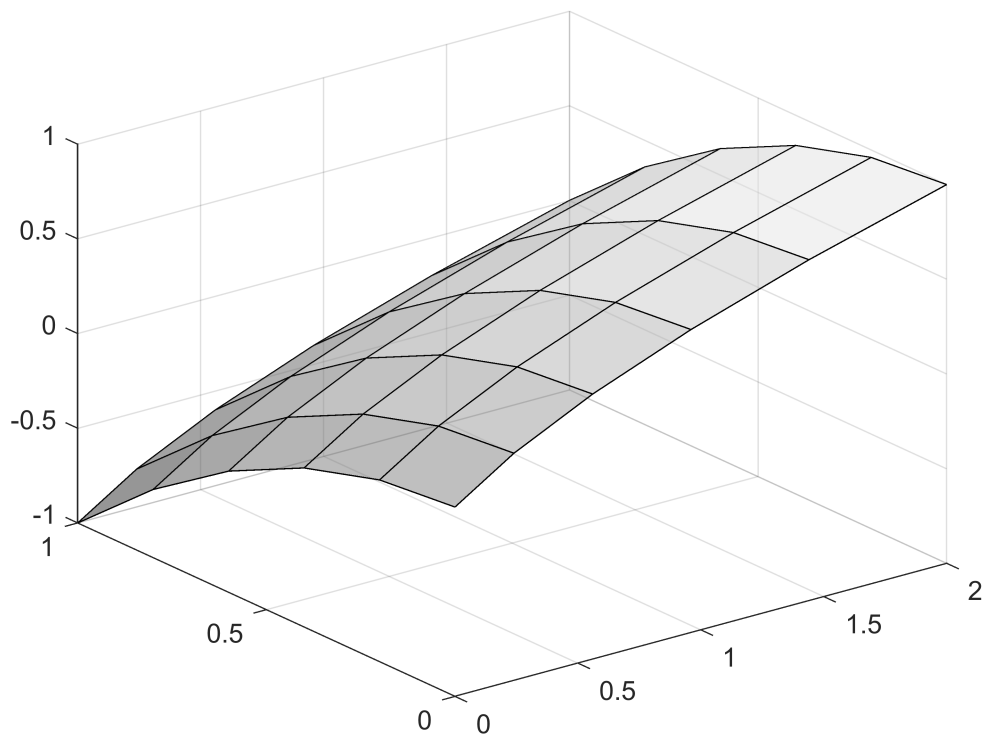


Cvičení 3 - Plochy

Příklad plochy

```
fx = @(u,v)(u.^2+u);  
fy = @(u,v)(v);  
fz = @(u,v)(u - v.^2);  
  
U=0:0.2:1;  
V=0:0.2:1;  
  
[X,Y]=meshgrid(U,V);  
figure,  
x=fx(X,Y);  
y=fy(X,Y);  
z=fz(X,Y);  
r=surf(x,y,z, 'FaceAlpha',0.5);  
colormap gray;
```



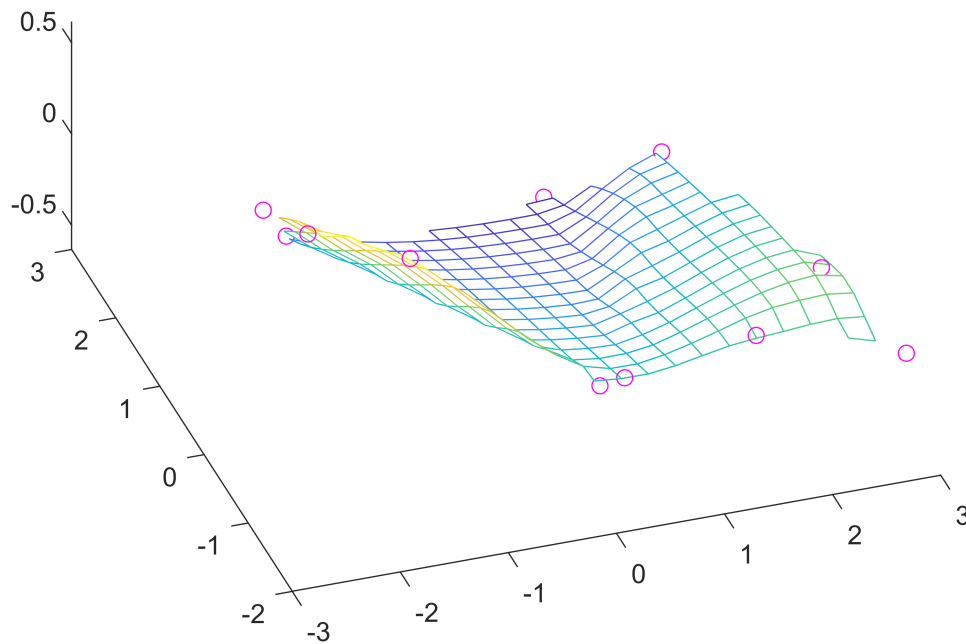
Interpolace

```
% nahodna data  
x = -3 + 6*rand(11,1);  
y = -3 + 6* rand(11,1);  
v = sin(x).^4 .* cos(y);
```

```
[xq,yq] = meshgrid(-3:0.25:3);
```

```
z = griddata(x,y,v,xq,yq,"cubic");
```

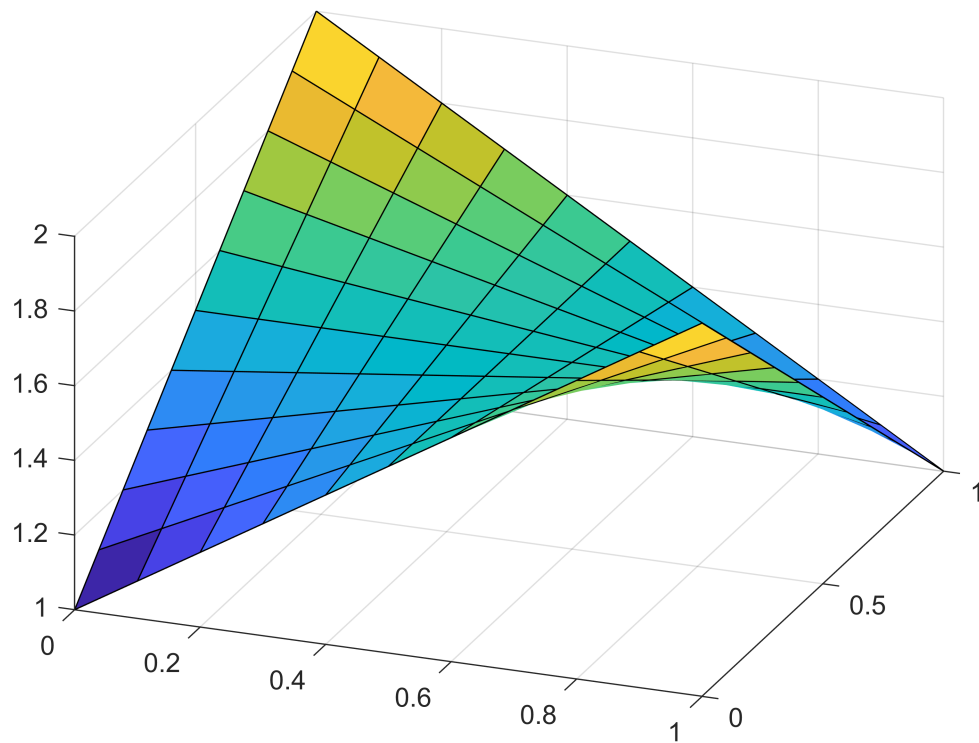
```
figure,  
plot3(x,y,v,"mo")  
hold on  
mesh(xq,yq,z)  
hold off
```



Příklad interpolace bilineární

```
[X,Y] = meshgrid(0:0.1:1,0:0.1:1);  
Z = 1 + X + Y - 2* X.* Y;
```

```
figure,  
surf(X,Y,Z);
```



Přímková plocha

```

v = 0 : 0.1 : 1;
u = 0 : 0.1 : 1;

[U,V] = meshgrid(u,v);

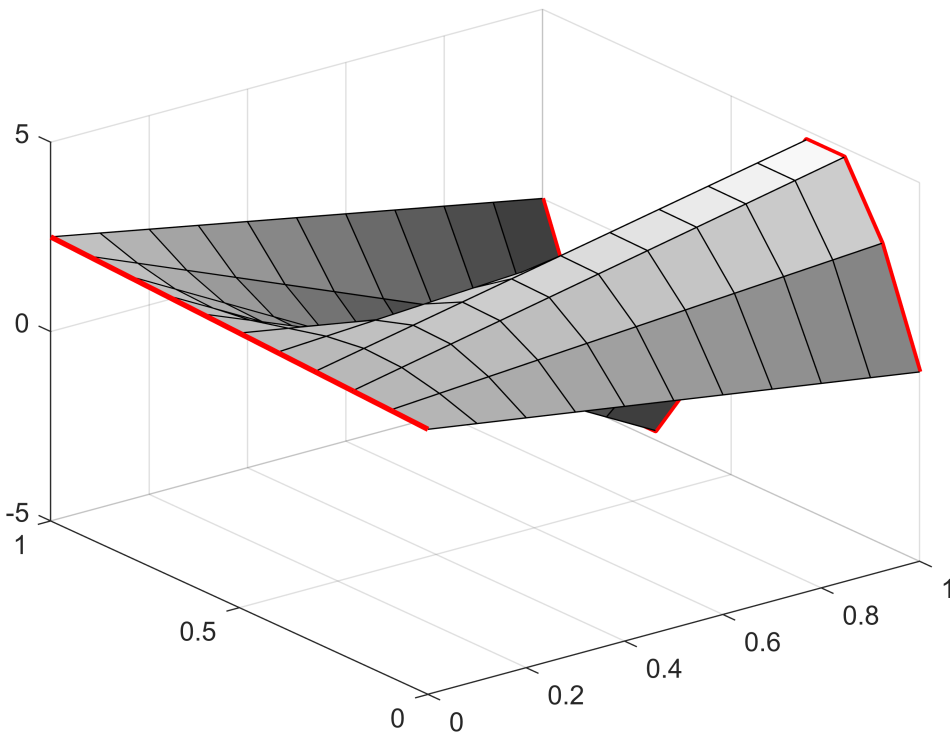
P0 = 2 + V/2;
P1 = 5*sin(V*(2*pi));

figure,
surf(U,V,(1-U).*P0+U.*P1);

hold on;
plot3(ones([1,11]),V,P1,'-r','LineWidth',2);
plot3(zeros([1,11]),V,P0,'-r','LineWidth',2);
colormap gray;

hold off

```



Kubická plocha

```

v = 0 : 0.1 : 1;
u = 0 : 0.1 : 1;

[U,V] = meshgrid(u,v);

P0 = 2 + V/2;
P1 = 5*sin(V*(2*pi));

vp0 = V + 10;
vp1 = V - 5;

F1 = 2*U.^3 - 3*U.^2 + 1;
F2 = -2*U.^3 + 3*U.^2;
F3 = U.^3 - 2*U.^2 + U;
F4 = U.^3 - U.^2;

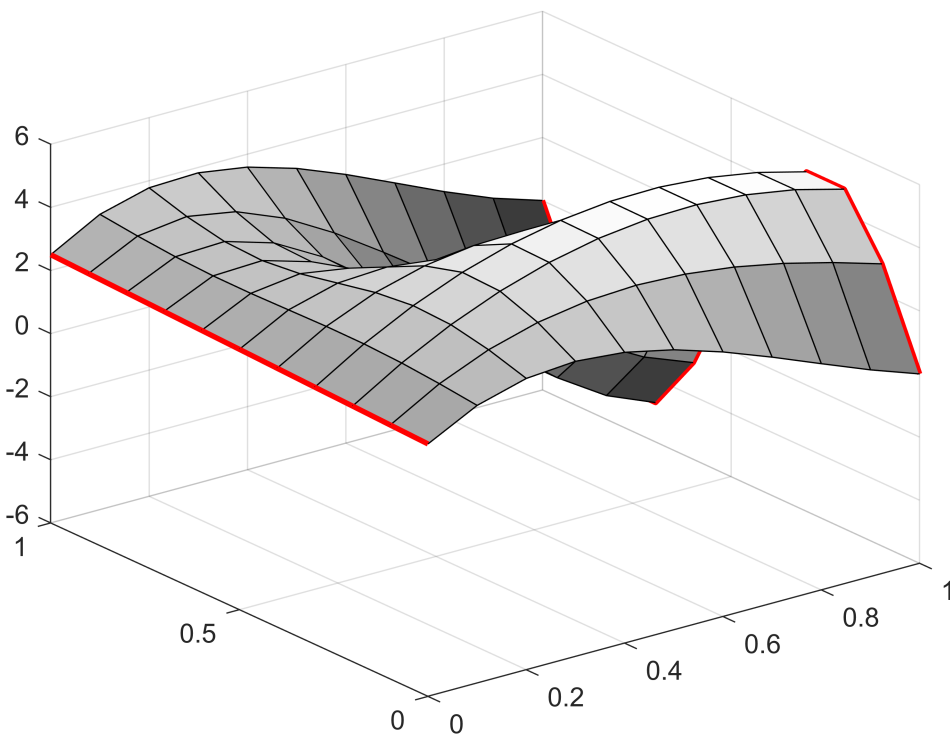
plocha = F1.*P0 + F2.*P1 + F3.*vp0 + F4.*vp1;

figure,
surf(U,V,plocha);

hold on;
plot3(ones([1,11]),V,P1,'-r','LineWidth',2);
plot3(zeros([1,11]),V,P0,'-r','LineWidth',2);
colormap gray;

```

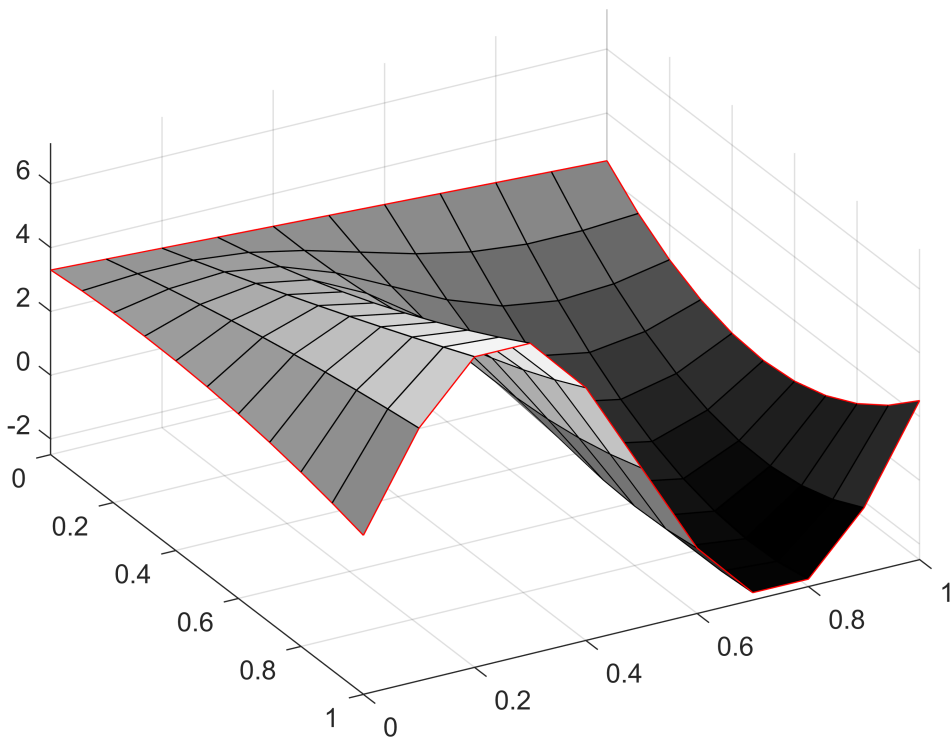
```
hold off
```



Bilineární Coonsova plocha

```
v = 0 : 0.1 : 1;  
u = 0 : 0.1 : 1;  
  
[U,V] = meshgrid(u,v);  
  
P0 = (2.5-3.3).*V + 3.3;  
P1 = 5*sin(V*(2*pi))+2.5;  
P2 = 10*(U-0.5).^2;  
P3 = -2*(U-0.3).^2+1.88+1.6;  
  
plocha = (1-U).*P0 + U.*P1 + (1-V).*P3 + V.*P2 - (1-U).*(1-V).*P0(1,1) - (1-U).*(V).*P0(11,11)  
  
figure,  
surf(U,V,plocha);  
  
hold on;  
surf(ones([1,11]),V,P1,'EdgeColor',[1,0,0]);  
surf(U,ones(11),P2,'EdgeColor',[1,0,0]);  
surf(zeros([1,11]),V,P0,'EdgeColor',[1,0,0]);  
surf(U,zeros(11),P3,'EdgeColor',[1,0,0]);  
colormap gray;
```

```
hold off
```



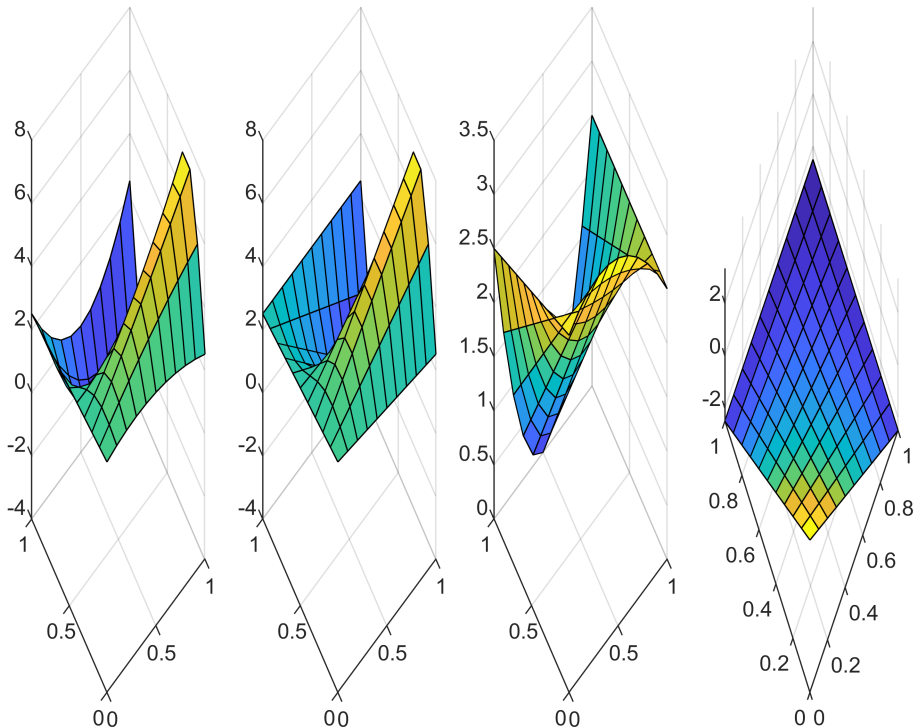
Bilineární Coonsova plocha - jako součet

```
v = 0 : 0.1 : 1;  
u = 0 : 0.1 : 1;  
  
[U,V] = meshgrid(u,v);  
  
P0 = (2.5-3.3).*V + 3.3;  
P1 = 5*sin(V*(2*pi))+2.5;  
P2 = 10*(U-0.5).^2;  
P3 = -2*(U-0.3).^2+1.88+1.6;  
  
plocha = (1-U).*P0 + U.*P1 + (1-V).*P3 + V.*P2 - (1-U).*(1-V).*P0(1,1) - (1-U).*(V).*P0(11,11)  
plocha1 = (1-U).*P0 + U.*P1;  
plocha2 = (1-V).*P3 + V.*P2;  
plocha3 = (1-U).*(1-V).*P0(1,1) - (1-U).*(V).*P0(11,11) - (U).*(1-V).*P1(1,1) - (U).*(V).*P1(11,11);  
  
figure,
```

```

subplot(1,4,1), surf(U,V,plocha);
subplot(1,4,2), surf(U,V,plocha1);
subplot(1,4,3), surf(U,V,plocha2);
subplot(1,4,4), surf(U,V,plocha3);
colormap gray;
view([-44 68])

```



Bikubická plocha

```

v = 0 : 0.1 : 1;
u = 0 : 0.1 : 1;

[U,V] = meshgrid(u,v);

P0 = (2.5-3.3).*V + 3.3;
P1 = 5*sin(V*(2*pi))+2.5;
P2 = 10*(U-0.5).^2;
P3 = -2*(U-0.3).^2+1.88+1.6;

F1u = 2*U.^3 - 3*U.^2 + 1;
F2u = -2*U.^3 + 3*U.^2;

F1v = 2*V.^3 - 3*V.^2 + 1;
F2v = -2*V.^3 + 3*V.^2;

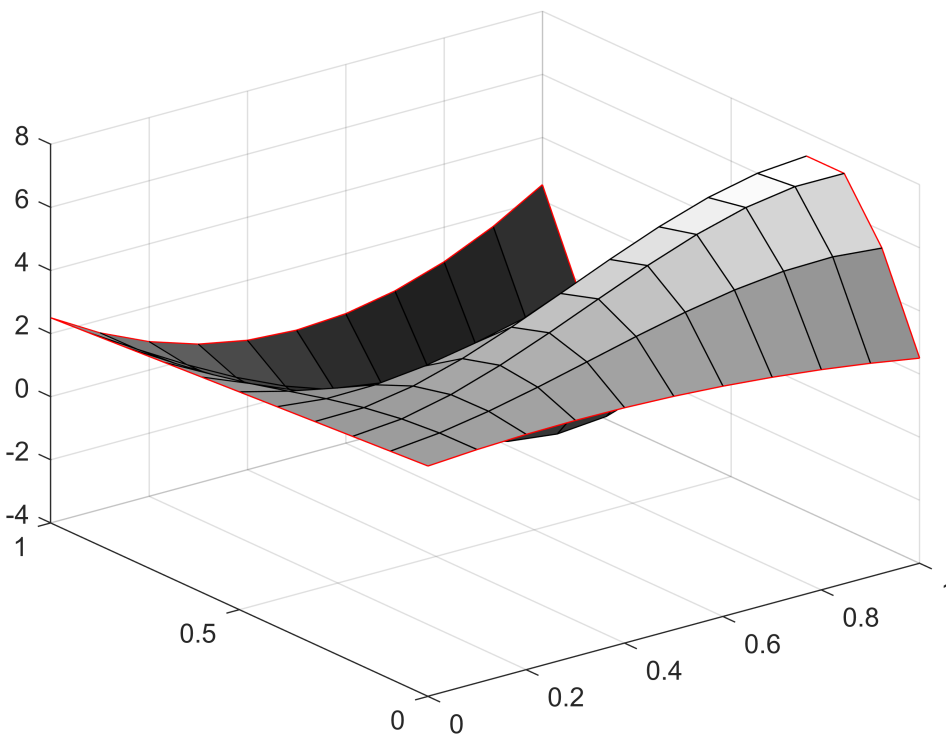
```

```
plocha = F1u.*P0 + F2u.*P1 + F1v.*P3 + F2v.*P2 - F1u.*F1v.*P0(1,1) - F1u.*F2v.*P0(11,11) - F2u.*F2v.*P0(11,11);
```

```
figure,  
surf(U,V,plocha);
```

```
hold on;  
surf(ones([1,11]),V,P1, 'EdgeColor', [1,0,0]);  
surf(U,ones(11),P2, 'EdgeColor', [1,0,0]);  
surf(zeros([1,11]),V,P0, 'EdgeColor', [1,0,0]);  
surf(U,zeros(11),P3, 'EdgeColor', [1,0,0]);  
colormap gray;
```

```
hold off
```



Bezierova plocha

```
x = linspace(0,1,4);  
y = linspace(0,1,4);  
  
u = linspace(0,1,25);  
v = linspace(0,1,25);  
[X,Y] = meshgrid(x,y);  
  
[U,V] = meshgrid(u,v);  
  
P = 10*rand([4,4]);
```



```

Bu=[];
Bu(:,:,1) = (1-U).^3;
Bu(:,:,2) = 3*U.*(1-U).^2;
Bu(:,:,3) = 3*(U.^2).*(1-U);
Bu(:,:,4) = U.^3;

Bv=[];
Bv(:,:,1) = (1-V).^3;
Bv(:,:,2) = 3*V.*(1-V).^2;
Bv(:,:,3) = 3*(V.^2).*(1-V);
Bv(:,:,4) = V.^3;

Q = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q = Q + (P(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

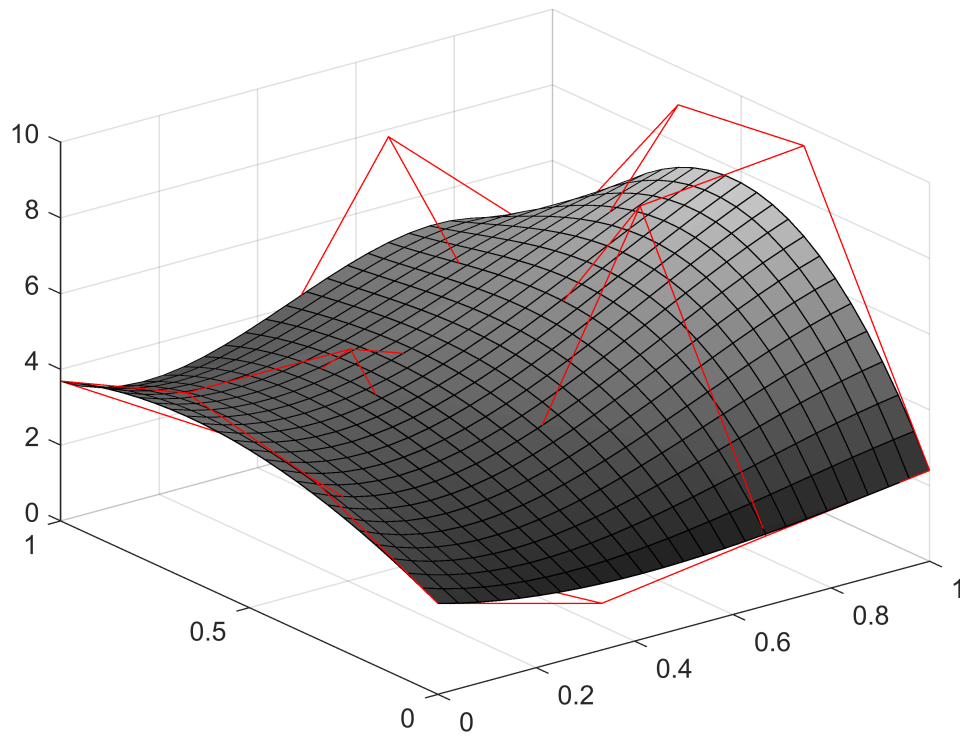
figure,

surf(U,V,Q);
hold on;
mesh(X,Y,P', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');

colormap gray;

hold off

```



```

P(2,2) = P(2,2) - 10;

Q = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q = Q + (P(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

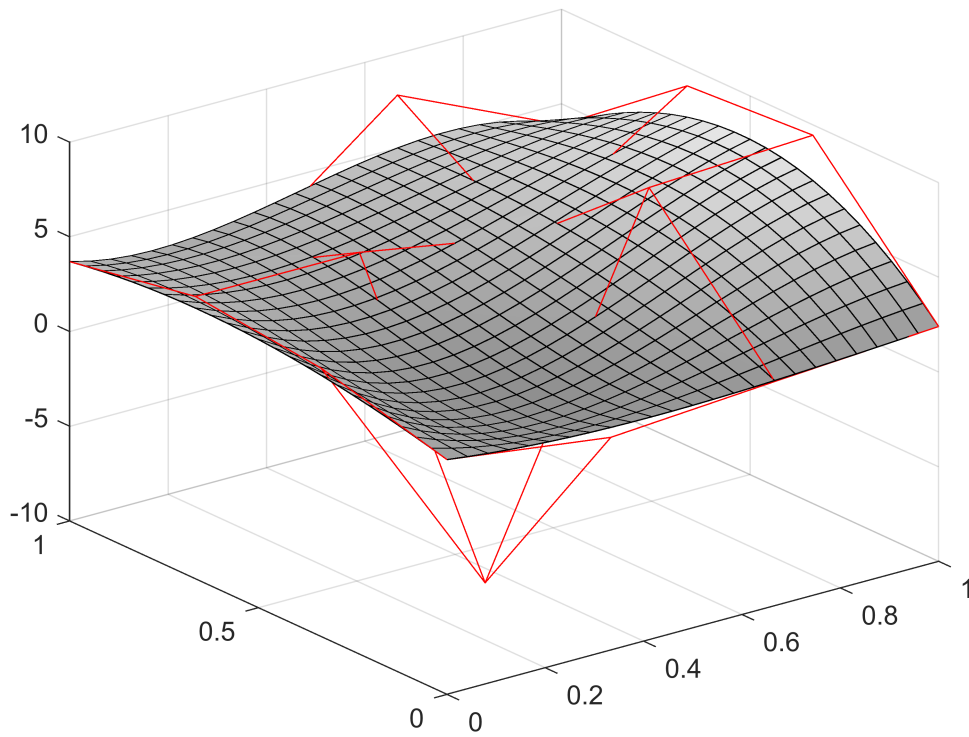
figure,

surf(U,V,Q);
hold on;
mesh(X,Y,P', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');

colormap gray;

hold off

```



Navazování plátů Beziér

```

x = linspace(0,1,4);
y = linspace(0,1,4);

u = linspace(0,1,25);
v = linspace(0,1,25);
[X,Y] = meshgrid(x,y);

[U,V] = meshgrid(u,v);

P1 = [5.0 4.5 7.0 3.0;
      6.5 3.0 1.5 9.5;
      7.0 1.0 0.5 2.5;
      5.5 0.0 2.5 3.0];

P2 = [3.0 1.0 0.0 0.0;
      9.5 3.5 5.5 3.0 ;
      2.5 2.5 2.0 1.5;
      3.0 9.5 6.0 7.0];

Bu=[];
Bu(:,:,1) = (1-U).^3;
Bu(:,:,2) = 3*U.*(1-U).^2;
Bu(:,:,3) = 3*(U.^2).*(1-U);
Bu(:,:,4) = U.^3;

```

```

Bv=[];
Bv(:,:,1) = (1-V).^3;
Bv(:,:,2) = 3*V.*(1-V).^2;
Bv(:,:,3) = 3*(V.^2).*(1-V);
Bv(:,:,4) = V.^3;

Q1 = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q1 = Q1 + (P1(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

Q2 = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q2 = Q2 + (P2(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

figure,
mesh(X,Y,P1', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');
hold on;
surf(U,V,Q1);

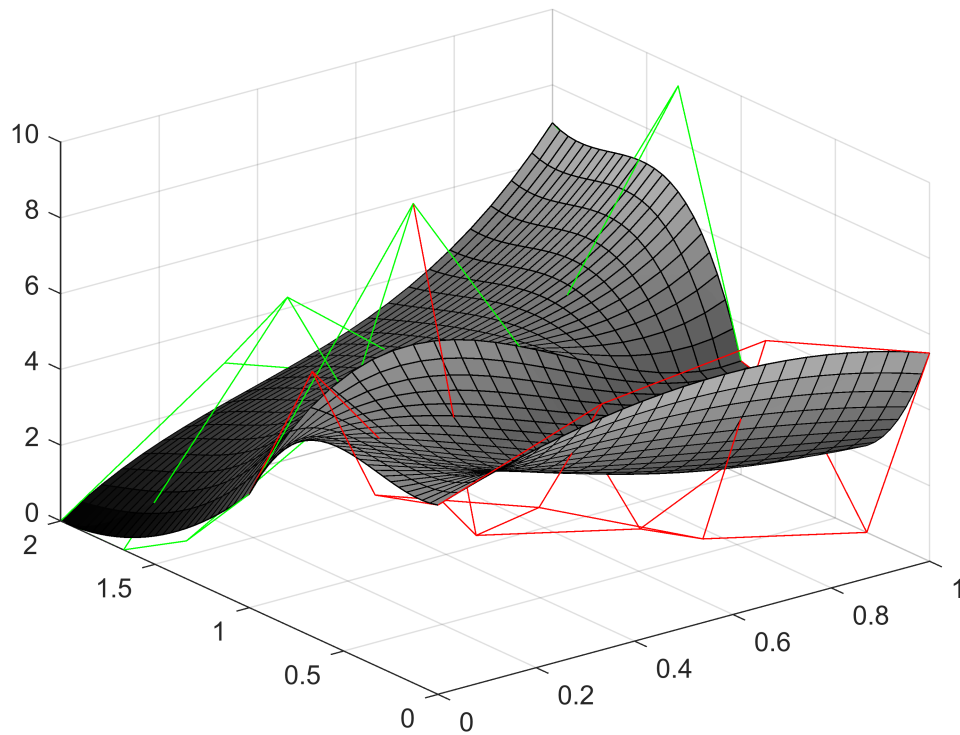
surf(U,V+1,Q2);

mesh(X,Y+1,P2', 'EdgeColor',[0,1,0], 'FaceAlpha','0.01');

colormap gray;

hold off

```



ÚKOL: Navazování plátů Beziér

```

x = linspace(0,1,4);
y = linspace(0,1,4);

u = linspace(0,1,25);
v = linspace(0,1,25);
[X,Y] = meshgrid(x,y);

[U,V] = meshgrid(u,v);

P1 = [5.0 4.5 7.0 3.0;
      6.5 3.0 1.5 9.5;
      7.0 1.0 0.5 2.5;
      5.5 0.0 2.5 3.0];

P2 = [3.0 -1.0 0.0 0.0;
      9.5 17.5 5.5 3.0 ;
      2.5 4.5 2.0 1.5;
      3.0 3.5 6.0 7.0];

Bu=[];
Bu(:,:,1) = (1-U).^3;
Bu(:,:,2) = 3*U.*(1-U).^2;
Bu(:,:,3) = 3*(U.^2).*(1-U);
Bu(:,:,4) = U.^3;

```

```

Bv=[];
Bv(:,:,1) = (1-V).^3;
Bv(:,:,2) = 3*V.*(1-V).^2;
Bv(:,:,3) = 3*(V.^2).*(1-V);
Bv(:,:,4) = V.^3;

Q1 = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q1 = Q1 + (P1(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

Q2 = zeros(25);
for i = 1 : 4
    for j = 1 : 4
        Q2 = Q2 + (P2(i,j).*Bu(:,:,i).*Bv(:,:,j));
    end
end

figure,
mesh(X,Y,P1', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');
hold on;
surf(U,V,Q1);

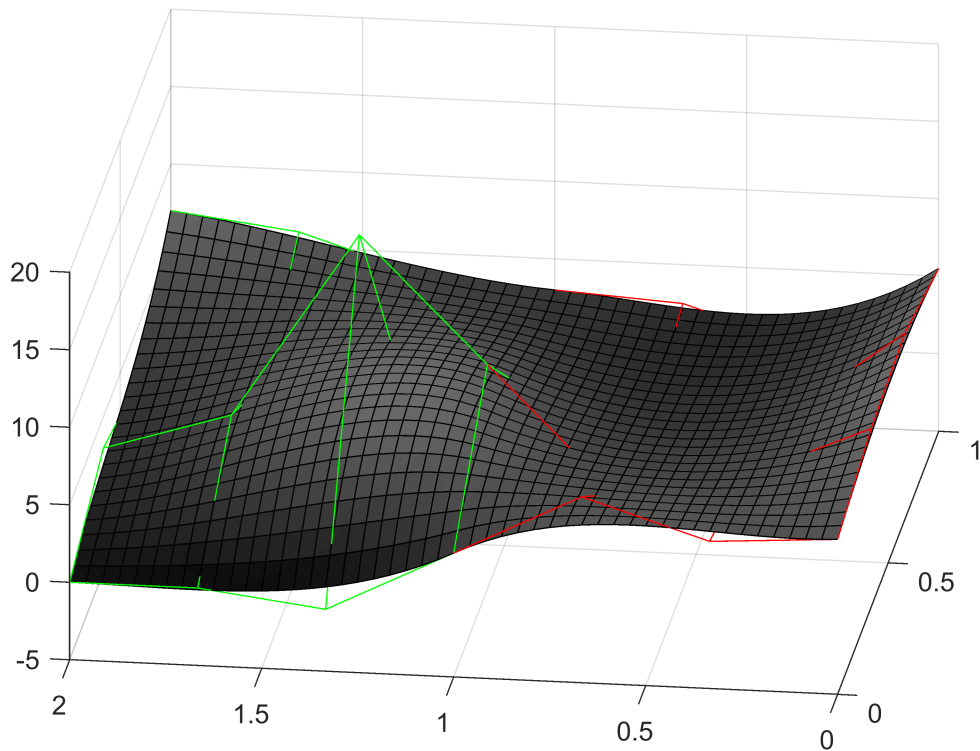
surf(U,V+1,Q2);

mesh(X,Y+1,P2', 'EdgeColor',[0,1,0], 'FaceAlpha','0.01');

colormap gray;
view([-82.5 34.4])

hold off

```



B spline plocha

```

x = linspace(0,1,4);
y = linspace(0,1,4);

% krivka nezacina v 0 a nekonci v 1
u = linspace((x(1)+4*x(2) + x(3))/6, (x(2)+4*x(3) + x(4))/6 ,10);
v = linspace((y(1)+4*y(2) + y(3))/6, (y(2)+4*y(3) + y(4))/6 ,10);
[X,Y] = meshgrid(x,y);

[U,V] = meshgrid(u,v);

P = [1.0 1.5 1.0 3.0;
     1.5 90.0 80.5 5.5;
     -10.0 40.0 30.5 -20.5;
     0.5 1.0 0.5 3.0];

Bu=[];
Bu(:,:,1) = (-U.^3 + 3*U.^2 - 3*U + 1)/6;
Bu(:,:,2) = (3*U.^3 - 6*U.^2 + 4)/6;
Bu(:,:,3) = (-3*U.^3 + 3*U.^2 + 3*U + 1)/6;
Bu(:,:,4) = (U.^3)/6;

Bv=[];
Bv(:,:,1) = (1/6) * (-V.^3 + 3*V.^2 - 3*V + 1);
Bv(:,:,2) = (1/6) * (3*V.^3 - 6*V.^2 + 4);
Bv(:,:,3) = (1/6) * (-3*V.^3 + 3*V.^2 + 3*V + 1);

```

```

Bv(:, :, 4) = (1/6) * V.^3;

Q = zeros(10);
for i = 1 : 4
    for j = 1 : 4
        Q = Q + (P(i,j).*Bu(:, :, i).*Bv(:, :, j));
    end
end

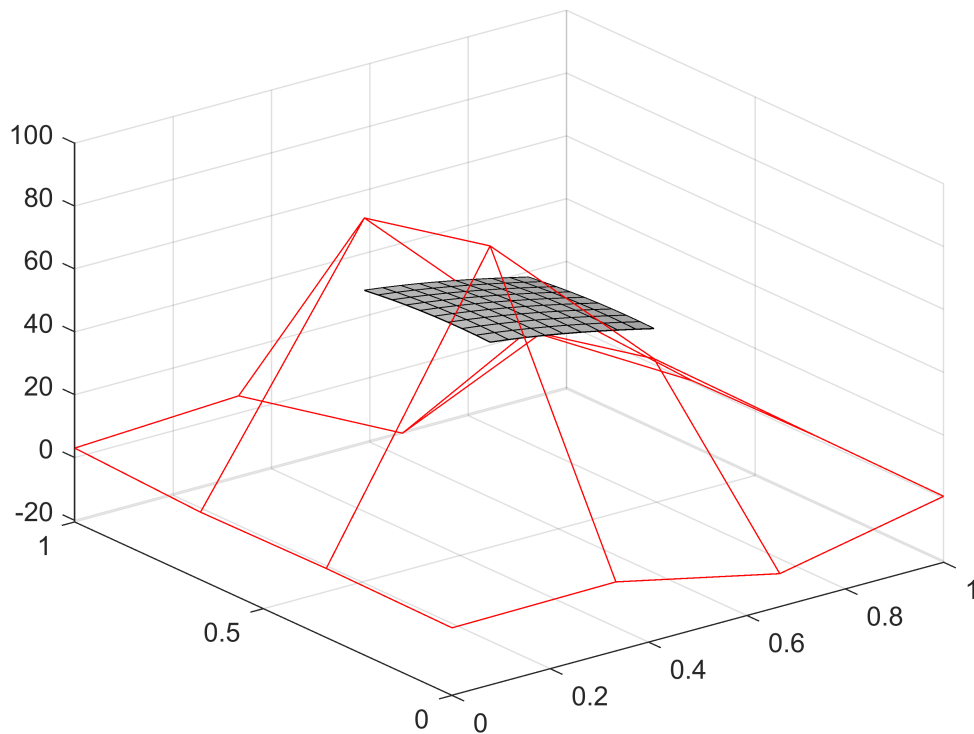
figure,

surf(U,V,Q);
hold on;
mesh(X,Y,P', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');

colormap gray;

hold off

```



B spline plocha

```

x = linspace(0,1,4);
y = linspace(0,1,4);

% krivka nezacina v 0 a nekonci v 1
u = linspace(0, 1 ,10);
v = linspace(0, 1 ,10);

```



```

[X,Y] = meshgrid(linspace(0,8,10),linspace(0,8,10));

[U,V] = meshgrid(u,v);

P = [1.0 1.0 1.0 1.0 1.5 1.0 3.0 3.0 3.0 3.0;
     1.0 1.0 1.0 1.0 1.5 1.0 3.0 3.0 3.0 3.0;
     1.0 1.0 1.0 1.0 1.5 1.0 3.0 3.0 3.0 3.0;
     1.0 1.0 1.0 1.0 1.5 1.0 3.0 3.0 3.0 3.0;
     1.5 1.5 1.5 1.5 90.0 80.5 5.5 5.5 5.5 5.5;
    -10.0 -10.0 -10.0 -10.0 40.0 30.5 -20.5 -20.5 -20.5 -20.5;
     0.5 0.5 0.5 0.5 1.0 0.5 3.0 3.0 3.0 3.0;
     0.5 0.5 0.5 0.5 1.0 0.5 3.0 3.0 3.0 3.0;
     0.5 0.5 0.5 0.5 1.0 0.5 3.0 3.0 3.0 3.0;
     0.5 0.5 0.5 0.5 1.0 0.5 3.0 3.0 3.0 3.0];

Bu=[];
Bu(:,:,1) = (-U.^3 + 3*U.^2 - 3*U + 1)/6;
Bu(:,:,2) = (3*U.^3 - 6*U.^2 + 4)/6;
Bu(:,:,3) = (-3*U.^3 + 3*U.^2 + 3*U + 1)/6;
Bu(:,:,4) = (U.^3)/6;

Bv=[];
Bv(:,:,1) = (1/6) * (-V.^3 + 3*V.^2 - 3*V + 1);
Bv(:,:,2) = (1/6) * (3*V.^3 - 6*V.^2 + 4);
Bv(:,:,3) = (1/6) * (-3*V.^3 + 3*V.^2 + 3*V + 1);
Bv(:,:,4) = (1/6) * V.^3;

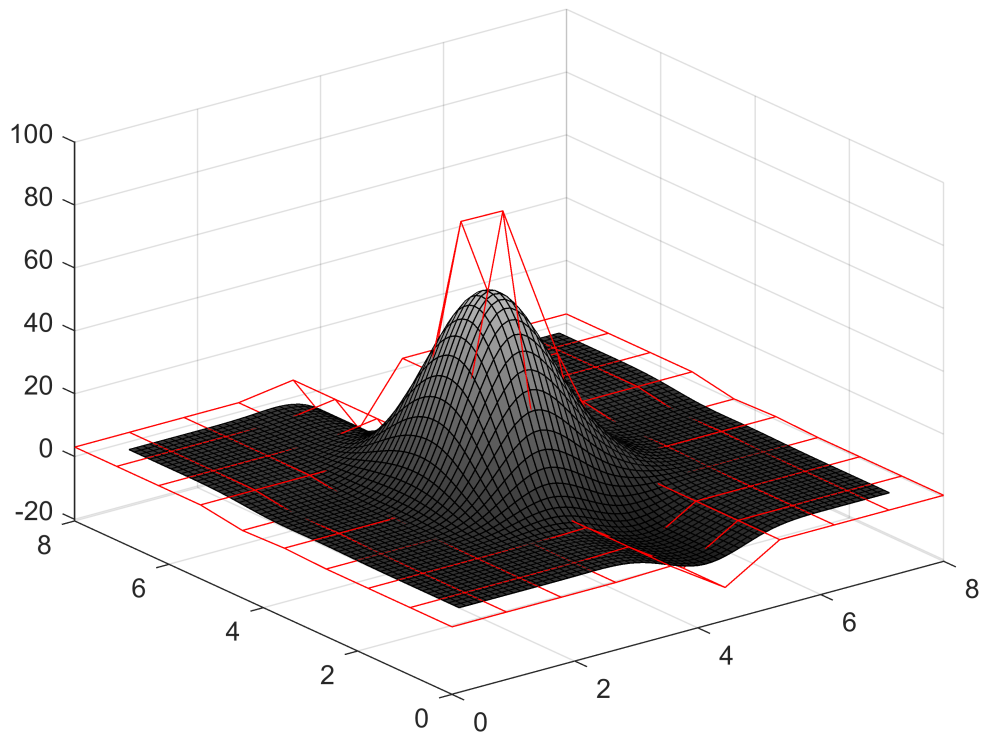
figure,
mesh(X,Y,P', 'EdgeColor',[1,0,0], 'FaceAlpha','0.01');
hold on;

for l = 1 : 7
    for k = 1 : 7
        Q = zeros(10);
        for i = 0 : 3
            for j = 0 : 3
                Q = Q + (P(i+1,j+k).*Bu(:,:,i+1).*Bv(:,:,j+1));
            end
        end
        surf(U+l*1 - 0.5,V+k*1 - 0.5,Q);
    end
end

colormap gray;

hold off

```



Implicitní plochy

```
[y,x,z] = ndgrid(linspace(-1.75,1.75,100),linspace(-1.1,2.1,100),linspace(-1.2,1.2,100));
%f = (x.*(x-1).^2.*(x-2) + y.^2).^2 + z.^2;
f = x.^2 + y.^2 + z.^2;

figure,

isosurface(x,y,z,f,.01);
view(3);
colormap gray;
axis equal
axis off
camlight
```



Implicitní plochy

```
[y,x,z] = ndgrid(linspace(-1.75,1.75,100),linspace(-1.1,2.1,100),linspace(-1.2,1.2,100));  
%f = (x.*(x-1).^2.*(x-2) + y.^2).^2 + z.^2;  
  
figure,  
hold on,  
for t = 0 : 0.01 : 0.5  
    f = (x+t).^2 + y.^2 + z.^2;  
    isosurface(x,y,z,f,.01);  
end  
hold off  
view(3);  
colormap gray;  
axis equal  
axis off  
camlight
```

