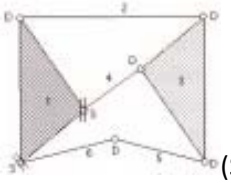
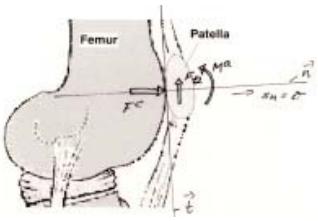
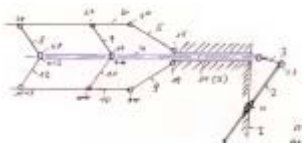
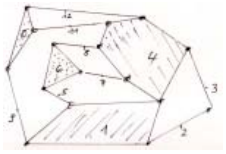
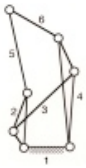
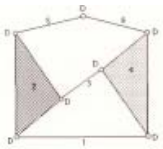
2-1: f=2 (S_x, ϕ_x; F_x, M_x) u=4 (S_y=0, S_z=0, ϕ_y=0, ϕ_z=0; F_y, F_z, M_y, M_z)

2-2: f=1 (ϕ_z; M_z) u=5 (S_x=0, S_y=0, S_z=0, ϕ_x=0, ϕ_y=0; F_x, F_y, F_z, M_x, M_y)
alternatively: f=4 (S_x, S_y, ϕ_y, ϕ_z) u=2 (S_z=0, ϕ_x=0) (if ligaments are flexible)

2-3: a)  b)  (Stephenson's chain) c) F=1

2-4: a) cam joint b) f=2, u=1 c) 

2-5: a)  b) b=1, n=12, g=16, F=1 c) 

2-6: a)  b)  c) b=3, n=6, g=7, F=1

2-7: a) f_3=4, u_3=2 b) type D_3S (Kugelrohrgelenk)

2-8: a) F=2 b) DOF_1: rotation of crank 2 (ϕ_2); DOF_2: rotation of crank 7 (ϕ_7);

2-9: a) F=7 (open loop) b) F=2 (closed loop) c) DOF_1: turning of bolt; DOF_2: rotation of arm

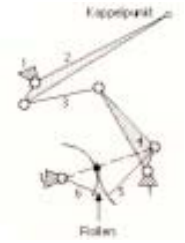
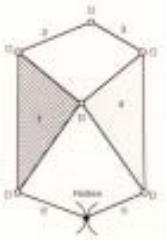
2-10: a) $F_{platform}$=6, f_{id}=4, => F_{real}=2 b) 2 linkages must be added.

2-11: F=1 (rotation of axle 2)

2-12: a) and b) F=1 => f_{34}=3 c) spherical joint (links 3 + 4 are not allowed to be in a straight line!)

2-13: F_{real}=2 DOF_1: vertical motion of wheel DOF_2: steering of wheel

2-14: F=0, s=1, F_{real}=F+s=1

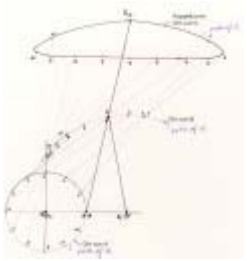
2-15: a)  b)  c) F=1

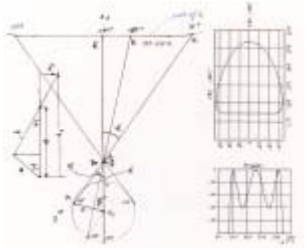
2-16: a) F= 6 * (8-1-9) + 15 = 3 DOF b) F=6 => a single rotation of an actuator is not possible!

2-17: a) 1. A_0ABB_0 2. A_0CBB_0 b) rocker mechanism, 2 dead positions, no full rotation of any links

c) n=8, g=10 (double hinges!), b=3 => F = 1 d)

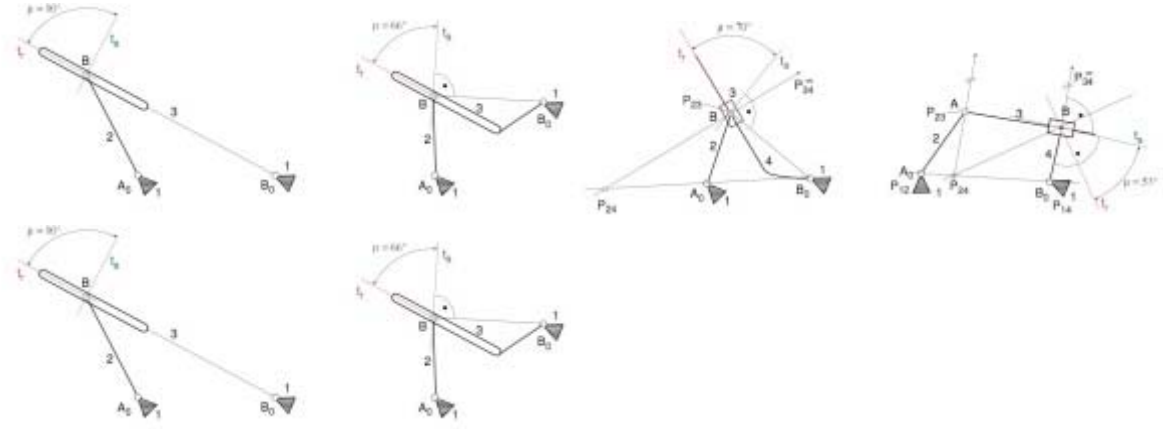
2-18:





2-19: a) a=19,658mm, d=32,239mm, k(AK)=134,021mm, ϕ=150° b)
c) k_x= a * cos ϕ + k * cos ψ; k_y= a * sin ϕ – k * sin ψ; $\Delta x = (k-a) - k_x$; (calculation with Mathematica or Maple)

2-20:



2-21: a) $s_{(\phi)}$=r *cos ϕ + sqrt[l^2-(l + r*sin ϕ)^2] b) ϕ_a=-6,38°, s_a=89,44mm, ϕ_i=160,53°, s_i=28,28mm
c) $\gamma_{(\phi)}$=arcsin((l+r*sin ϕ)/l) d) $\mu_{(\phi)}$=48,19° e) $x_k = A_{0x}+r*\cos(\phi+\gamma_0)+k*\cos(\kappa-\gamma+\gamma_0)$
$y_k = A_{0y}+r*\sin(\phi+\gamma_0)+k*\sin(\kappa-\gamma+\gamma_0)$

2-22: a) $\psi=\pi-\sigma-\lambda$ [σ=arctan(a*sin ϕ/(d- a*cos ϕ)), λ=arcos[e/(sqrt(a^2+d^2-2*a*d*cos ϕ))]
b)dead point positions: ϕ_a=0, c_a=sqrt((d-a)²-e²), $\phi_i=\pi$, c_i=sqrt((d+a)²-e²)
c) rocker angle (for $\phi_0=\phi_a-\phi_i$): ψ_a=arcos((a-e)/d), $\psi_i=\pi$-arcos((a+e)/d), $\psi=\psi_i-\psi_a$
d) transmission angle: $\mu=3/2\,\pi-\phi-\sigma-\lambda$
e) $x_k = A_{0x}+a*\cos(\phi+\gamma_0)+k*\cos(\gamma_0-\pi/2+\psi+\kappa)$, $y_k = A_{0y}+a*\sin(\phi+\gamma_0)+k*\sin(\gamma_0-\pi/2+\psi+\kappa)$

2-23: a) $c_{(\phi)}$=sqrt(a^2+d^2-2*a*d*cos ϕ)
b) c_a=30mm, c_i=90mm, c_0=60mm
c) μ_a=arcos(a²+c²-d²)/(2*a*c) bzw. μ_a=180°- arcos(a²+c²-d²)/(2*a*c)
d) $x_k = A_{0x}+a*\cos(\phi+\gamma_0)+k*\cos(\kappa-\sigma+\gamma_0)$, $y_k = A_{0y}+a*\sin(\phi+\gamma_0)+k*\sin(\kappa-\sigma+\gamma_0)$