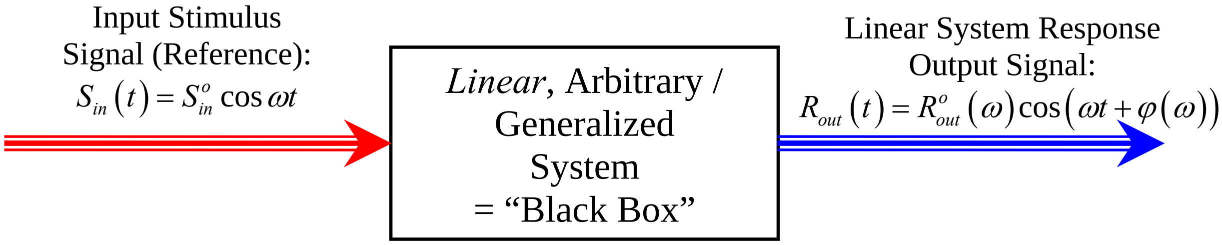
Now let us return to our input stimulus/"black-box" system output response problem that we mentioned at the beginning of these lecture notes, and discuss *this* situation in greater detail:



The ***instantaneous*** input ***stimulus*** signal $S_{in}(t) = S_{in}^{o}\cos\omega t$ and the ***instantaneous*** output ***response*** signal $R_{out}(t) = R_{out}^{o}(\omega)\cos(\omega t + \varphi(\omega))$ are ***purely real time-domain*** quantities.

We can "***complexify***" the ***instantaneous*** input/output ***time-domain*** signals just as we have done above by adding suitable / appropriate "***imaginary***" (*aka* ***quadrature***) terms to each, which are {±} 90° ***out-of-phase*** with the above ***purely real*** time-domain quantities:

$$\tilde{S}_{in}(t) = S_{in}^{o}\cos\omega t + iS_{in}^{o}\sin\omega t = S_{in}^{o}e^{i\omega t}$$

$$\tilde{R}_{out}(t) = R_{out}^{o}(\omega)\cos(\omega t + \varphi(\omega)) + iR_{out}^{o}(\omega)\sin(\omega t + \varphi(\omega)) = R_{out}^{o}(\omega)e^{i(\omega t + \varphi(\omega))}$$

The $t = 0$ phasor diagram associated with these two complex phasors is shown in the figure below: