ALA BLATTNR. 09 26.06.2014

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26. Juni 2014

1. (i)

$$f(x, y) = 2x^2y^2 - 3xy + 4x + 2$$

$$f_x = 4xy^2 - 3y + 4 \qquad f_y = 4x^2y - 3x$$

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(ii)

$$f(x, y) = cos(x^2y) \cdot e^{xy}$$

$$f_x = -sin(x^2y) \cdot 2xy \cdot e^{xy} + cos(x^2y) \cdot y \cdot e^{xy}$$
$$f_y = -sin(x^2y) \cdot x^2 \cdot e^{xy} + cos(x^2y) \cdot x \cdot e^{yx}$$

(iii)

$$f(x, y) = \frac{sin\ x + cos\ y}{x^2 + y^2}$$

$$f_x = \frac{cos\ x \cdot x^2y^2 - (sin\ x + cos\ y) \cdot 2x}{(x^2 + y^2)^2}$$
$$f_y = \frac{-sin \cdot x^2y^2 - (sin\ x + cos\ y) \cdot 2y}{(x^2 + y^2)^2}$$

(iv)

$$f(x, y) = \sqrt{1 - x^2 - y^2}$$

$$f_x = \frac{1}{2}(1 - 2x)^{-\frac{1}{2}} \qquad f_y = \frac{1}{2}(1 - 2y)^{-\frac{1}{2}}$$

2. TODO

3. (i)

$$
\begin{aligned}
&f(x,y) = -x^2 - y^2 + xy + x + 6\\
&f_x = -2x + y + 1\\
&f_y = -2y + x\\
&f_{xx} = -2\\
&f_{yy} = -2\\
&f_{xy} = 1\\
&f_{yx} = -2
\end{aligned}
$$

$$A = \begin{pmatrix} -2 & 1 \\ -2 & -2 \end{pmatrix}$$

A ist negativ definit, da $f_{xx} = -2$ und $\Delta = 2$.

(ii)

$$
\begin{aligned}
&f(x,y) = 3x^2 + 2y^2 - xy - 4x + y + 1\\
&f_x = 6x - y - 4\\
&f_y = 4y - x + 1\\
&f_{xx} = 6\\
&f_{yy} = 4\\
&f_{xy} = -1\\
&f_{yx} = -1
\end{aligned}
$$

$$B = \begin{pmatrix} 6 & -1 \\ -1 & 4 \end{pmatrix}$$

B ist positiv definit, da $f_{xx} = 6$ und $\Delta = 23$ (> 0).

(iii)

$$
\begin{aligned}
&f(x,y) = 3x^2 + y^2 + 4xy - x + y + 2 && f_x = 6x + 4y - 1\\
&f_y = 2y + 4x + 1\\
&f_{xx} = 6\\
&f_{yy} = 2\\
&f_{xy} = 4\\
&f_{yx} = 4
\end{aligned}
$$

$$C = \begin{pmatrix} 6 & 4 \\ 4 & 2 \end{pmatrix}$$

C ist indefinit, da $f_{xx} = 12$ also positiv ist, aber $\Delta = -4$ (< 0)

(iv)

$$\begin{aligned}
&f(x,y) = x^3 + 4y^3 - 9x - 48y + 7 \\
&f_x = 3x^2 - 9 \\
&f_y = 12y^2 - 48 \\
&f_{xx} = 6x \\
&f_{yy} = 12y \\
&f_{xy} = 0 \\
&f_{yx} = 0
\end{aligned}$$

D $= \begin{pmatrix} 6x & 0 \\ 0 & 12y \end{pmatrix}$ D ist positiv definit, da $f_{xx} = 6$ und $\Delta = 72$ (> 0)

4.