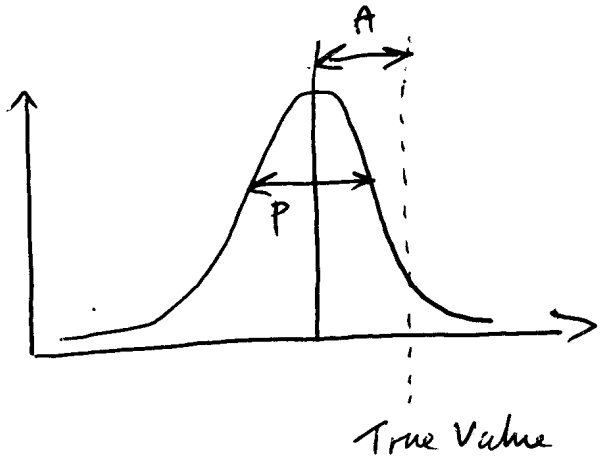
Psheet 1

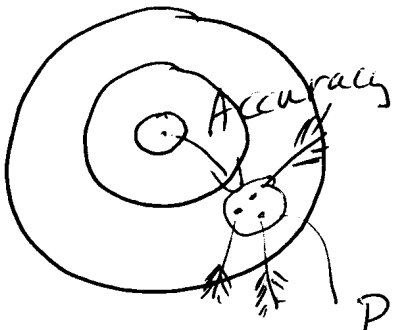
① The sensitivity of a sensor ~~or~~ is the ratio of the change in output S to the change in measurand x.
So if the transfer function is $S(x)$, the sensitivity is $\frac{dS}{dx}$.

Note that sensitivity is often used interchangably with threshold, which is defined as the smallest change in ~~one~~ measurand (stimulus) which can be measured

② 


Precision is how narrowly the value can be measured - usually expressed as a FWHM or a standard deviation.

Accuracy is how close the measured value is to the true value




Target metaphor:
Accuracy is how close the arrows are to the bullseye.
Precision is how closely they are clustered together.

③ Active sensors require a source of power eg microphone.

Passive sensors power themselves, eg thermocouple

(4) Transducers are reversible - they convert both a physical property to an electrical signal and vice versa. eg Piezoelectric

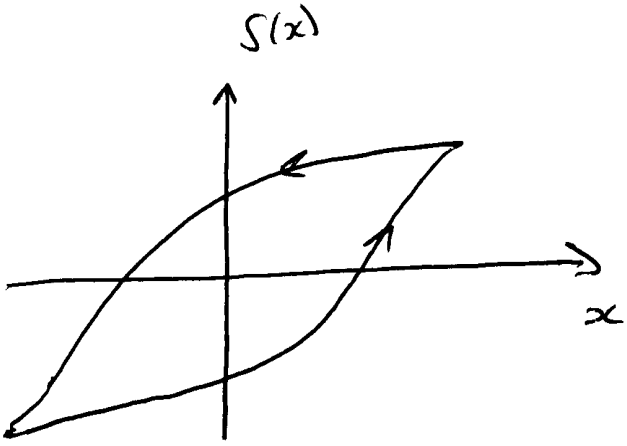
Sensors only need to go one way, ie physical property to electrical signal. eg Thermistor

So all transducers are sensors. Note that these terms are often used interchangably.

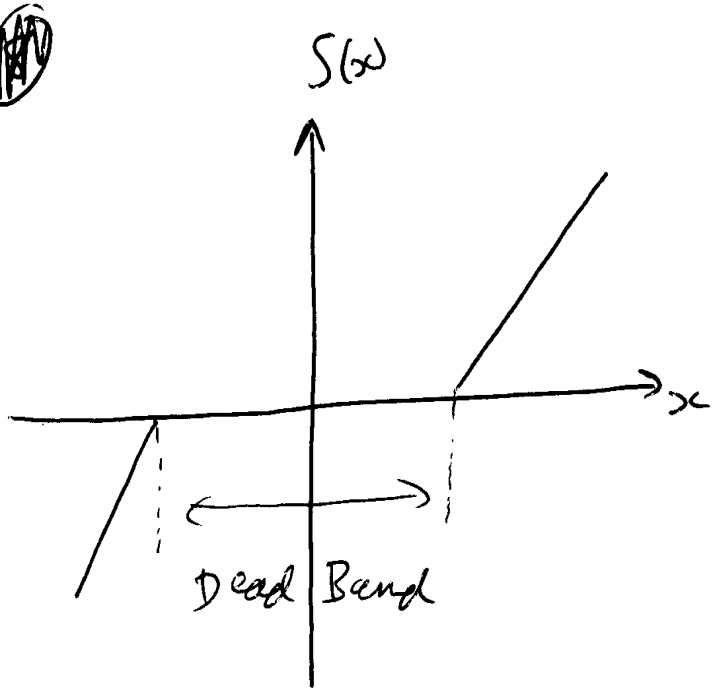
(5) $S = S_m\left(1 - e^{-t/\tau}\right)$ where $\tau$ is the time constant, $S_m$ steady state output.

(6) The GaN based UV sensor from lectures

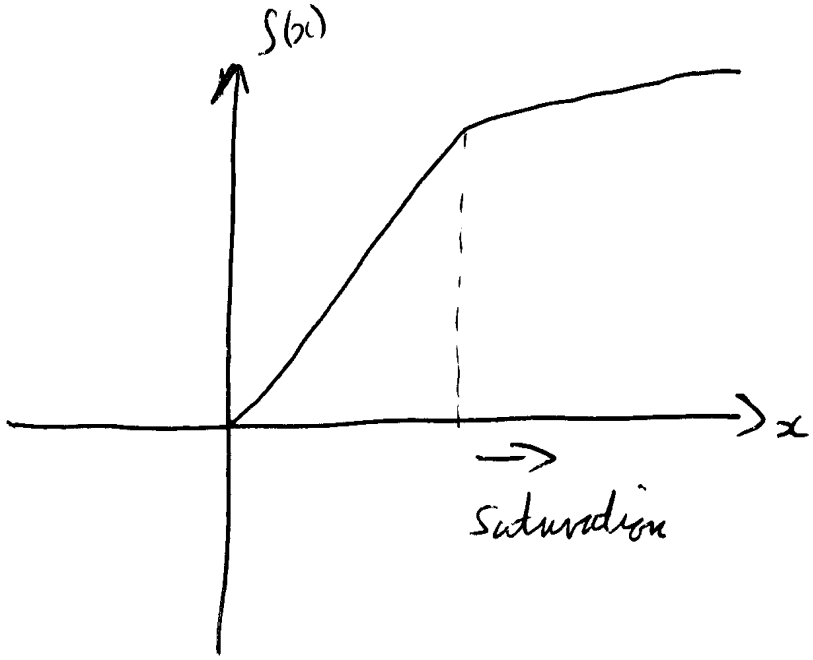
(7)




Hysteresis is a deviation in the sensor output when it is approached from opposite directions




Dead band is the insensitivity of the sensor to a range of input signals




Saturation is when the maximum output is achieved. Further increases in stimulus have no or little effect.

(8) Temperature, pressure, humidity, noise, vibration, chemical vapours, light, heat, UV, x-ray, ionising radiation.

Anything that can affect the sensor which is not a measurand.

(9)

(a) $C = C(h) = 2\pi\varepsilon_0 \dfrac{H - h(1-K)}{\log_e(b/a)}$

$$= \frac{(6.283)(8.85e{-}12)\left[.2 - .02(1-78.5)\right]}{\log_e(2)}$$

$$= 1.404e{-}10 \text{ F}$$

$$= 140.4 \text{ pF}$$

(b) $h = 0 \Rightarrow C = \dfrac{(2\pi)(8.85e{-}12)(0.2)}{\log_e(2)}$

$$= 16.04 \text{ pF}$$

Factor of 10 difference

(c) Well suited - large difference between fully immersed and fully withdrawn. Mechanically Robust.

$C(h)$ is a linear function of $h$.

$$\text{sensitivity} = \frac{dC}{dh} = \frac{-2\pi\varepsilon_0(1-K)}{\log_e b/a} = -8.022\times10^{-11}(1-K) \text{ F/m}$$

(d) Very sensitive to dielectric constant of fluid.

If used oil, $\left.\dfrac{dC}{dh}\right|_{oil} = -(8.022e{-}11)(1-4.5)$

$$= 2.81e{-}10 \text{ F/m}$$

ie much more sensitive.