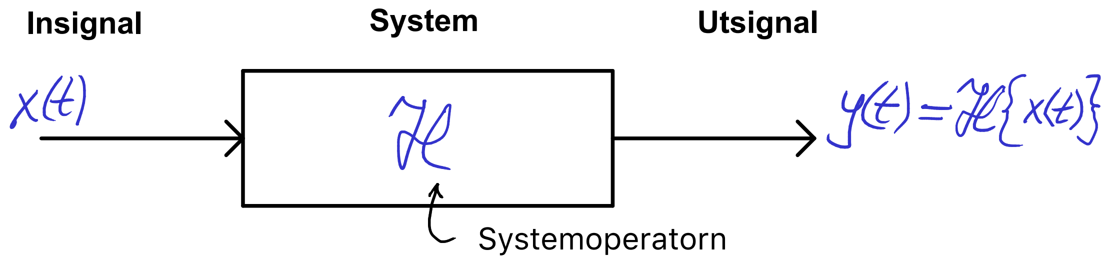
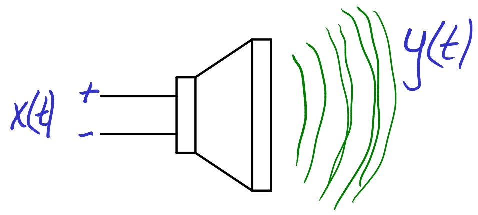
Linjära System – Föreläsning 8: Inledning, signal- och systemegenskaper

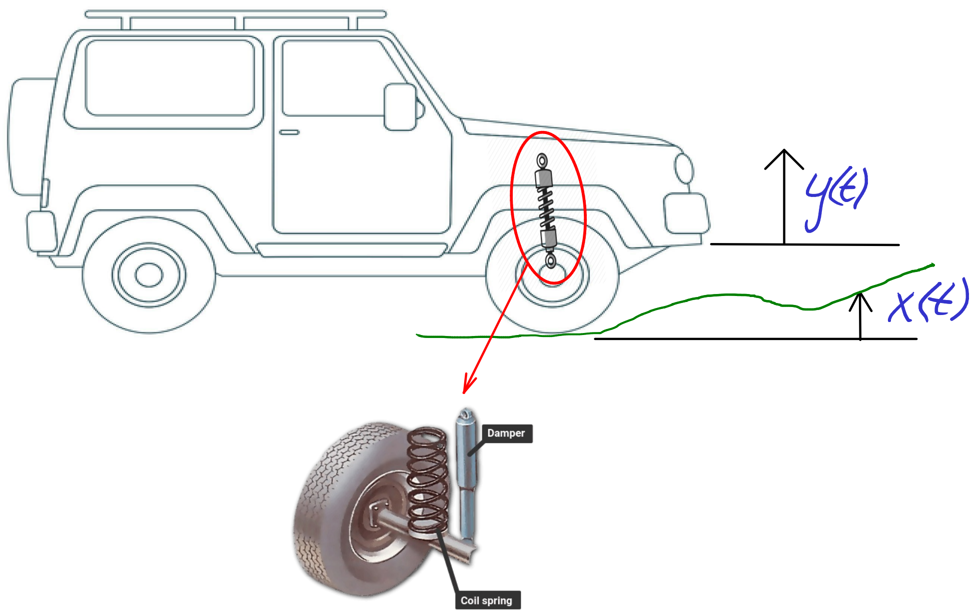


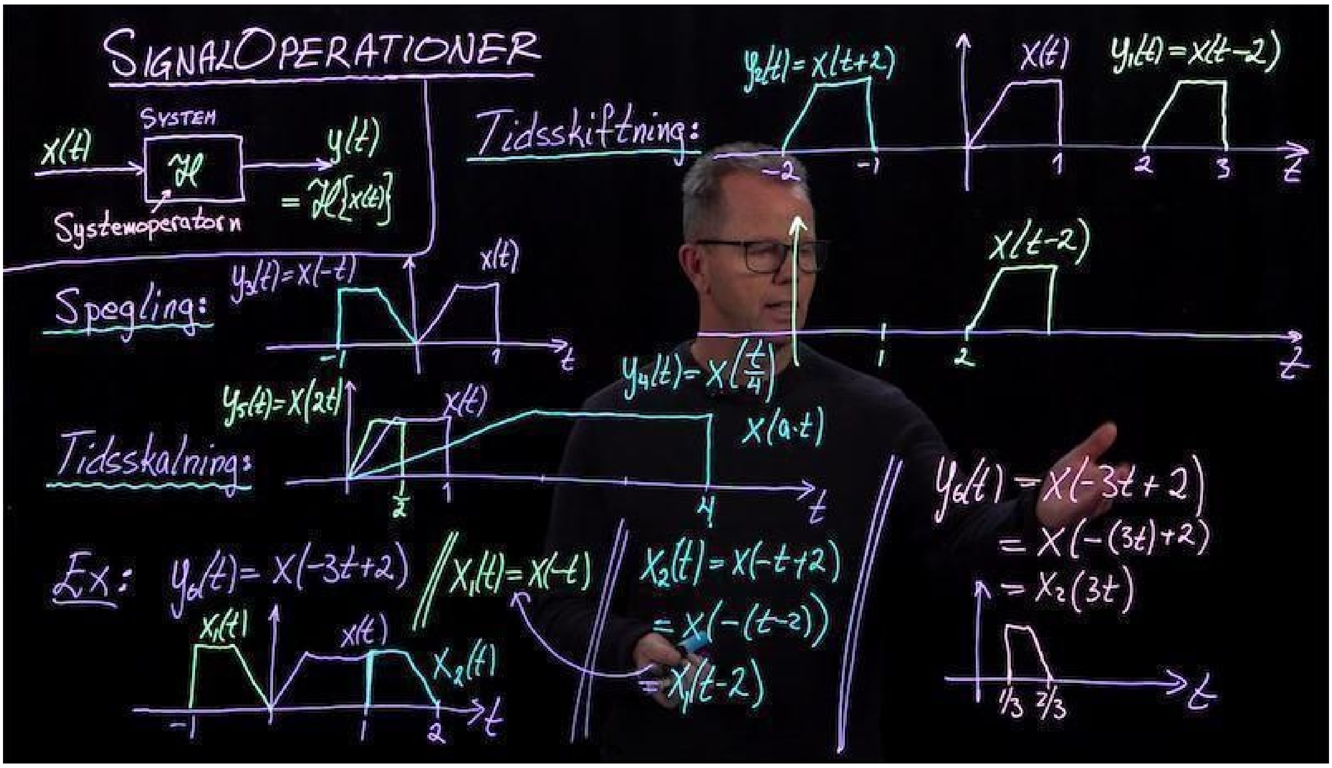
Ett SYSTEM = en matematisk modell av ett fysikaliskt system (alt. en algoritm) som för olika insignaler x genererar olika utsignaler y

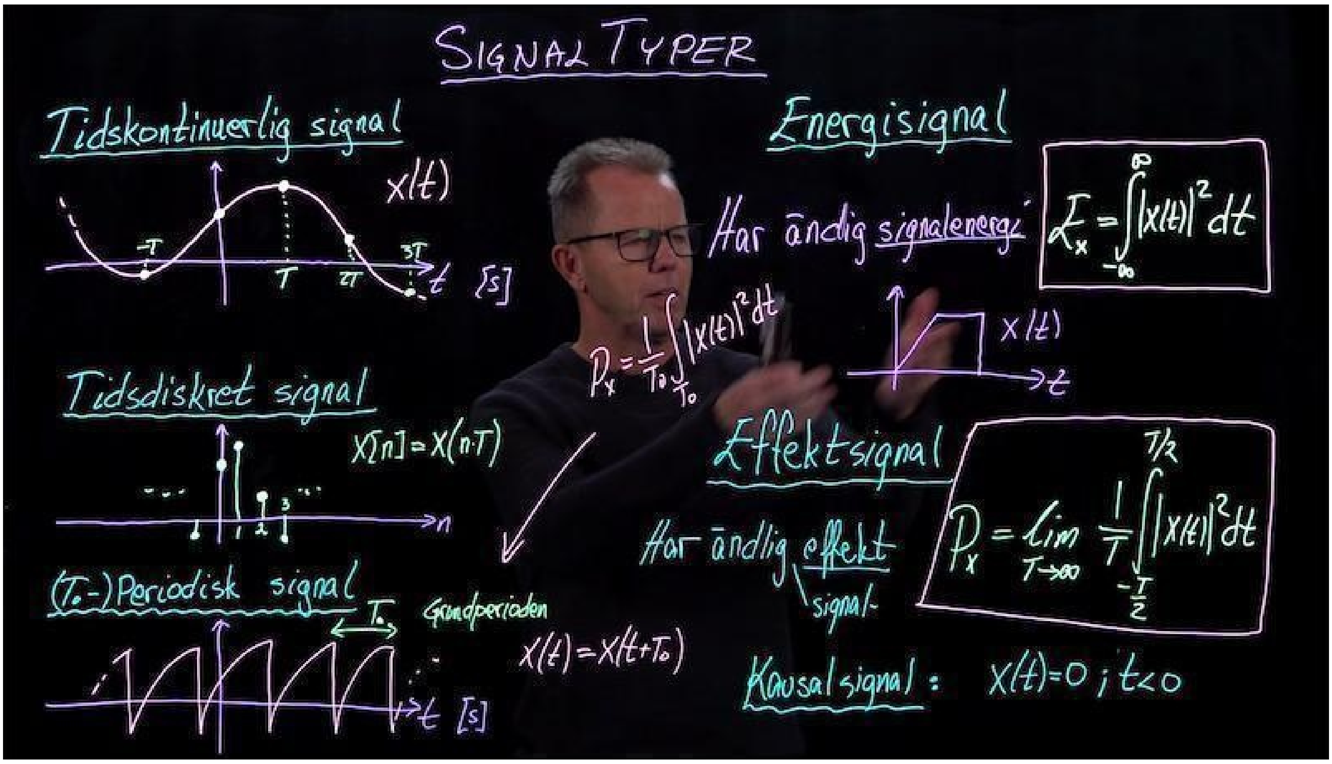
En SIGNAL = en informationsbärande matematisk funktion som representerar en (ofta mätbar) fysikalisk storhet.

Exempel:



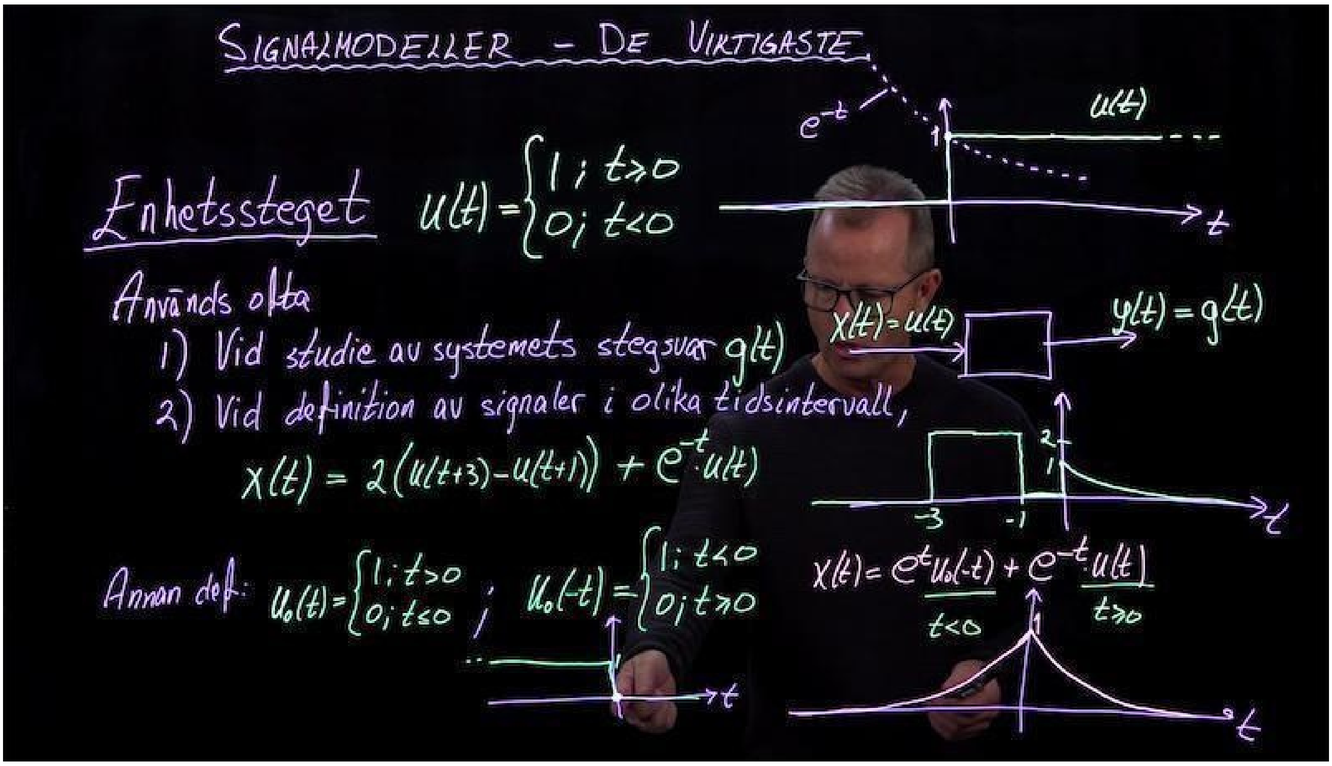


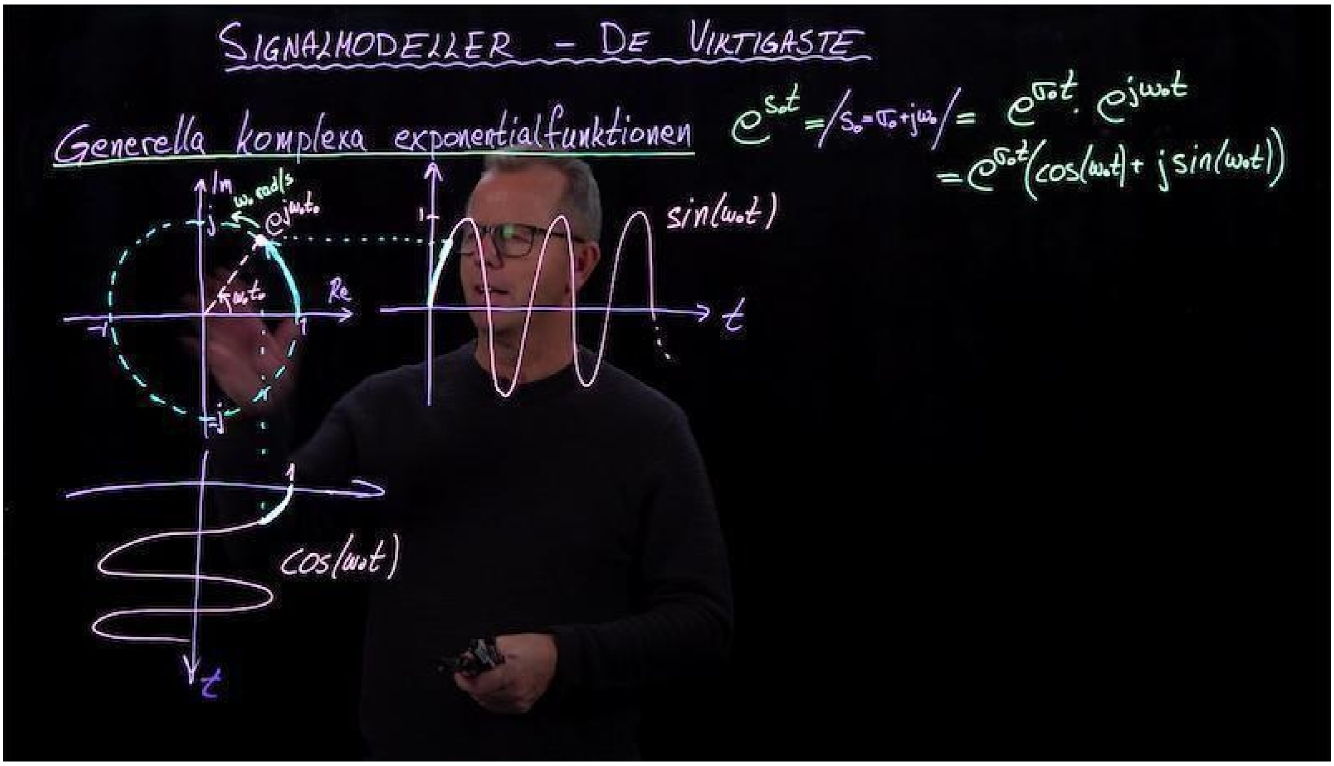


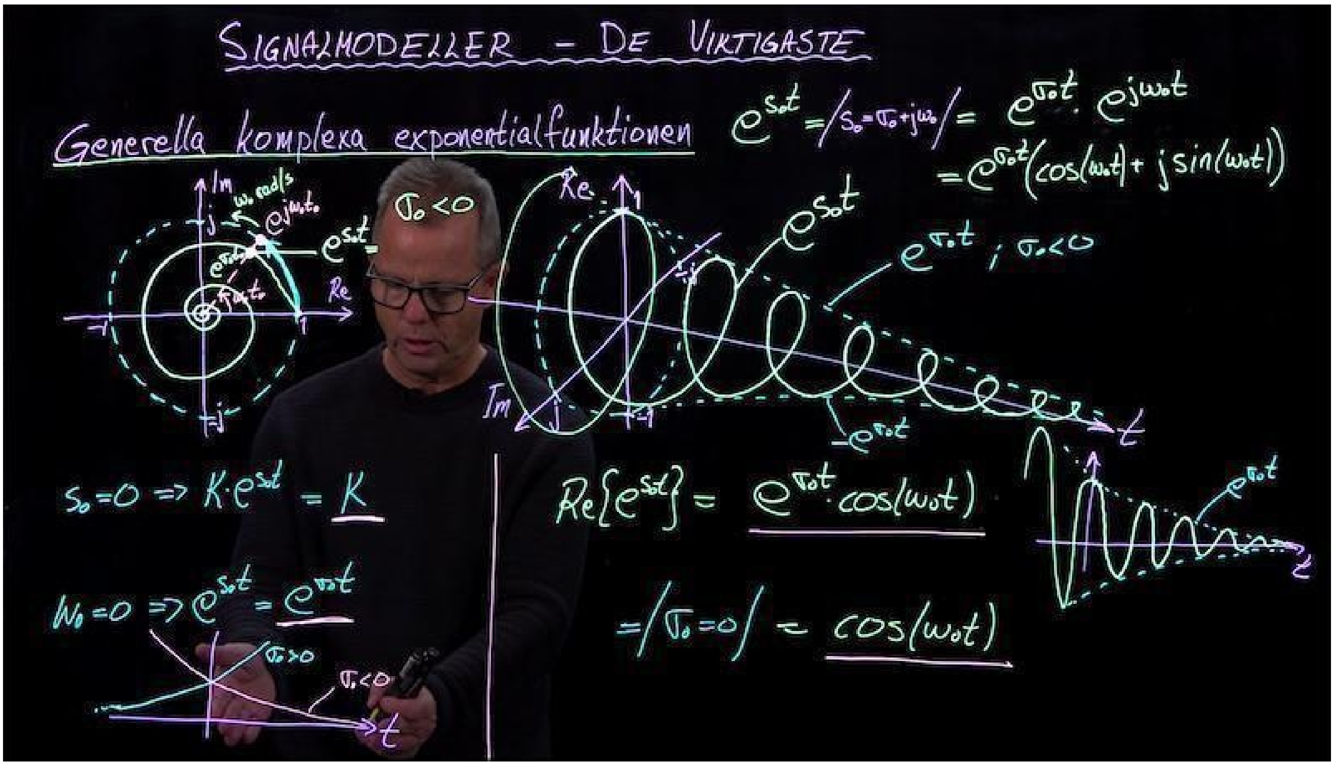


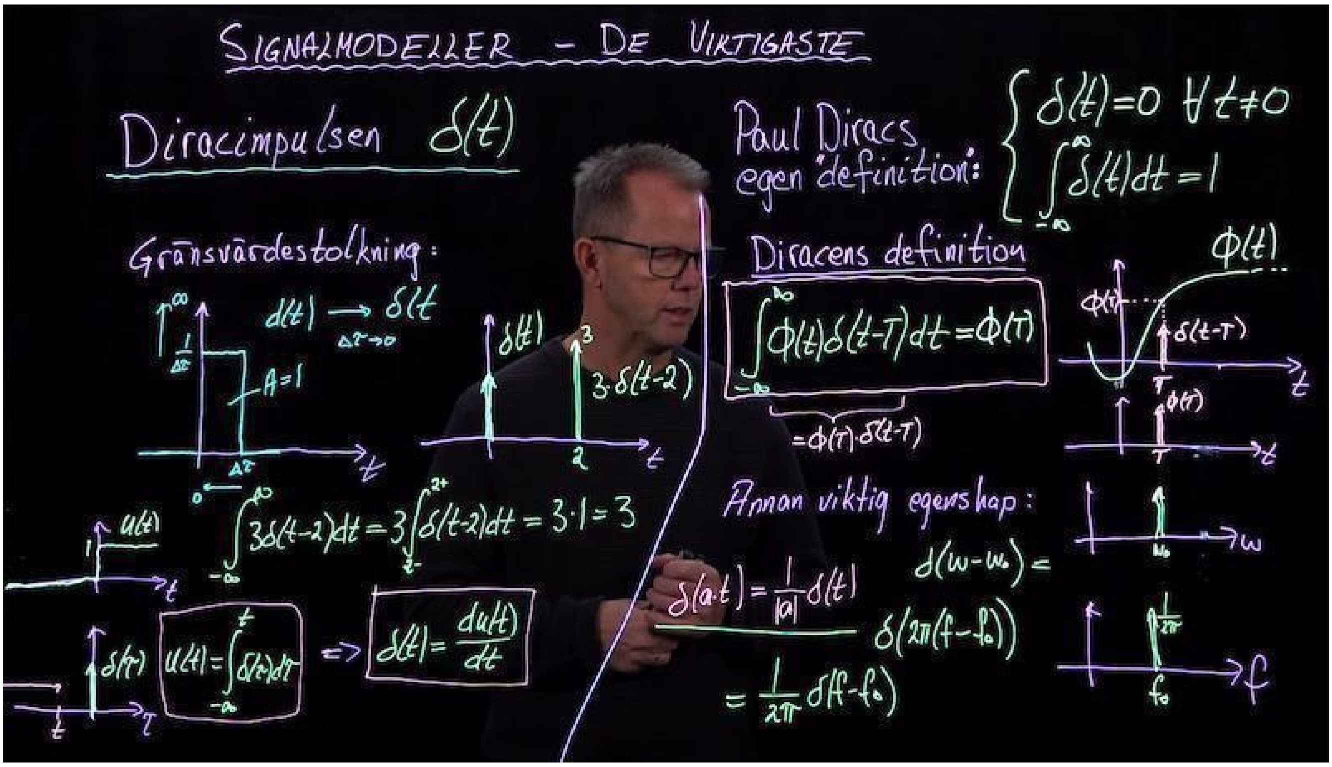
Stationär signal

Transient signal


SIGNALMODELLER - DE VIKTIGASTE
Enhetssteget
Används ofta
1) Vid studie av systemets stegsvar g(t)
2) Vid definition av signaler i olika tidsintervall,
x(t) = 2(u(t+3) - u(t+1)) + e^{-t}·u(t)
Annan def:
y(t) = g(t)
x(t) = e^t u₀(-t) + e^{-t}·u(t)
t<0
t≥0

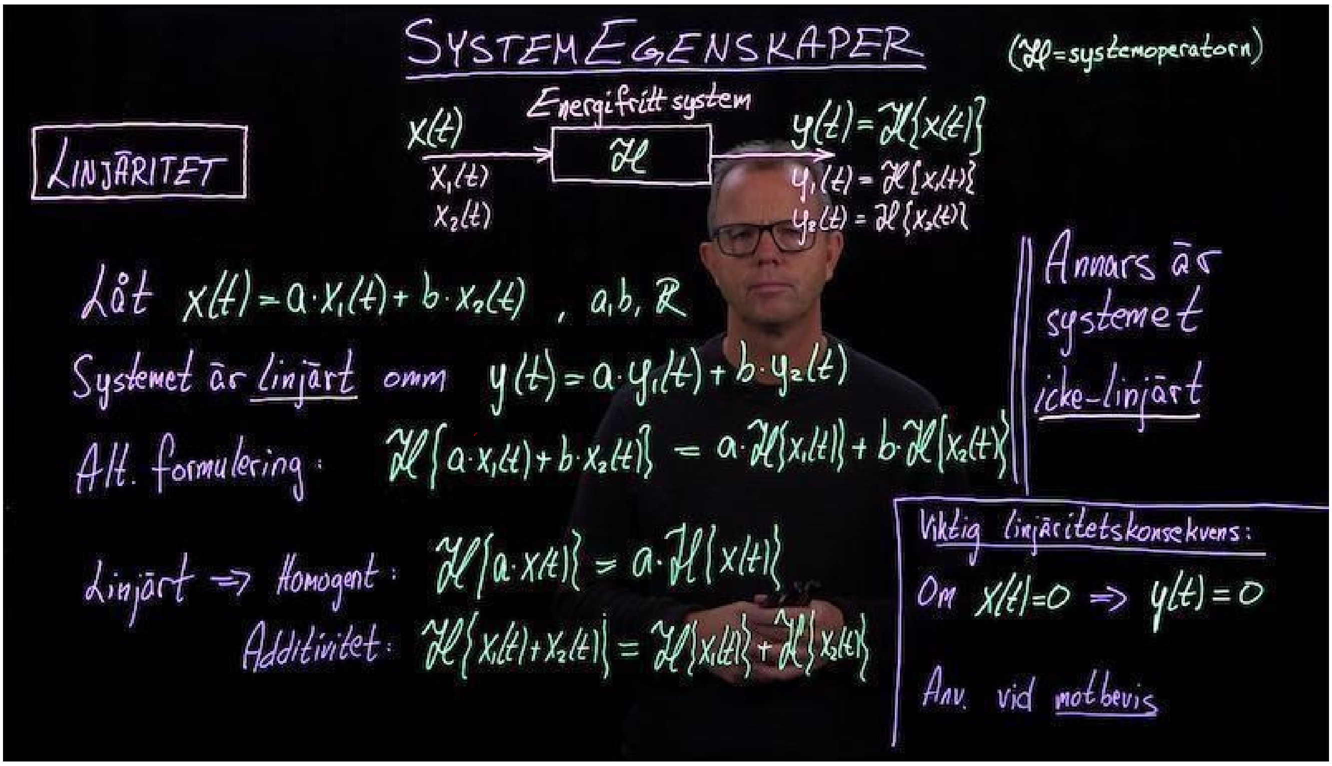

SIGNALMODELLER - DE VIKTIGASTE
Generella komplexa exponentialfunktionen
sin(ω₀t)
cos(ω₀t)



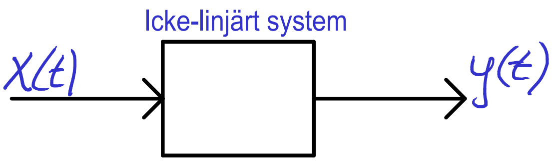


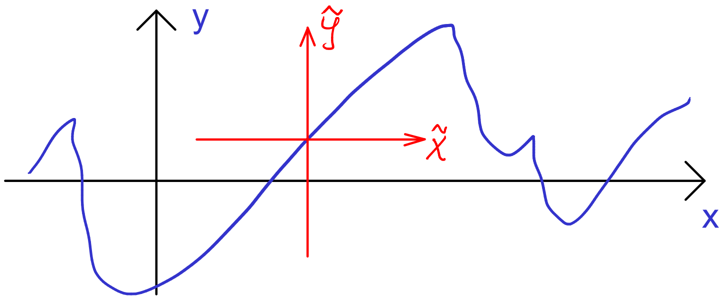
Exempel:

$$\boxed{x(t) = \int_{-\infty}^{\infty} x(\tau)\delta(t-\tau)\,d\tau}$$

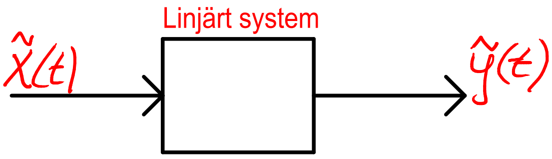


De flesta fysikaliska system är <u>inte</u> linjära.





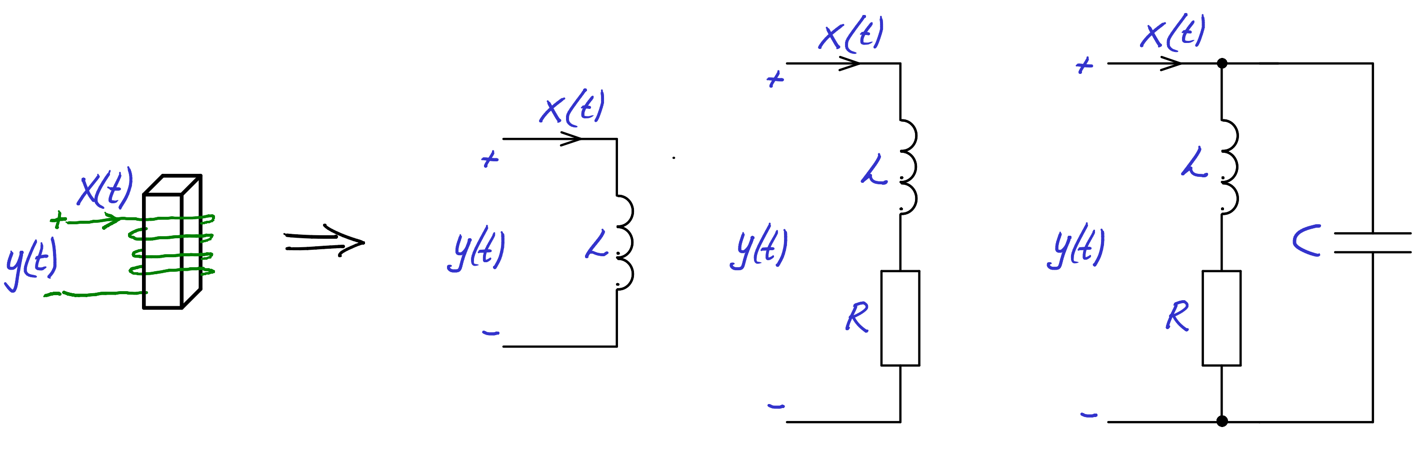
Linjärisera ⇒



Exempel – fysikaliskt system med olika linjära modeller:

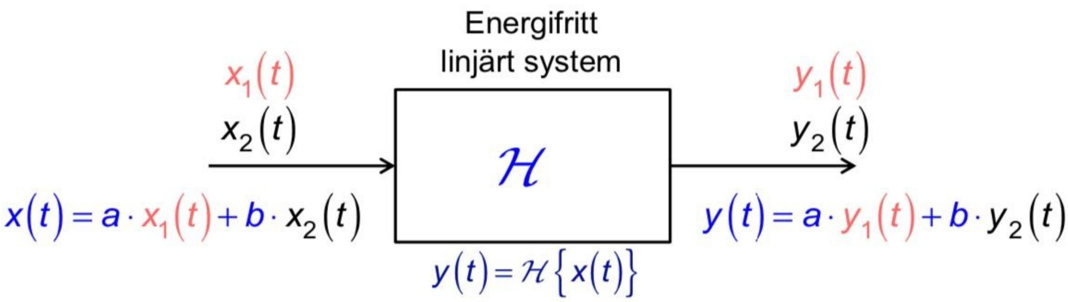
<u>Spole</u>

<u>Olika linjära modeller</u>



Metod för att testa linjäritet

1) **Antag** att insignalerna $x_n(t)$ ger motsvarande utsignaler $y_n(t) = \mathcal{H}\{x_n(t)\}$ och **låt** $x(t) = a \cdot x_1(t) + b \cdot x_2(t)$, där $a, b \in \mathbb{R}$

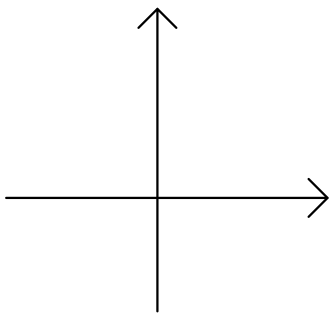


2) **Om** $y(t) = \mathcal{H}\{x(t)\} = \cdots$/kan omformas till:/$\cdots = a \cdot y_1(t) + b \cdot y_2(t)$ så är systemet **linjärt**

Exempel:

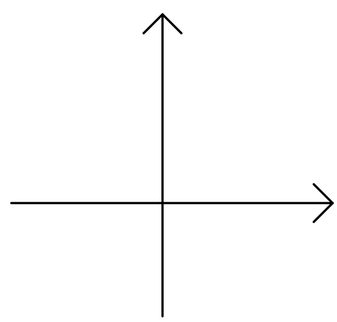
① $y(t) = t \cdot x(t-4)$ $\Rightarrow$ $y_n(t) = t \cdot x_n(t-4)$

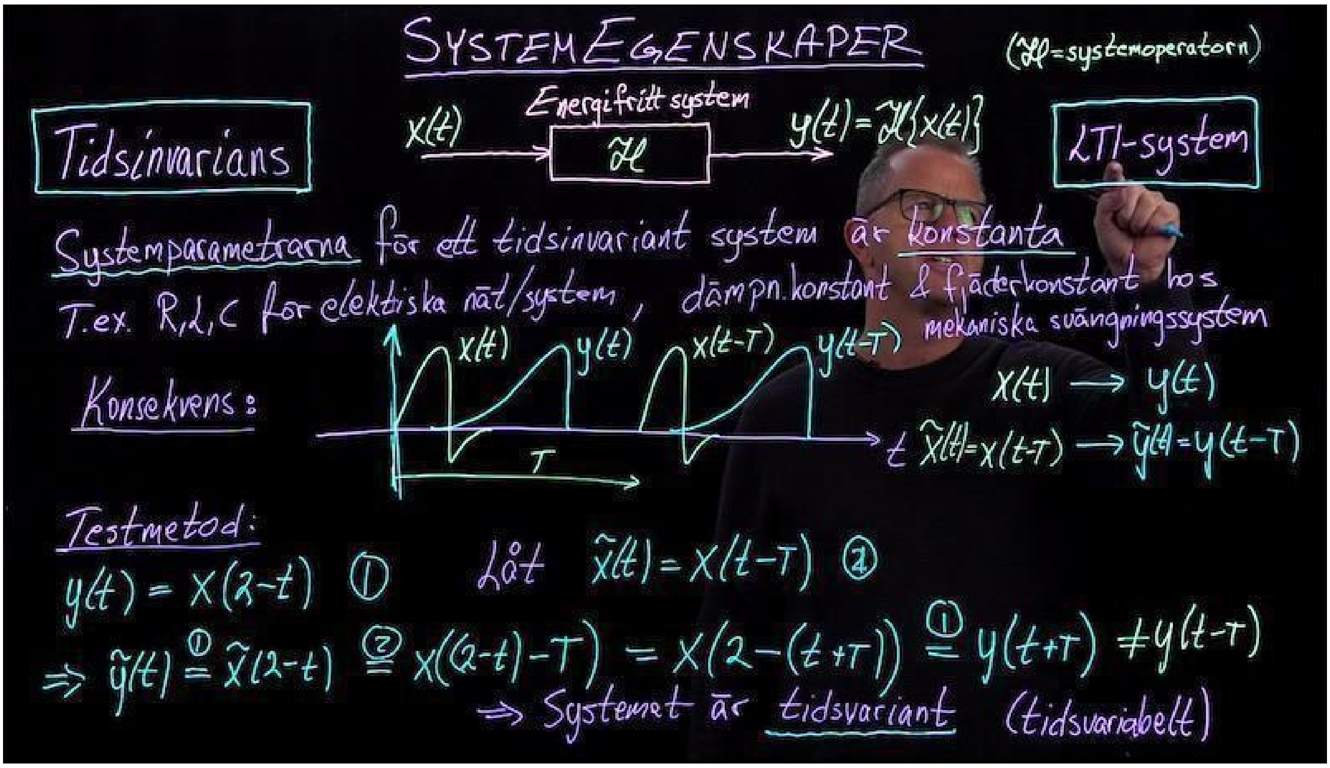
② $y(t) = 5x(t) + 3$ $\Rightarrow$ $y_n(t) = 5x_n(t) + 3$



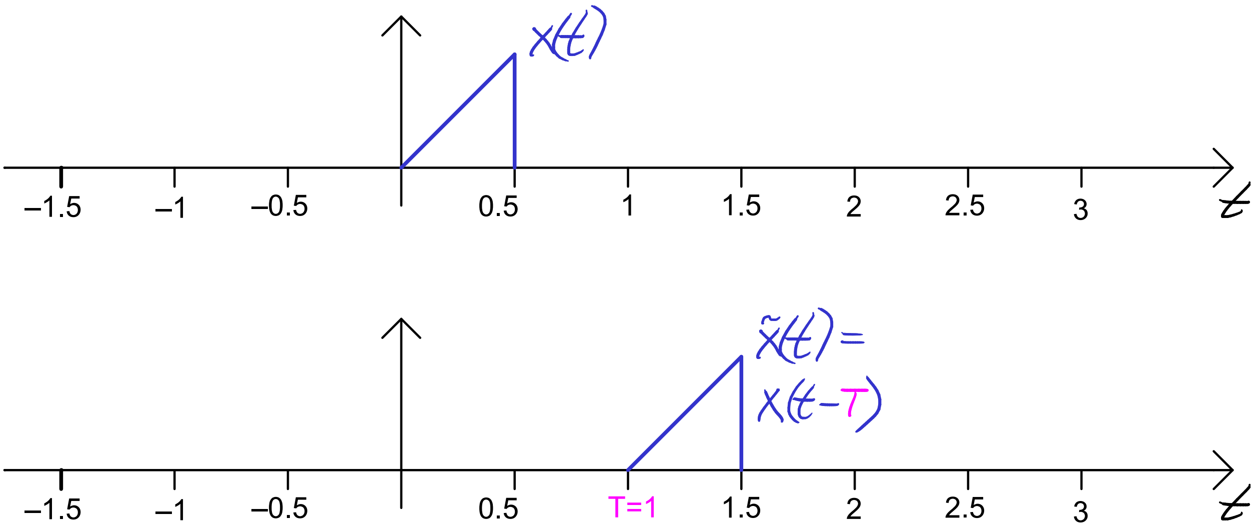
③ $$\frac{dy(t)}{dt} + 2y(t) = 3\frac{dx(t)}{dt} \Rightarrow \frac{dy_n(t)}{dt} + 2y_n(t) = 3\frac{dx_n(t)}{dt}$$

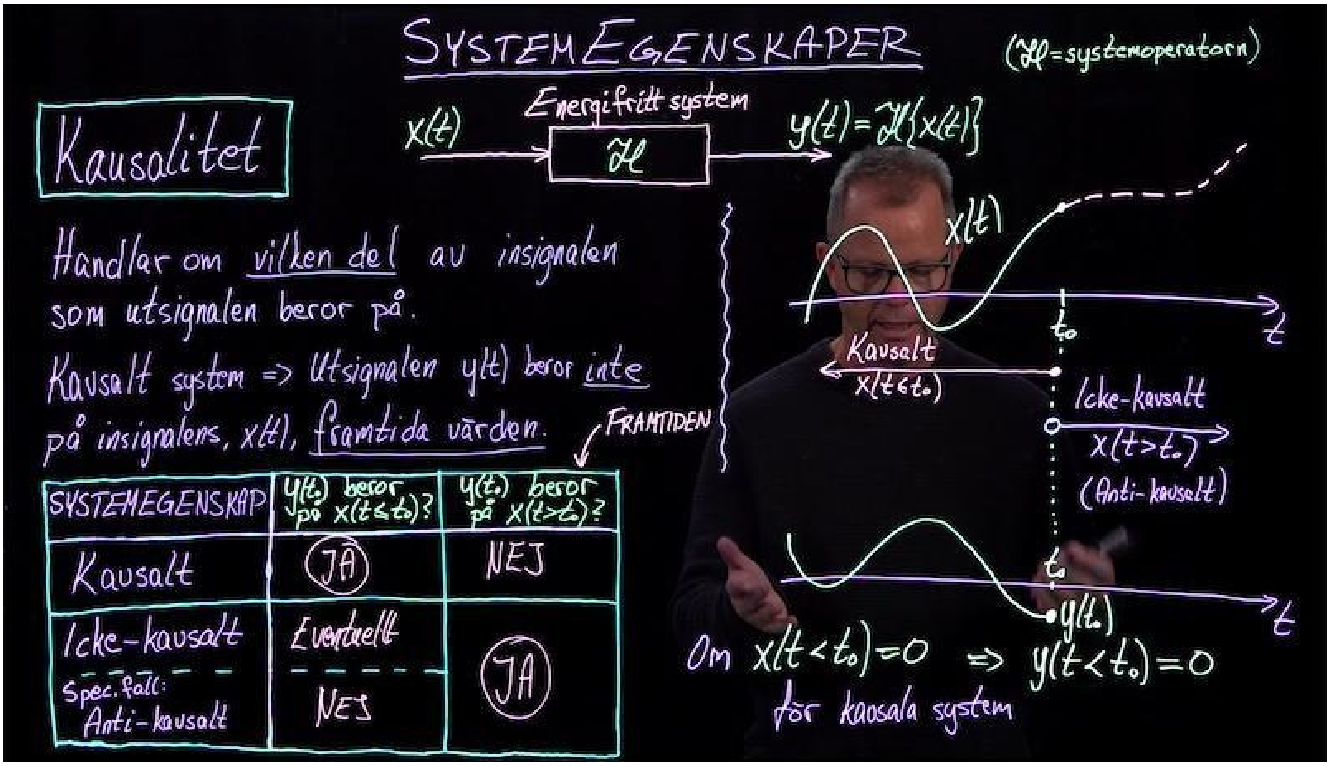
$$(y_n' + 2y_n = 3x_n')$$ ★





Grafisk illustration av föreläsningsexemplet

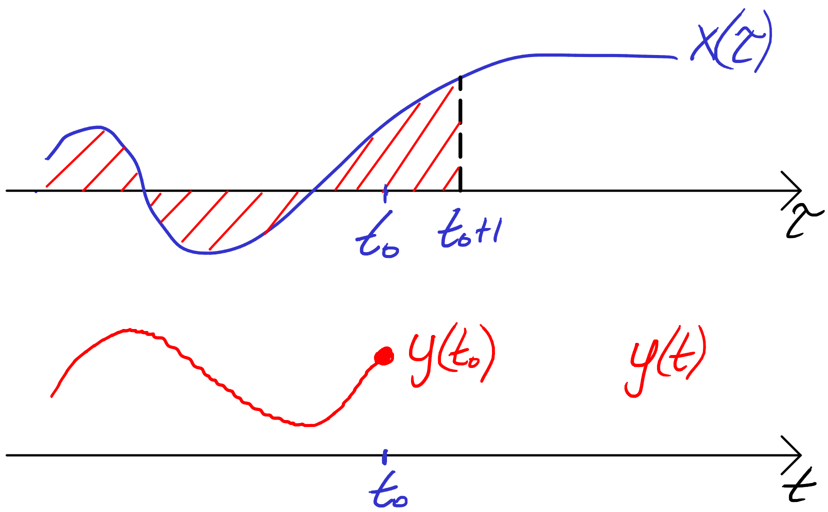




Exempel

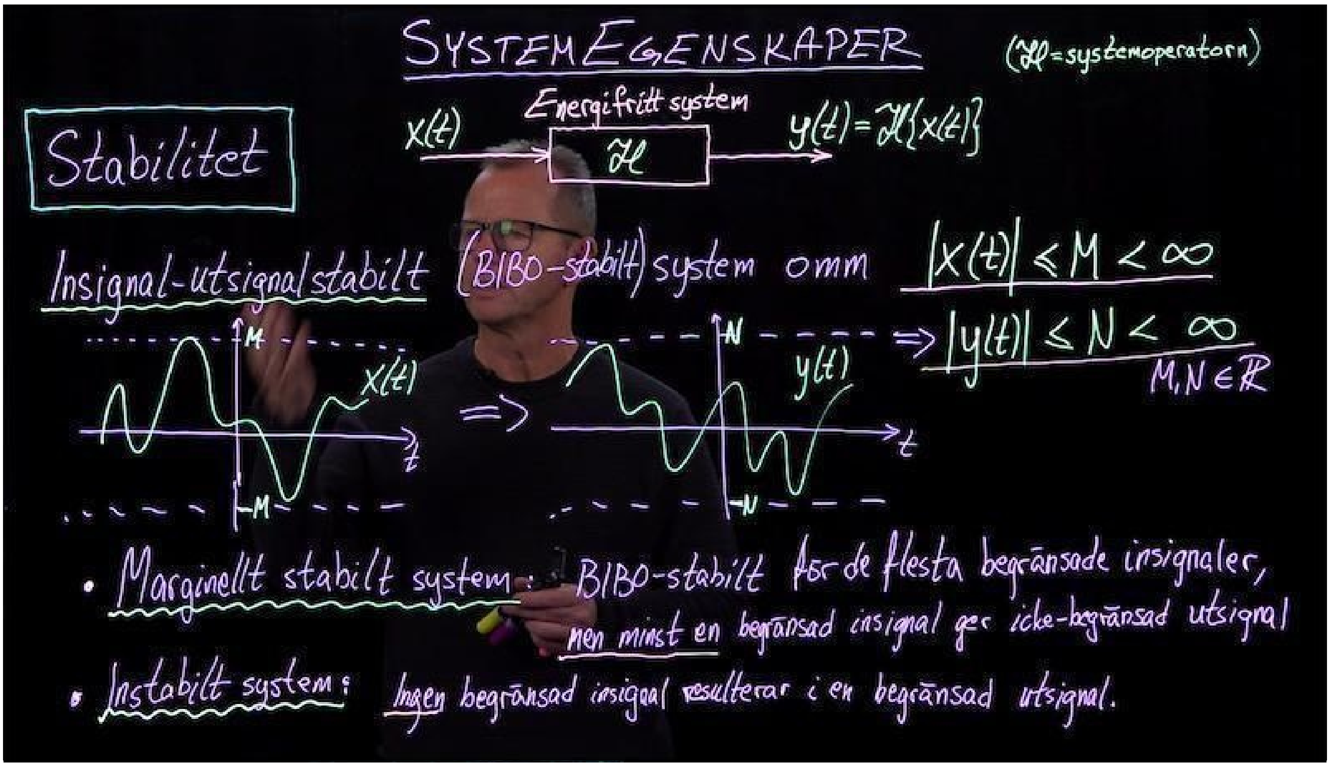
① $y(t) = \sqrt{x(t-2)}$

② $y(t) = \int_{-\infty}^{t+1} x(\tau)\,d\tau$



③ $y(t) = x(t+3)$

④ $y(t) = x(-t)$



Exempel:

① $y(t) = 5x(t-2) + 3$

② $y(t) = \dfrac{dx(t-3)}{dt}$

③ $\dfrac{dy(t)}{dt} - y(t) = x(t)$

Stabilisering av instabila system med hjälp av återkoppling (kommer senare i kursen)