2.a) Find the Jacobian of the coordinate transformation

```
syms theta r x y
J=[-r*sin(theta), r*cos(theta)
    cos(theta), sin(theta)]
```

J =

$$\begin{pmatrix} -r\sin(\theta) & r\cos(\theta) \\ \cos(\theta) & \sin(\theta) \end{pmatrix}$$

2.a) Express the inverse transformation of partial derivatives

```
J_theta_r=inv(J)
```

J_theta_r =

$$\begin{pmatrix} -\frac{\sin(\theta)}{r\cos(\theta)^2+r\sin(\theta)^2} & \frac{\cos(\theta)}{\cos(\theta)^2+\sin(\theta)^2} \\ \frac{\cos(\theta)}{r\cos(\theta)^2+r\sin(\theta)^2} & \frac{\sin(\theta)}{\cos(\theta)^2+\sin(\theta)^2} \end{pmatrix}$$

2.c) Check that the inverse transformation (7) satises the chain rule

```
d_dx_1=diff(J_theta_r(1,1),theta)+diff(J_theta_r(1,2),r)
```

d_dx_1 =

$$-\frac{\cos(\theta)}{r\cos(\theta)^2+r\sin(\theta)^2}$$

```
d_dy_1=diff(J_theta_r(2,1),theta)+diff(J_theta_r(2,2),r)
```

d_dy_1 =

$$-\frac{\sin(\theta)}{r\cos(\theta)^2+r\sin(\theta)^2}$$

```
theta_1=atan(y/x);

d_dx_2=diff(theta_1,x)
```

d_dx_2 =

$$-\frac{y}{x^2\left(\frac{y^2}{x^2}+1\right)}$$