus

Analytical solutions for plasticity, mean stress method

1. Describe the principle of the mean stress method
2. Construct the equilibrium equation of cylindrical specimen upsetting for elementary volume, create a sketch. Write down and explain the formula for mean pressure
3. Write down the equilibrium equation of deformation in conical channel for elementary volume, create a sketch. Write down and explain the formula for mean pressure

Determination of flow curve; friction; work done during deformation, limit of plastic deformation

1. Define the flow curve
2. Describe the effect of state variables on the flow curve
3. Describe the methods for flow curve determination
4. Explain the determination of flow curve with the help of cylindrical specimen upsetting (measurement principle, sketch, measured values, evaluation)
5. Define the types of friction measures in forming and show their limits values
6. Describe the effect of friction on forming processes (upsetting and reduction)
7. Describe methods for the determination of frictional coefficient
8. Explain the ring compression test and the determination of frictional coefficient (measurement principle, sketch, measured values, evaluation)
9. Describe the material models for forming
10. Describe the determination of mean flow stress for different material models with examples (Nádai-model, 4 parameter model; for partial and total domain)
11. Describe the determination of ideal and actual plastic work. Specify the estimation of temperature change due to plastic deformation
12. Define the limits of deformation and forming limit diagrams (FLD)

Technology of upsetting and reduction, its tools, machines

1. What is the definition of upsetting? Explain the basic methods of upsetting.
2. Describe the calculation of true strain for upsetting.
3. Define the workability for upsetting with the shape properties.
4. Explain the calculation of force-, work, and efficiency in case of heading.
5. Demonstrate the force-stroke characteristic of upsetting and the flow curve of the material to be formed.
6. Draw a sketch of reduction.
7. Introduce the workability of reduction.
8. Demonstrate the determination of force for reduction and determination of the optimal half angle of the conical die.
9. Explain the validation for buckling.
10. Demonstrate the steps of technological design of upsetting and reduction.
11. Explain the classification of the upsetting presses.
12. Draw a schematics of a single stroke cold upsetting press with split die.
13. Draw a schematics of a double stroke cold upsetting press with split die.
14. Draw a sketch and explain the tool parts for upsetting and reduction (die, punch, splitter).

The technology of extrusion, its tools, machines

1. Explain the definition of extrusion, draw the sketch for the extrusion processes.
2. Explain the basic properties and characteristic of extrusion.
3. List the steps of technological design of extrusion.
4. Give examples for shape simplification.
5. Explain the workability for extrusion upon geometric conditions, for forward extrusion of a solid body, forward extrusion of a hollow body, backward extrusion of a hollow body.
6. Explain the determination of dimensions of the preform.
7. Explain how to determination of the standard diameter for the preform with sketch.
8. Explain the application methods of the surface treatment and the lubricant.
9. Explain for forward extrusion of a solid body: the typical phases of extrusion, the force characteristics, determination of the punch pressure, force maximum, and work.
10. Explain for forward extrusion of a hollow body: the typical phases of extrusion, the force characteristics, determination of the punch pressure, force maximum, and work.
11. Explain for forward extrusion of a hollow body: the typical phases of extrusion, the force characteristics, determination of the punch pressure, force maximum, and work.
12. Draw a sketch of a forward extrusion tool applied on universal press.

Design of the extrusion tools

1. Explain the distribution of the die pressure for wire drawing and reduction with a sketch. Show the determination of the maximum load.
2. Explain the distribution of the die pressure for forward extrusion of a solid body with a sketch. Show the determination of the maximum load.
3. Explain the design principles for the extrusion die and punch.
4. Explain the calculation of the stress components and the equivalent stress and their distribution with sketch in case of internal and external loaded thick-walled pipe.
5. Explain the assembly of the double prestressed extrusion ring.
6. Explain the concept of optimal and the non-optimal design.

Technology of forging, its tools, machines

1. Explain the aim and types of forging, and the effect on the material properties.
2. Explain the basic operations of open die forging with sketches.
3. Explain the construction concepts of open die forging.
4. Explain the method of closed die forging, the main parts of the tools, properties of the piece.
5. Draw an example for forging a typical part.
6. Explain the designing steps of the closed die forging.
7. Explain with sketches the choice of the split position.

Sheet Forming

General description of sheet metals and forming technologies

1. Describe the manufacturing of sheet semi-finished products
2. Describe the effect of hot and cold rolling on the microstructure and mechanical properties
3. Give examples for mild steel narrow strip materials and describe the application fields
4. Describe the classification of sheet metal forming technologies
5. Give examples for sheet cutting operations
6. Give examples for sheet metal forming operations
7. Give examples for special sheet forming methods

Basic terms of shear cutting, geometric errors of cut surface

1. Describe shear cutting with a sketch and the resulting geometry
2. Describe the force-stroke characteristics of shearing, the effects of clearance and material grade
3. Describe the change in geometric errors of cut surface as a function of clearance

Mechanical cutting with sheet metal shears

1. Describe the cutting processes employing shears
2. Describe the force-, and work characteristics for:
    a. straight cutting edge, parallel edge orientation
    b. straight cutting edge, skew edge orientation
3. Describe the geometric errors of cut surface in case of skew edge orientation
4. Sketch the tilting and rolling cutting
5. Describe the slitting of coiled sheets
6. Explain the feeding condition and force requirement in case of slitting
7. Explain the determination of the smallest allowable cut radius and blade orientations in case of cutting with circular blade

Technological planning of blanking-piercing

1. Define the technology of blanking-piercing with a sketch
2. Show examples of workpiece layouts, explain the material efficiency
3. Show example for strip design
4. Explain the terms of single-, and double-sided clearance and its calculation
5. Explain the calculation of center of pressure
6. Sketch a progressive die with alignment plate, name the parts
7. Sketch a progressive die with column alignments, name the parts
8. Explain the calculation of dimensions and tolerances of a blanking-piercing tool with the help of a sketch
9. Show examples for punch design and punch holders
10. Show examples for the hole design of the die plate

Precision shearing

1. Sketch the shaving operation for external and internal dimensions
2. Interpret the following terms: shaving allowance, number of operations, shaving with same-, or opposite-direction to shearing
3. Draw a sketch of fine blanking, explain the tool elements and their functions
4. Explain the process of fine blanking
5. Describe the force-stroke diagram and calculation of total force
6. Explain the effect of microstructure on surface quality
7. List the requirements for fine blanking tool and press

Forming machines

1. Explain the fundamental press machine types
2. Explain the classification of forming machines
3. Explain the principles of operation for energy characteristics machines
4. Draw the conceptual sketch of the hydraulic press

5. Sketch stroke-time diagram for a hydraulic press
6. Describe conceptual sketch and working mechanism of the crank press
7. Describe the kinematic sketch of the crank mechanism and the definition of motion parameters
8. Explain the force characteristics of the crank press and its determination
9. Explain the working ability of the crank press with the help of the force characteristics
10. Describe the parts and principles of the eccentric press, explain the setting of stroke length and stroke position
11. Explain the characteristics of eccentric press and the determination of its load capacity

Bending technology

1. Describe the classification of bending operations
2. Describe the distribution of stress and strain for bending
3. Explain the calculation of strain resulted from bending
4. Explain the definition of neutral layer position
5. Explain the determination of the minimum radius for bending
6. Explain the determination of blank size for bending
7. Explain the term of spring back, the definition and possibilities to minimize it
8. Explain the definition of force and work calculation in case of V-die bending
9. Sketch a bend die

Technology of deep drawing

1. Draw the sketch of deep drawing, explain the failures of deep drawn cup
2. Explain the determination of the blank size
3. Define the limit drawing ratio. What are the influencing parameters and the range of the values
4. Explain the determination of the number of drawing operations
5. Explain the determination of the number of drawing operations to the first annealing and to the subsequent annealing
6. Explain the force-stroke diagram for deep drawing
7. Explain the steps of determination the drawing force and work
8. Sketch a single and double action drawing tool
9. Explain the steps of determination of tool dimensions for drawing
10. Sketch the kinematics of a hinge mechanism double action crank press for drawing operation

Technology for wall ironing drawing

1. Draw the sketch of the technology of wall ironing
2. Explain the determination of deformations in ironing
3. Explain the determination of number of operations
4. Sketch a drawing die and drawing plunger and explain the method of determination of tool dimensions
5. Explain the determination of force components in ironing
6. Explain the determination of required force for ironing
7. Explain the calculation of a simplified heat balance for ironing

Properties and qualification of sheet metal materials, The limit of fomability

1. Draw and explain the method of Erichsen test, show advantages and disadvantages
2. Draw and explain the method of cup drawing test, show andvantages and disadvantages
3. Explain the determination of the following material properties with tensile test: average normal anisotropy, plane anisotropy
4. Sketch and interpret the Lillet-diagram
5. Explain the factors influencing the limit of formability
6. Explain the deformation (strain) measurements on sheet specimen
7. Introduce the strain diagram and the possible deformation methods of sheets
8. Sketch and interpret the forming limit diagram (FLD) and curve (FLD)
9. Explain the method, the sketch and the results of Nakazhima-test

Other cutting processes and special sheet metal forming processes

1. Introduce the method of oxy-fuel cutting: sketch, used gases, conditions of cutting, the parts of the cutting torch
2. Explain the process of plasma cutting
3. Explain the method of laser cutting: sketch, used laser types
4. Compare the thermal cutting processes in manufacturing
5. Explain the method of water jet cutting: sketch, abrasive water jet cutting, the surface quality of the cut surface
6. Sketch and introduce the process of rubber cushion cutting
7. Sketch and introduce the process of rubber cushion deep drawing
8. Sketch and introduce the process of rubber bag deep drawing
9. Sketch and introduce the hydroform process
10. Sketch and introduce the process of hydromechanical deep drawing
11. Sketch and introduce the deep drawing with heated flange
12. Introduce the process of metal spinning: with traditional and shear spinning; and the incremental forming
13. Introduce the high speed forming processes: blast forming, electro-hydraulic and electromagnetic forming
14. Introduce the characteristics and the requirements of the super plastic forming