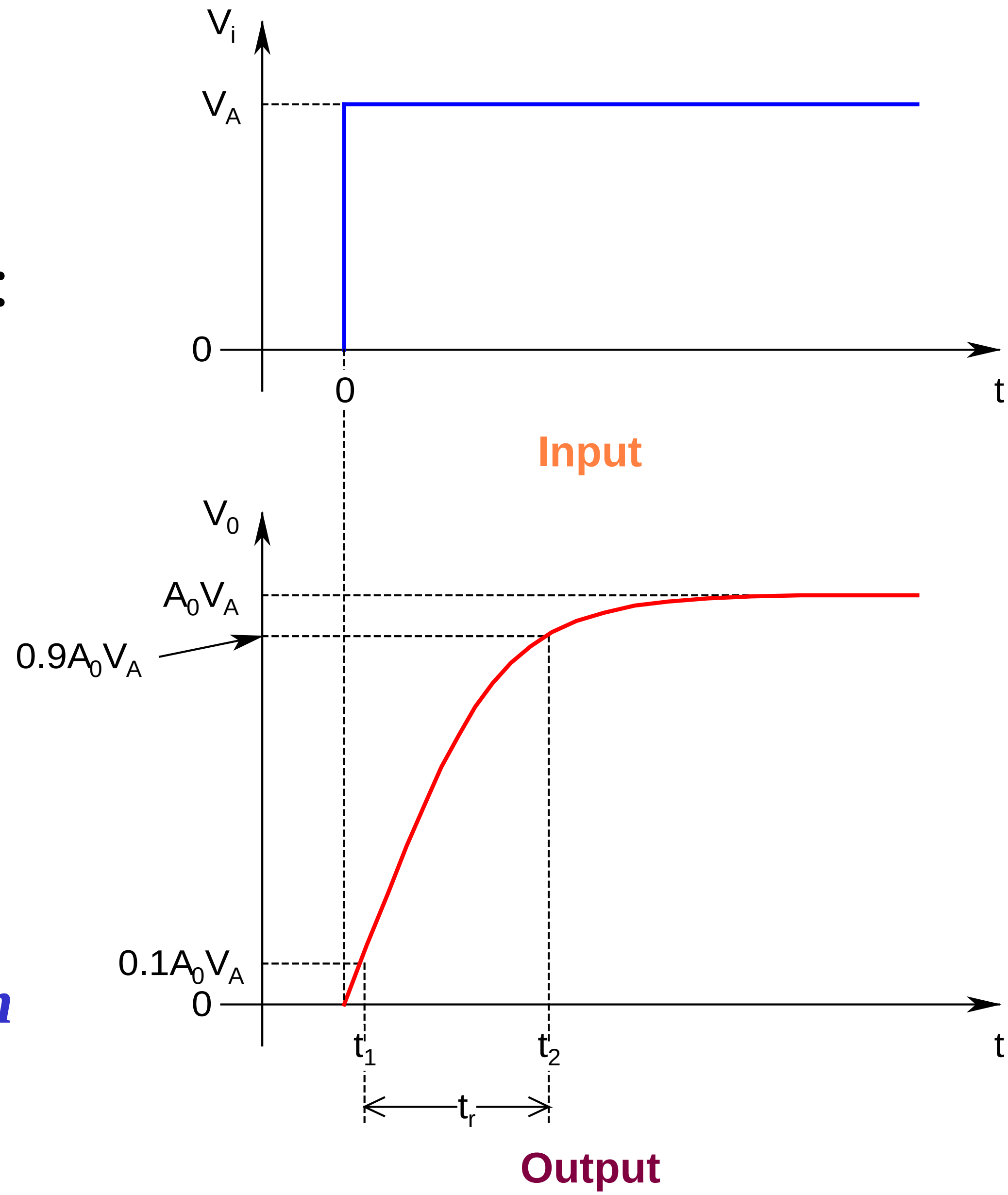
➢ *Calculation of Rise/Fall Time*:

- *Time taken for the output to rise (fall) from 10% (90%) to 90% (10%)*
- *Can be calculated from the figure*



- ***At t = t₁***:

  $0.1A_0V_A = A_0V_A[1 - \exp(p_1t_1)]$

  $\Rightarrow t_1 = \ln(0.9)/p_1$

- ***At t = t₂***:

  $0.9A_0V_A = A_0V_A[1 - \exp(p_1t_2)]$

  $\Rightarrow t_2 = \ln(0.1)/p_1$

- Thus, the ***rise time***:

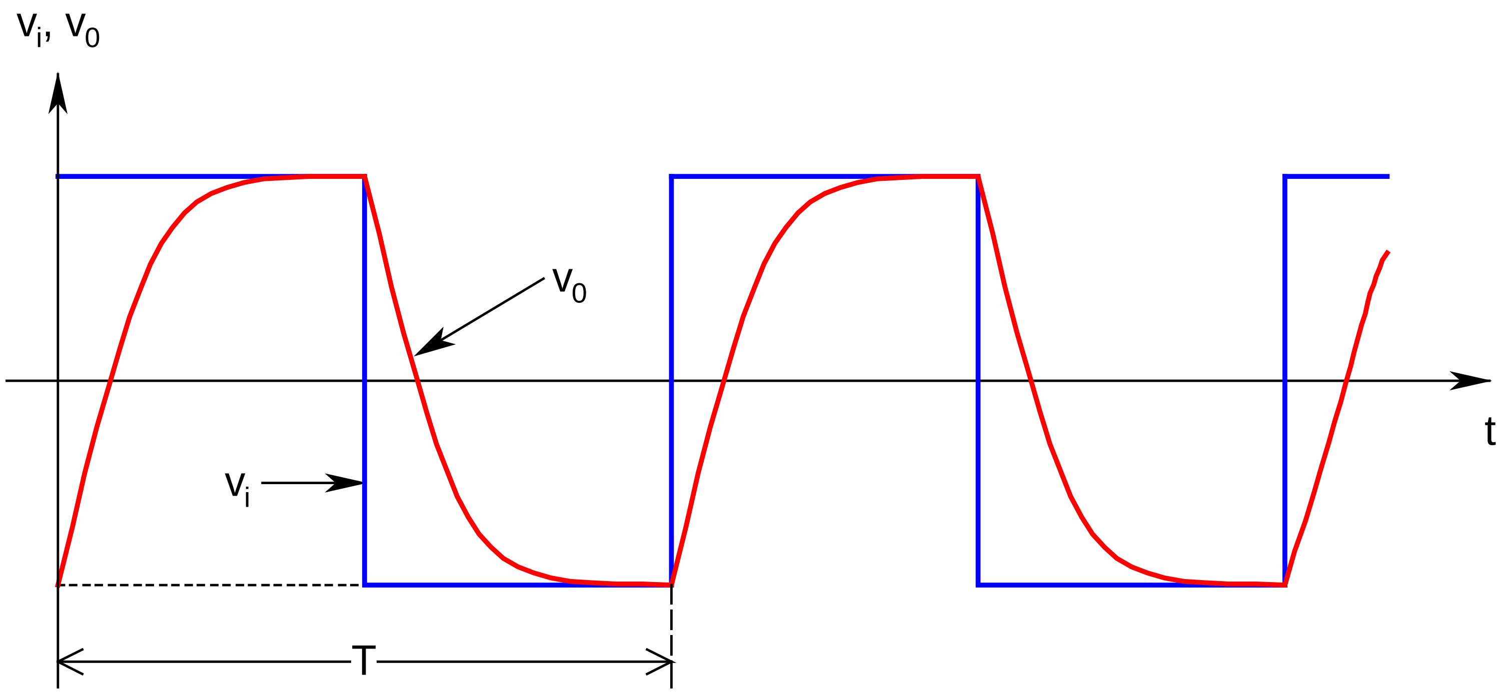
  $t_r = t_2 - t_1 = -2.2/p_1 = 2.2/\omega_H = 0.35/f_H$

- Hence, ***higher the f_H***, ***smaller the t_r***

- ***The same expression holds for the fall time (t_f) as well***

- Thus, circuits having ***high bandwidth*** under ***sinusoidal excitation*** (***analog domain***), will also have ***superb switching characteristics*** under ***square-wave excitation*** (***digital domain***)
- Under ***square-wave excitation***, ***due to t_r/t_f***, ***enough time should be provided for the transient in the output to get completed***
- ***Rule of Thumb***:
  - ***At least 5 time constants should be allowed for each rising and falling transient***
  - This determines the ***maximum allowable frequency*** of the ***input pulse train***:

    $$f_{max} = 1/T_{min} \approx 1/(10\tau) = \omega_H/10 = |p_1|/10$$



Effect of t_r/t_f on the Output for Square-Wave Excitation

- ***As f↑, T↓, V_0 first starts to become trianglular*** (***incomplete transient***), ***then the amplitude starts to drop***, ***and eventually drops to zero*** (***no output at all***!)