

$$f_{xx} + f_{yy}$$

$$\frac{\partial}{\partial x} \left( \frac{\partial F}{\partial x} \right) = \frac{\partial}{\partial x} \left( \frac{\partial F}{\partial x} \right)$$

$$\frac{\partial F}{\partial x} = \frac{\partial F}{\partial u} \frac{\partial u}{\partial x}$$

$$f_{xx} + f_{yy}$$

$$\frac{\partial}{\partial x} \left( \frac{\partial F}{\partial x} \right)$$

$$u = x \cos \theta - y \sin \theta$$

$$v = x \sin \theta + y \cos \theta$$

$$\cos \theta = \frac{x}{r}$$

$$\sin \theta = \frac{y}{r}$$

$$\frac{\partial F}{\partial x} = \frac{\partial F}{\partial u} \frac{\partial u}{\partial x} + \frac{\partial F}{\partial v} \frac{\partial v}{\partial x}$$

$$\frac{\partial u}{\partial x} = \cos \theta \quad \frac{\partial v}{\partial x} = \sin \theta$$

$$\frac{\partial F}{\partial x} = \frac{\partial F}{\partial u} \cos \theta + \frac{\partial F}{\partial v} \sin \theta$$

$$\frac{\partial}{\partial x} \left( \frac{\partial F}{\partial x} \right) = \frac{\partial}{\partial x} \left( \frac{\partial F}{\partial u} \cos \theta + \frac{\partial F}{\partial v} \sin \theta \right)$$

$$= \cos \theta \frac{\partial}{\partial x} \left( \frac{\partial F}{\partial u} \right) + \sin \theta \frac{\partial}{\partial x} \left( \frac{\partial F}{\partial v} \right)$$

$$\cos \theta \left[ \frac{\partial}{\partial u} \left( \frac{\partial F}{\partial u} \right) \frac{\partial u}{\partial x} + \frac{\partial}{\partial v} \left( \frac{\partial F}{\partial u} \right) \frac{\partial v}{\partial x} \right]$$

$$+ \sin \theta \left[ \frac{\partial}{\partial u} \left( \frac{\partial F}{\partial v} \right) \frac{\partial u}{\partial x} + \frac{\partial}{\partial v} \left( \frac{\partial F}{\partial v} \right) \frac{\partial v}{\partial x} \right]$$

$$= \frac{\partial^2 F}{\partial u^2} \cos^2 \theta + \frac{\partial^2 F}{\partial v^2} \sin^2 \theta + 2 \sin \theta \cos \theta f_{uv} + \sin \theta \cos \theta f_{vu}$$

Subject \_\_\_\_\_

$$\cos(\theta + 90^\circ) = -\sin(\theta)$$

$$\sin(\theta + 90^\circ) = \cos \theta$$

Date: \_\_\_/\_\_\_/\_\_\_

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Now

similarly  $f_{yy}$

just change  $\theta \rightarrow \theta + 90^\circ$

$$f_{yy} = \frac{\partial^2 F}{\partial u^2} \sin^2 \theta + \frac{\partial^2 F}{\partial v^2} \cos^2 \theta - \sin \cos \theta f_{uv} - \sin \cos \theta f_{vu}$$

$$f_{xx} + f_{yy} = \frac{\partial^2 F}{\partial u^2} + \frac{\partial^2 F}{\partial v^2}$$

$$f_{xx} + f_{yy} = f_{uu} + f_{vv}$$