My control systems cheat sheet

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June 28, 2025 Compiled on June 28, 2025 at 1:12pm

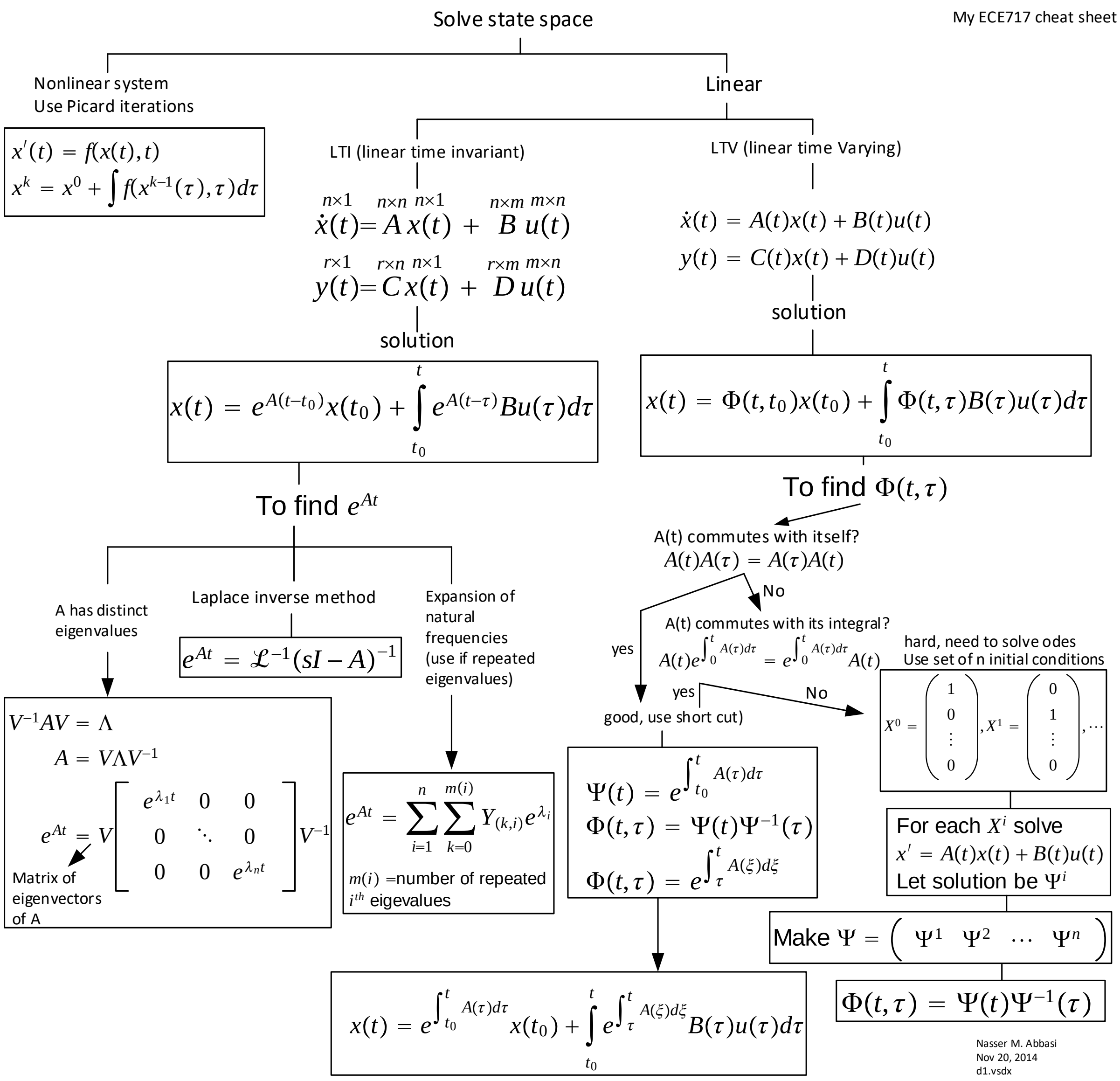

Figure 1: Flow chart to solve state space $x' = Ax$

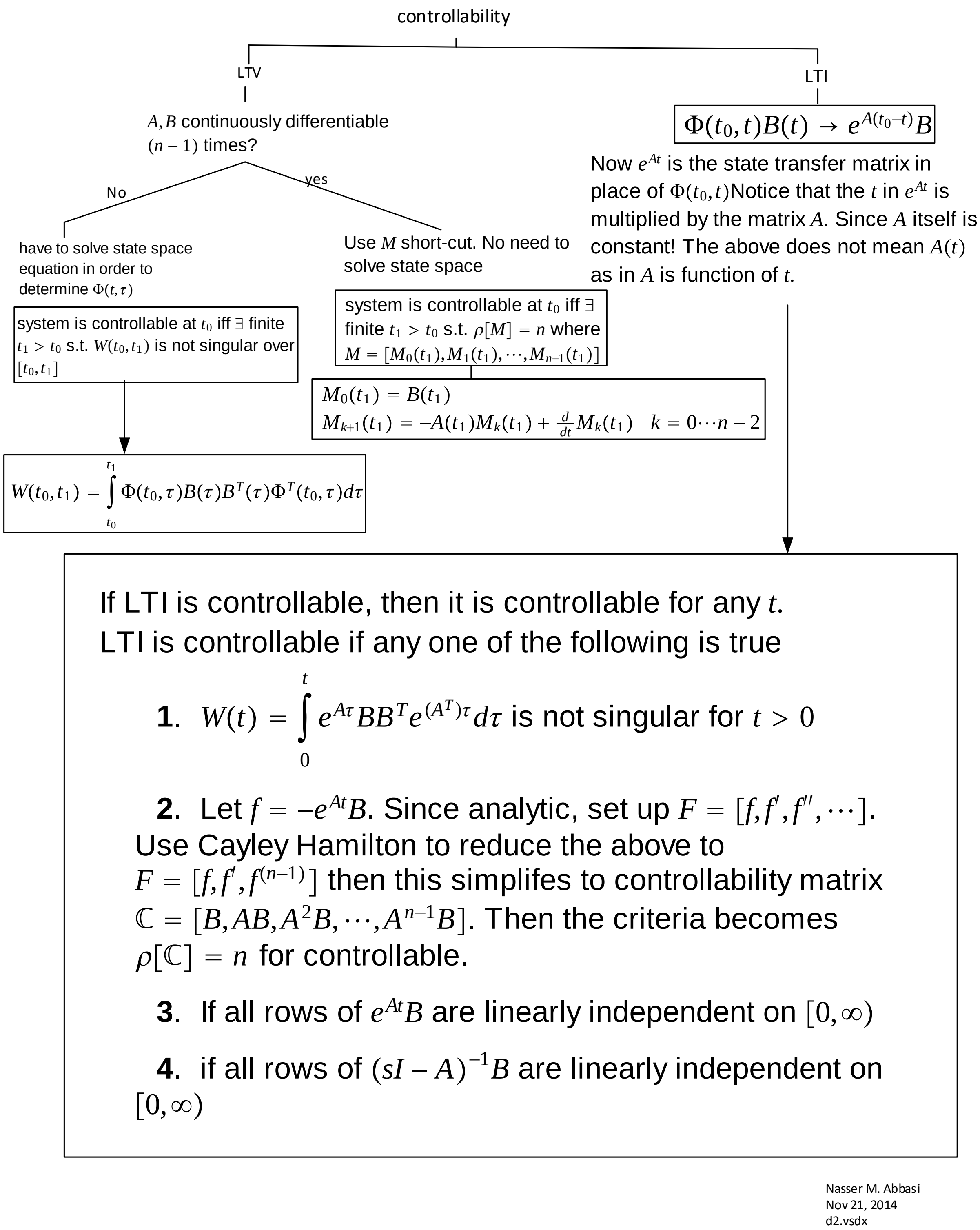

Figure 2: Controllability flow chart

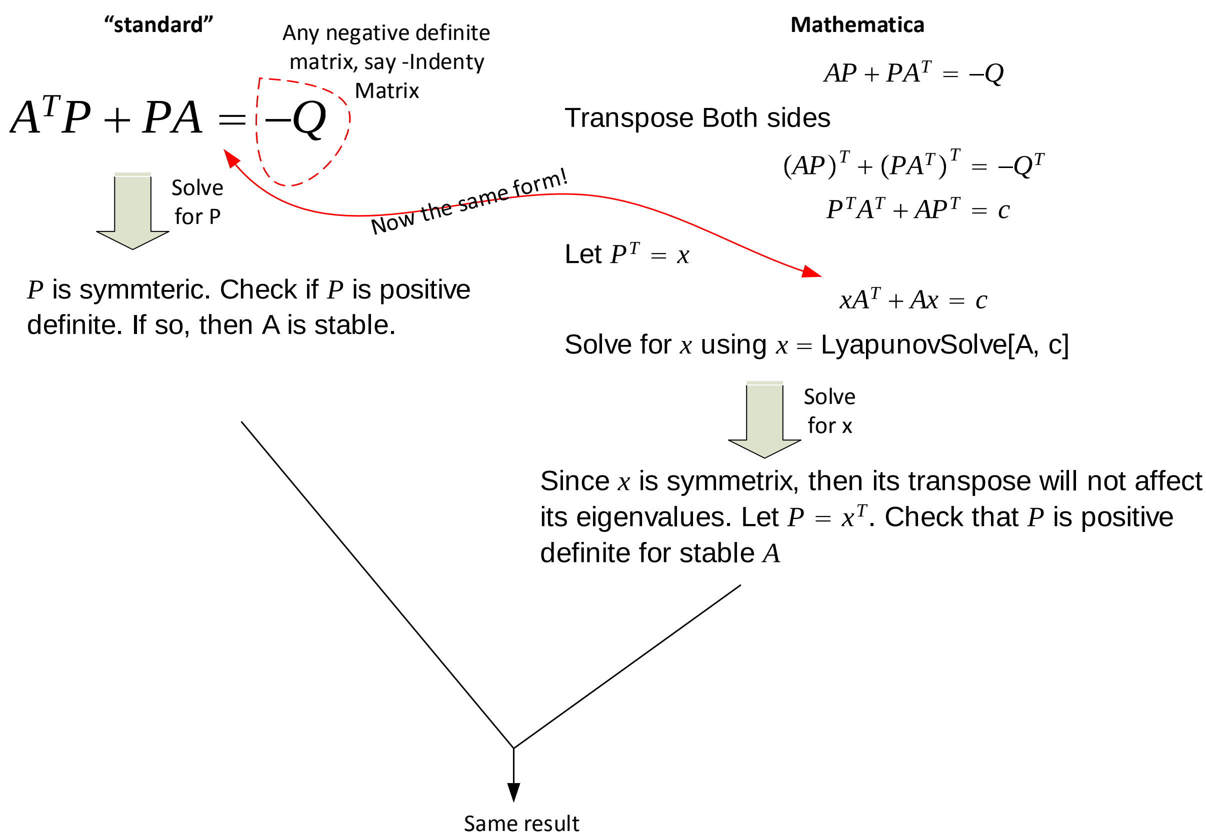

Figure 3: Lyupnov flow chart

Lyapunov stability. All what this says, is that if we start with any initial conditions $x_0(t_0)$ at time t_0 near the origin, then if solution $x(t)$ is always bounded from above for any future time t, then we say that the origin is stable equilibrium point.

To make this more mathematically precise, we say that for any $||x_0|| \leq \delta(t_0,)$ we can find $\epsilon(\delta)$ such that $||x(t)|| \leq \epsilon$ for any $t \geq t_0$.

In this both δ and ϵ are some positive quantities. And ϵ depends on choice of δ

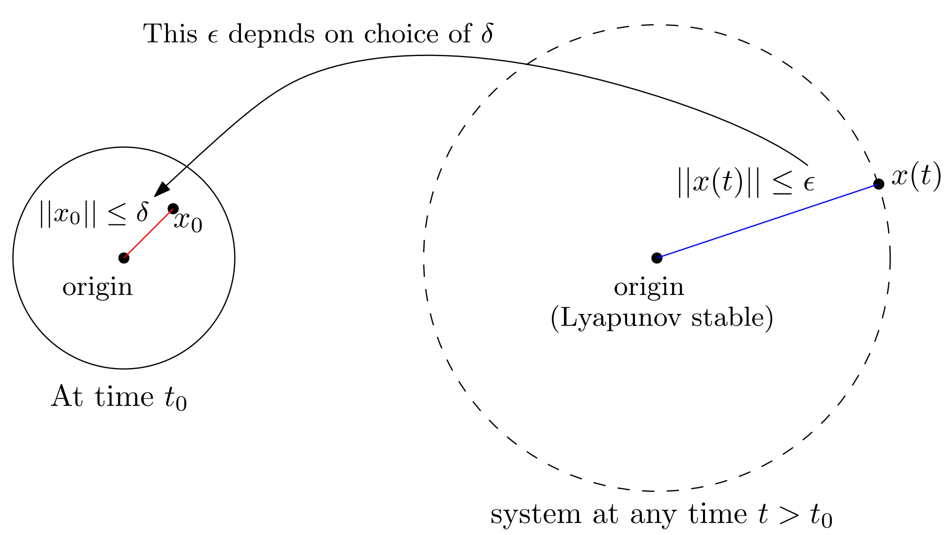

Figure 4: Lyupnov stability definition

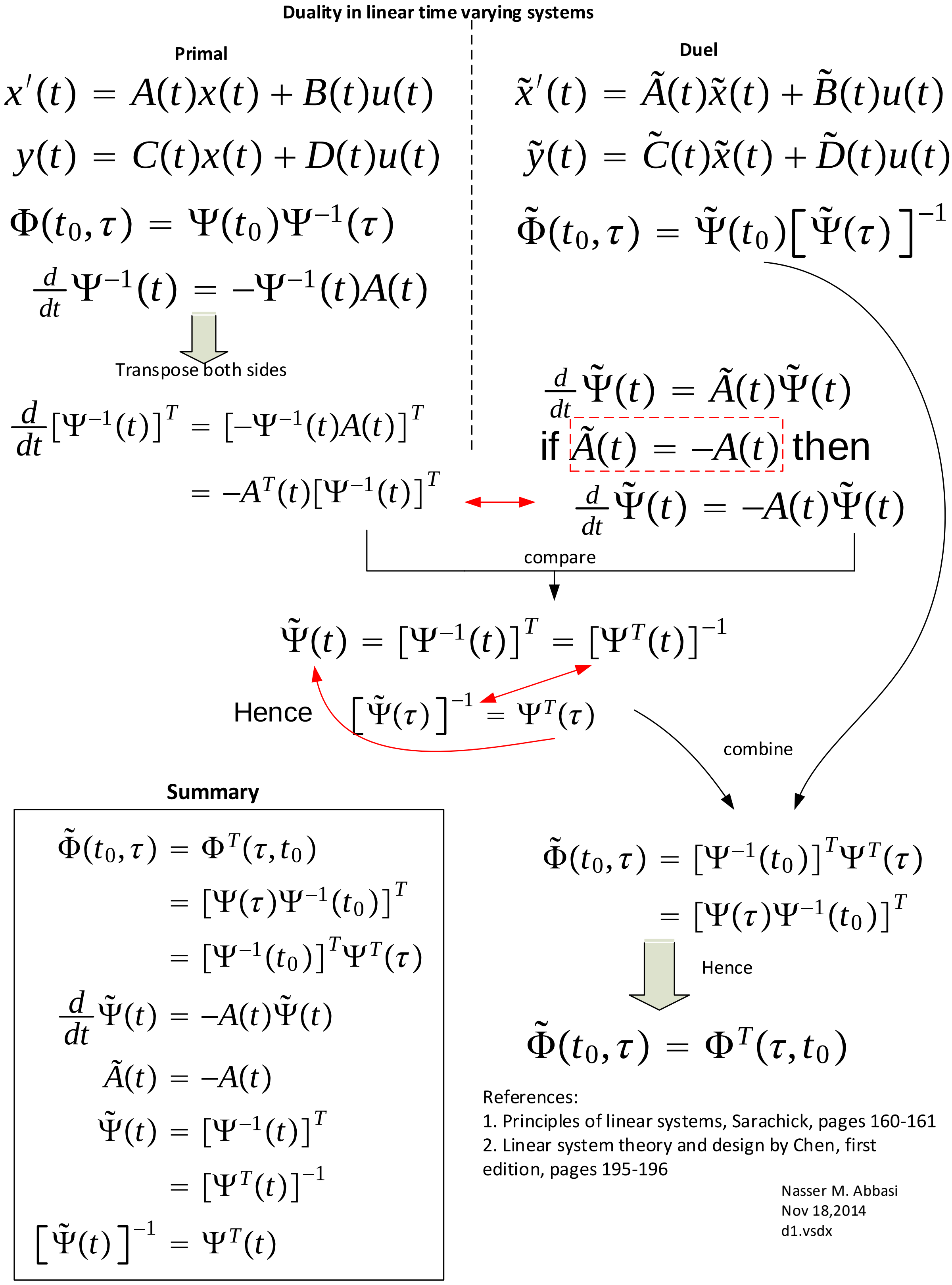

Figure 5: Duality in Linear time varying

Graphical methods for linear control systems analysis (SISO)

- root locus (time domain)
- Bode plot (frequency domain)
- Nyquist plot (frequency domain)
- Nichols plot (frequency domain)

Performace specifications

- frequency based specifications
- time domain specification

specification	note
Gain margin	measure absolute stability.
Phase margin	measure relative stability, tendency to oscillate during damped response
delay time T_d	speed of response as function of frequency ω, defined as $T_d(\omega) = -\frac{d\gamma}{d\omega}$ where γ is phase of open loop transfer function

Figure 6: Graphical methods for linear control system analysis