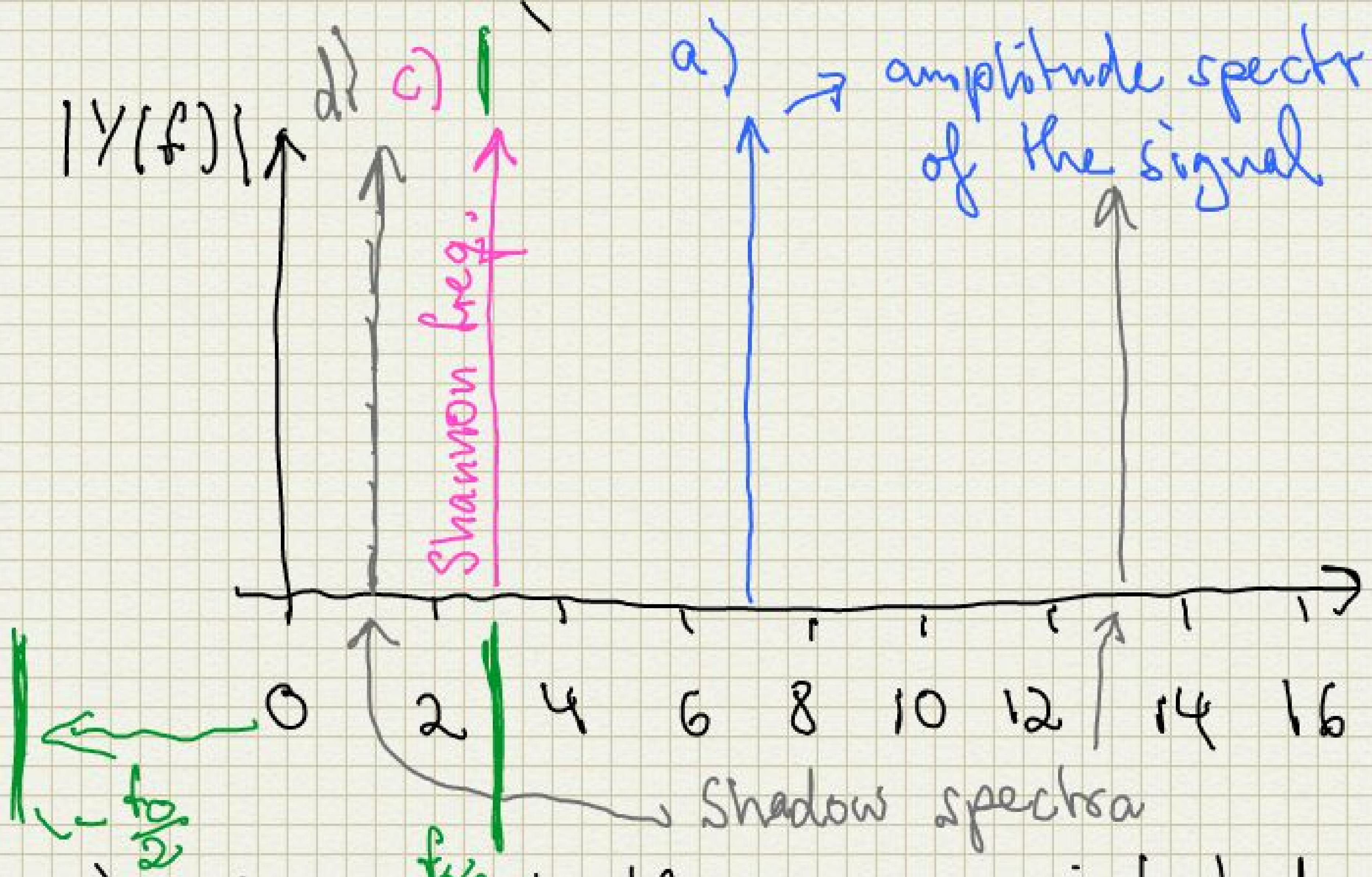

b) Shannon's theorem is violated

$f_0 > 2 \cdot f_s$ here 6Hz X 14 Hz

signal freq.

d) $f_{sampled} = f_s + l f_0$

$l = \cancel{\pm 0}; \pm 1; \pm 2; \ldots$

e) 1Hz (Shadow spectrum that lies in between $\left[-\frac{f_0}{2}; \frac{f_0}{2}\right]$)

Exam from 13th of Sept. 2013

Task 2

a) Optical displacement measurement
Ultrasonic sensor
Angle measurement (etc...)

b) 1) Measure angle / position increments $\Delta\varphi / \Delta x$ and time intervals Δt

2) Direct speed measurement (Doppler effect)

c) Piezoelectric sensor is suited
" " not well suited for quasi static forces/accelarations

d) Derivatives enhance noise!
Especially if signal is derived 2 times!

e) $v = \dfrac{d\,x(\varphi(t))}{dt}$

$$= l_1 \sin(\varphi(t))\,\dot{\varphi}(t) + l_1 \frac{\lambda 2}{4} \sin(2\varphi(t))\dot{\varphi}$$

$$= l_1 \dot{\varphi}(t)\left[\sin(\varphi) + \frac{\lambda}{2}\sin(2\varphi)\right]$$

$$a = \frac{d\,v(\varphi(t))}{dt}$$

$$= l_1 \ddot{\varphi}(t)\left[\sin(\varphi) + \frac{\lambda}{2}\sin(2\varphi)\right] + \dots$$

$$l_1 \dot{\varphi}\left[\dot{\varphi}\cos(\varphi) + \frac{\lambda}{2}\cos(2\varphi)\cdot 2\dot{\varphi}\right]$$

$$= l_1 \ddot{\varphi}(t)\left[\sin\varphi + \frac{\lambda}{2}\sin(2\varphi)\right] + l_1 \dot{\varphi}^2 \left[\dots \right.$$

$$\left. \cos(\varphi) + \lambda\cos(2\varphi)\right]$$

f) $v(\varphi(t)) = l_1 \dot{\varphi}\left[\sin\varphi + \frac{\lambda}{2}\sin(2\varphi)\right]$

$$= 1\text{m}\ \frac{3000 \cdot 2\pi}{60 \frac{\text{sec}}{\cancel{\text{min}}}\ \cancel{\text{min}}}\left[\sin 73{,}7^\circ + \frac{1}{3}\sin(2\cdot 73{,}7^\circ)\right]$$

$$= 329.7\ \frac{\text{m}}{\text{sec}}$$