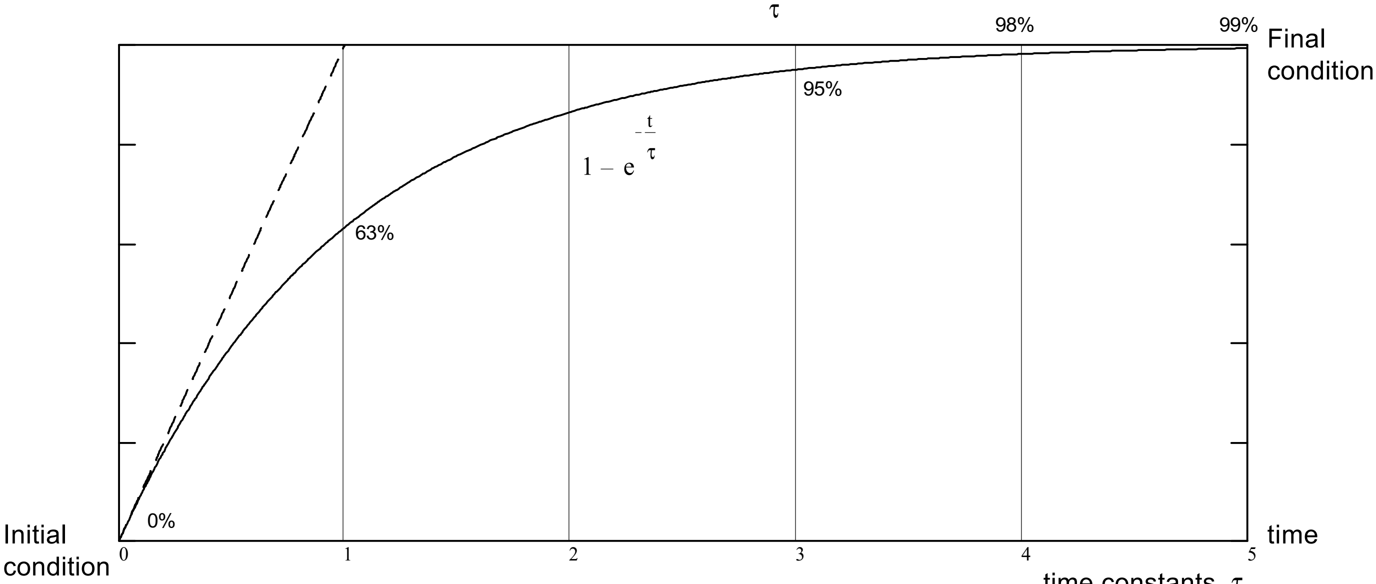
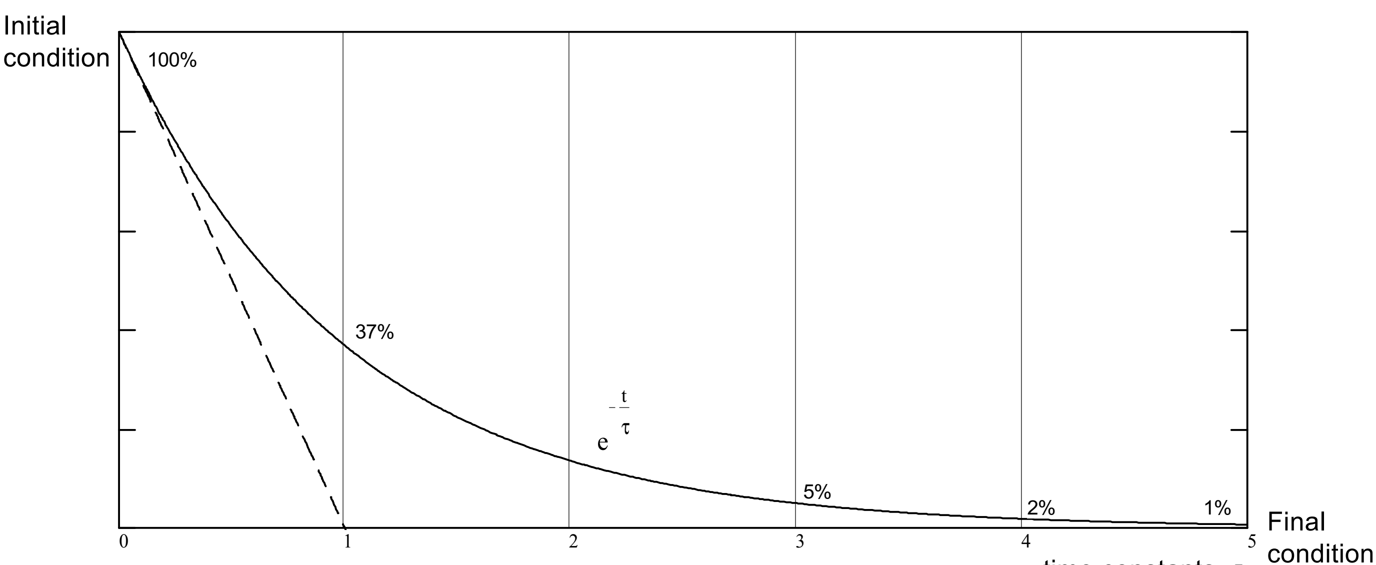
ECE 3510 Exponential Curves

Let's take a closer look at some of the characteristics of exponential curves, the curves that show up stable first order systems. The transient effects always die out after some time, so the exponents are always negative.

Step response of: $H(s) = \dfrac{k}{s + \dfrac{1}{\tau}}$



Rising Exponential Curve



Decaying Exponential Curve

Some Important Features:

1) These curves proceed from an initial condition to a final condition. If the final condition is greater than the initial, then the curve is said to be a "rising" exponential. If the final condition is less than the initial, then the curve is called a "decaying" exponential.

2) The curves' initial slope is $\pm$ $1/\tau$. If they continued at this initial slope they'd reach the final condition in one time constant.

3) In the first time constant the curve goes 63% from initial to the final condition.

4) By four time constants the curve is within 2% of the final condition and is usually considered finished. Mathematically, the curve approaches the final condition asymptotically and never reaches it. In reality, of course, this is nonsense. Whatever difference there may be between the mathematical solution and the final condition will soon be overshadowed by random fluctuations (called noise) in the real system.

$e^{-4} = 0.018 \quad < 2\%$