Math 4530

Solutions to hw due January 28

Chapter 1: 6.2-6.6, 6.9 (kappa3,kappa4), 6.10 (kappa3d1, tau3d1).
Chapter 2: 1.6-1.7, 5.1-5.5
This file contains the solutions to the chapter 2 problems.

```
> restart:with(plots):
```

2.1.6, 2.1.7: These are done by hand, see the hand work file. Related pictures will be done in 5.1-5.5 .

2.5.1. We follow the hint in 2.1.13 (see also hand work notes)

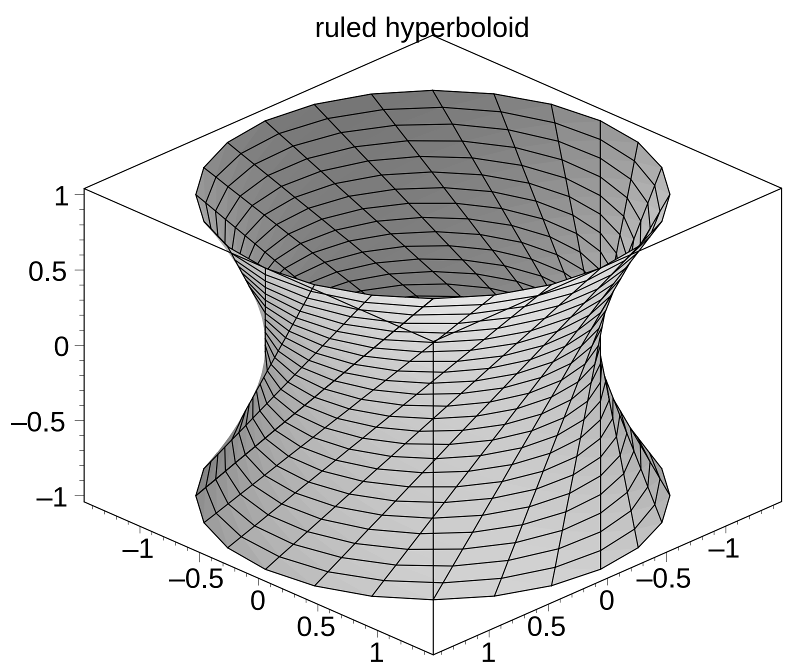
```
> Hyp:=[a*(cos(u)-v*sin(u)),b*(sin(u)+v*cos(u)),c*v];
```

$$Hyp := [a\,(\cos(u) - v\sin(u)),\, b\,(\sin(u) + v\cos(u)),\, c\,v]$$

```
> Hyp1:=subs({a=1,b=1,c=1},Hyp);
```

$$Hyp1 := [\cos(u) - v\sin(u),\, \sin(u) + v\cos(u),\, v]$$

```
> plot3d(Hyp1,u=0..2*Pi,v=-1..1,axes=boxed,title=
  'ruled hyperboloid');
```

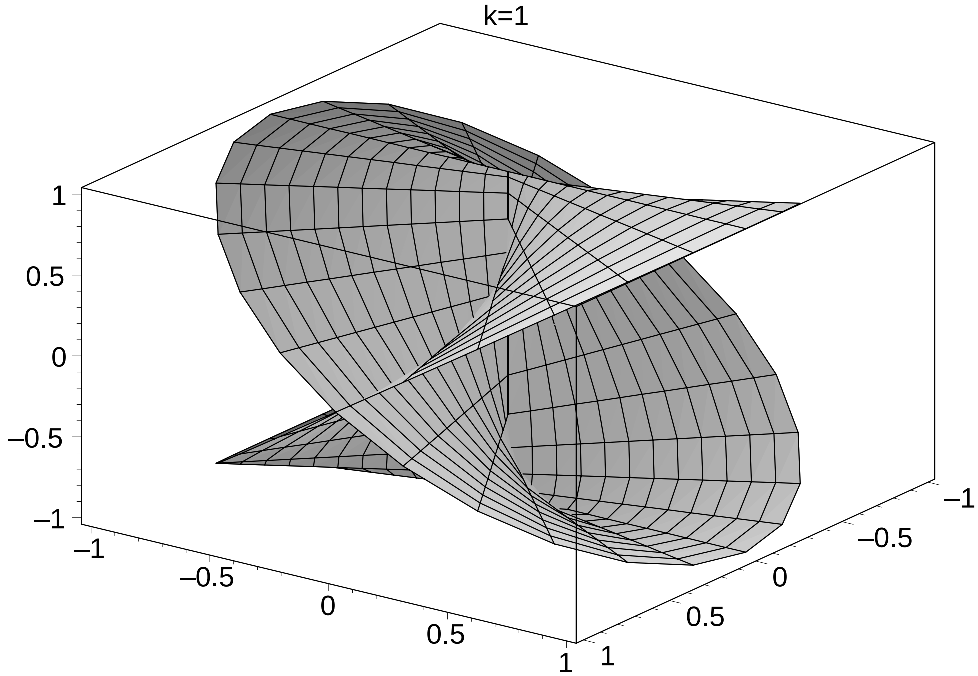


2.5.2

```
> Rul:=[v*cos(u),v*sin(u),sin(k*u)]:
> Rul1:=subs(k=1,Rul);
```

$$Rul1 := [v\cos(u),\, v\sin(u),\, \sin(u)]$$

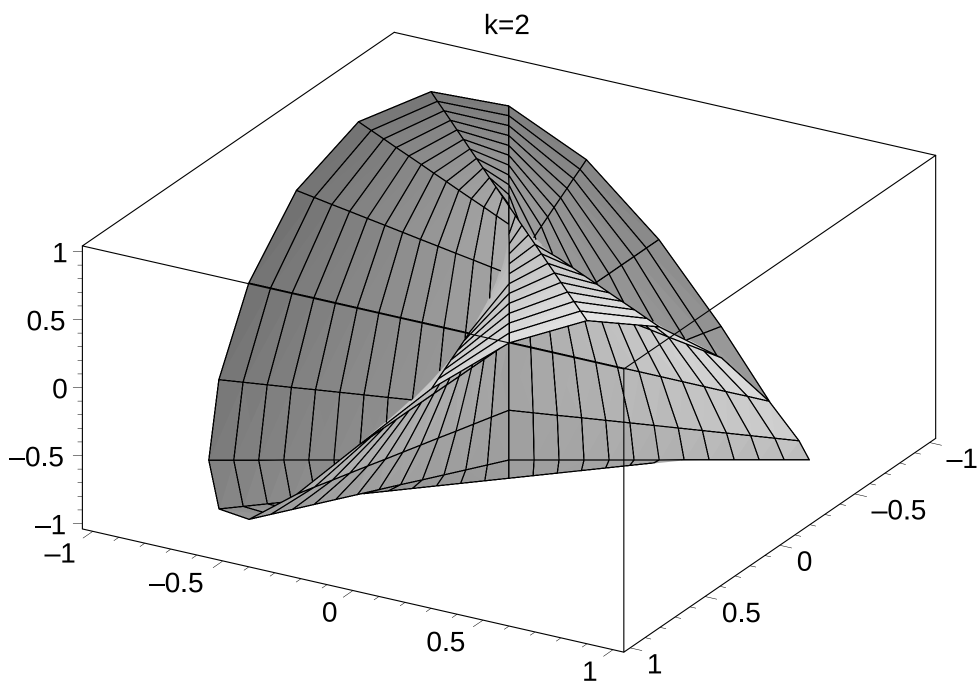
```
> plot3d(Rul1,u=-Pi..Pi,v=-1..1,axes=boxed,title='k=1');
```




```
> Rul2:=subs(k=2,Rul);
```

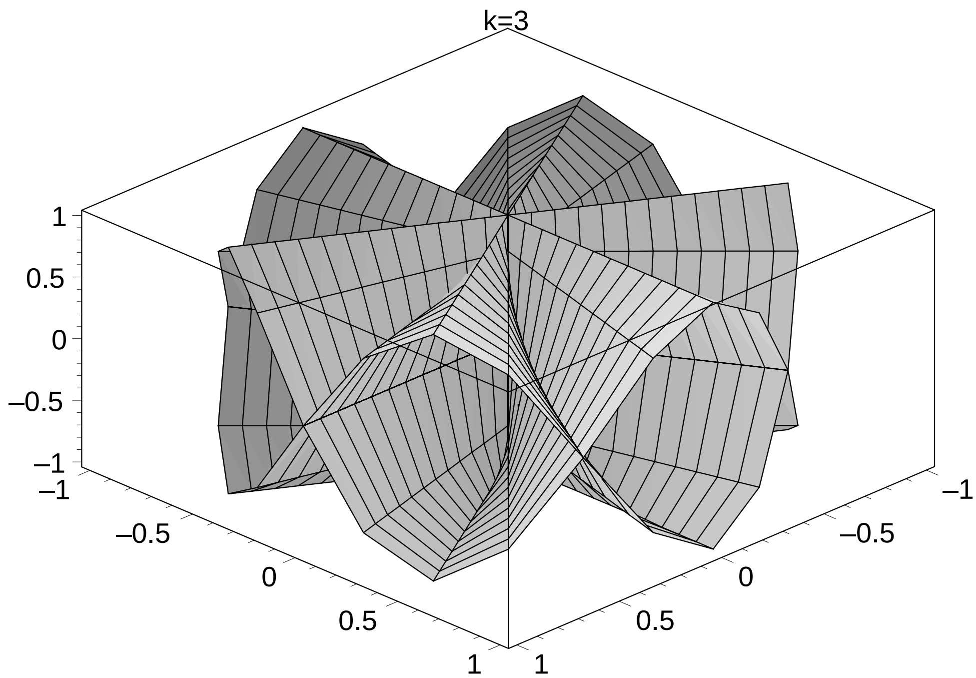
$$Rul2 := [v\cos(u), v\sin(u), \sin(2\,u)]$$

```
> plot3d(Rul2,u=-Pi..Pi,v=-1..1,axes=boxed,title=‘k=2‘);
```



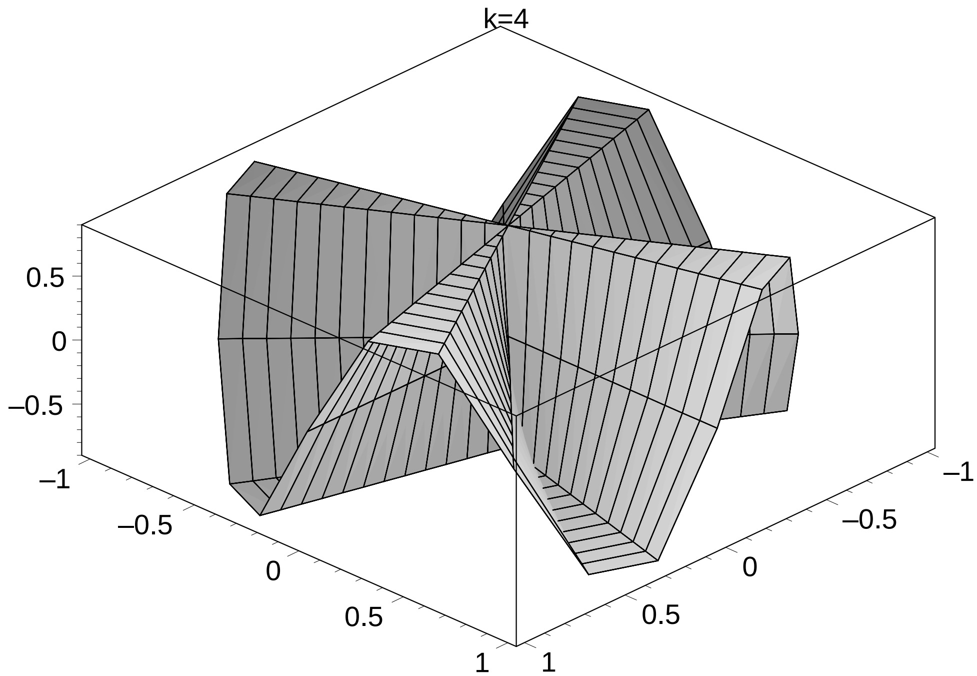
```
> Rul3:=subs(k=3,Rul);
  plot3d(Rul3,u=-Pi..Pi,v=-1..1,axes=boxed,title=‘k=3‘);
```

$$Rul3 := [v\cos(u), v\sin(u), \sin(3\,u)]$$




```
> Rul4:=subs(k=4,Rul);
  plot3d(Rul4,u=-Pi..Pi,v=-1..1,axes=boxed,title=‘k=4‘);
```

$$Rul4 := [v\cos(u), v\sin(u), \sin(4\,u)]$$



Conclusions: if we take integer k's, then the even-k pictures cover a surface "doubly" and are graphs above the x-y plane (except at the origin.) The odd-k surfaces are "double-sheeted graphs" with respect to the x-y plane. I could show this analytically if I wanted to....The even k surfaces look like graphs one studies in Math 3220, when one discusses continuity vs. continuity along lines.

2.5.3: To rotate a curve in the x-z plane, about the z-axis:

```
> surfrev:=proc(Alph)  #Alph is a curve with parameter u
  local x1,x2,x3;   #components
  x1:=Alph[1]*cos(v);
  x2:=Alph[1]*sin(v);
  x3:=Alph[2];
  [x1,x2,x3];
  end:
> curv1:=[R+r*cos(u),r*sin(u)];
     #to generate torus of 2.1.7
  surfrev(curv1);
```

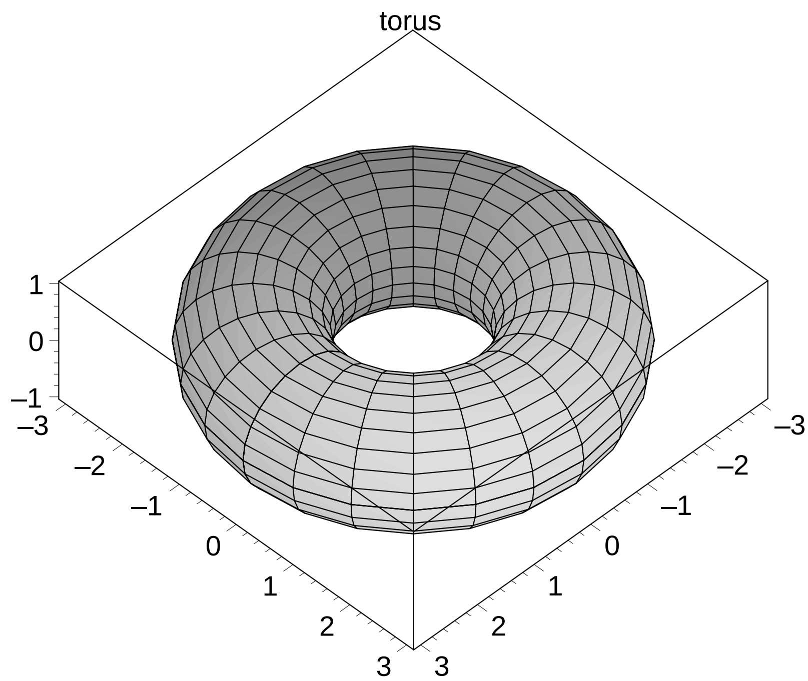
$$curv1 := [R + r\cos(u), r\sin(u)]$$

$$[(R + r\cos(u))\cos(v), (R + r\cos(u))\sin(v), r\sin(u)]$$

```
> curv1a:=subs({R=2,r=1},curv1);
  surf1a:=surfrev(curv1a);
  plot3d(surf1a,u=0..2*Pi,v=0..2*Pi,axes=boxed,title='torus');
```

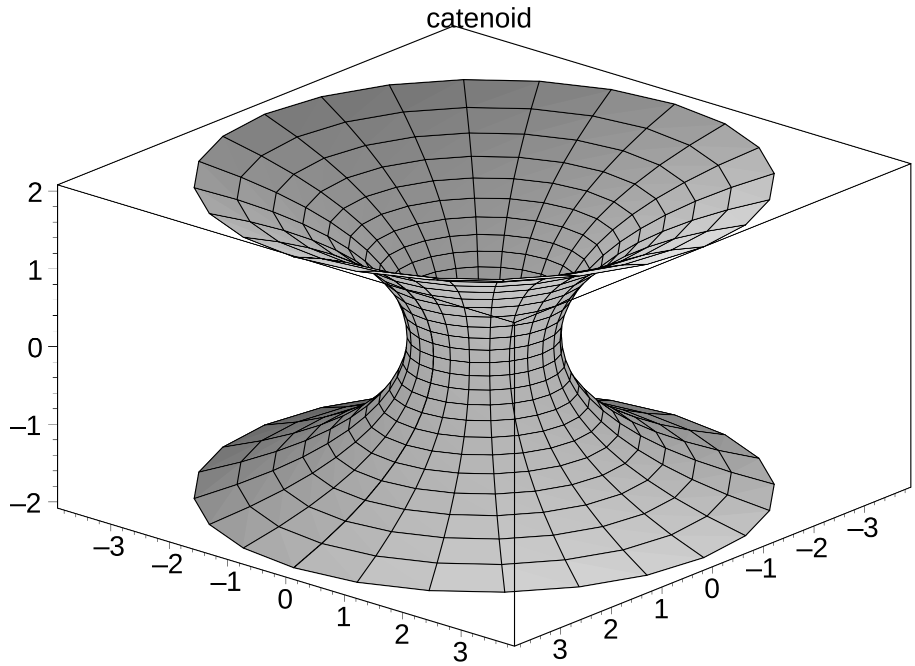
$$curv1a := [2 + \cos(u), \sin(u)]$$

$$surf1a := [(2 + \cos(u))\cos(v), (2 + \cos(u))\sin(v), \sin(u)]$$




```
> curv1b:=[cosh(u),u]:
  surf1b:=surfrev(curv1b);
  plot3d(surf1b,u=-2..2,v=0..2*Pi,axes=boxed,title='catenoid');
```

$$surf1b := [\cosh(u)\cos(v), \cosh(u)\sin(v), u]$$

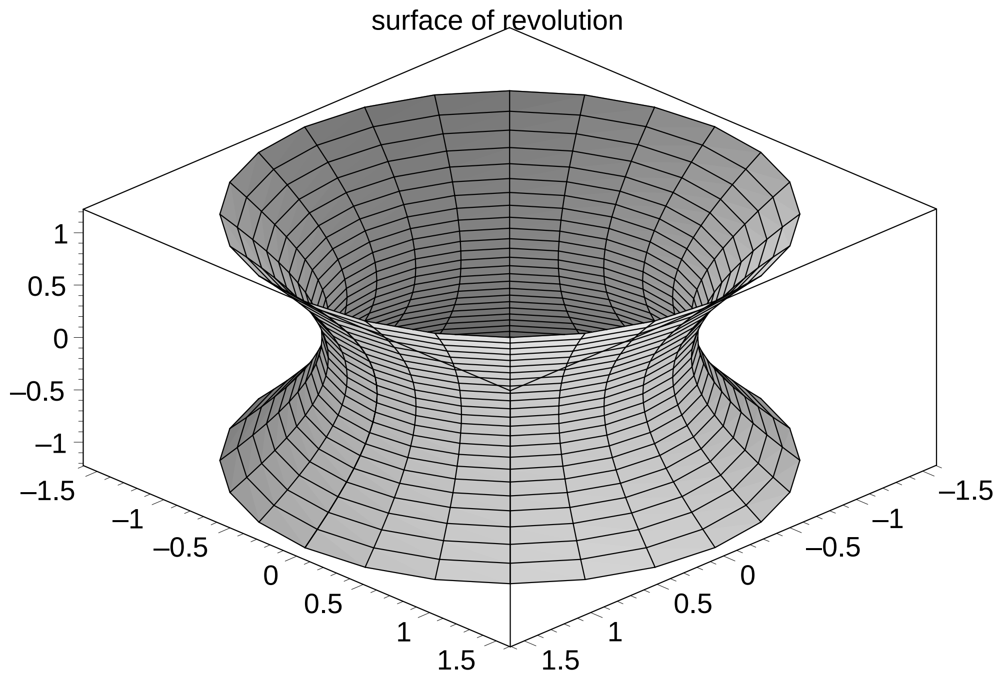



```
> rulsurf:=proc(beta,delta)
    #from page 85
  local x1,x2,x3;
  x1:=beta[1]+v*delta[1];
  x2:=beta[2]+v*delta[2];
  x3:=beta[3]+v*delta[3];
  [x1,x2,x3];
  end:
```

2.5.4: surface of revolution by rotating [cosh(u),0,sinh(u)] about z-axis. Ruled surface using previous work

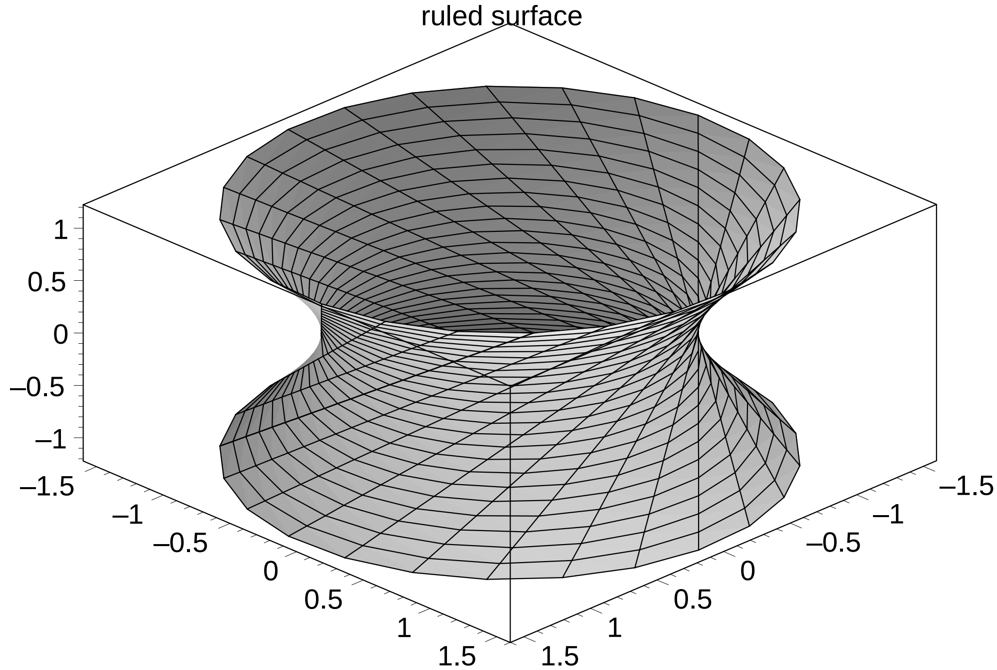
```
> curv2:=[cosh(u),sinh(u)]:
  surf2:=surfrev(curv2);
  plot3d(surf2,u=-1..1,v=0..2*Pi,axes=boxed,
  title=‘surface of revolution‘);
```

$$surf2 := [\cosh(u)\cos(v), \cosh(u)\sin(v), \sinh(u)]$$




```
> Bet:=[cos(u),sin(u),0]:
  Delt:=[-sin(u),cos(u),1]:
  surf3:=rulsurf(Bet,Delt);
  plot3d(surf3,u=0..2*Pi,v=sinh(-1)..sinh(1),
  axes=boxed,title='ruled surface');
```

$$surf3 := [\cos(u) - v\sin(u), \sin(u) + v\cos(u), v]$$



2.5.5 Monge parameterization:

```
> Monge:=proc(F); #F is a function of u and v
   [u,v,F];
  end:
> f:=u^2+v^2;
  Monge(f);
```

$$f := u^2 + v^2$$

$$[u, v, u^2 + v^2]$$

```
>
```