Classical Control Top Ten List

1. Feedback control is a pervasive, powerful, enabling technology that, at first sight, looks simple and straightforward, but is amazingly subtle and intricate in both theory and practice.
2. In a dynamic system, changes cannot be effected instantaneously, and so an otherwise correct control decision applied at the wrong time could result in catastrophe.
3. Nonlinearities are always present, e.g., backlash, Coulomb friction, saturation, hysteresis, quantization, dead band, and kinematic nonlinearities. A linearized model can be used to approximate a nonlinear system near an operating point.
4. Stability of a dynamic system must be guaranteed. Closed-loop systems go unstable because of an imbalance between strength of corrective action and system dynamic lags. Stable systems must have adequate stability margins to work once built.
5. Stable systems have a frequency response. If a stable linear system has a sinusoidal input applied, then the steady-state output will be a sinusoid of the same frequency, however, the amplitude ratio and phase difference of the two sinusoids are frequency dependent.
6. The open-loop transfer function is the product of all the transfer functions in the loop, i.e., controller, actuator, plant, and sensor. Compared to the closed-loop system transfer function, the open-loop transfer function is much less complex. The Nyquist criterion and the Root Locus procedure allow one to use the open-loop transfer function to predict closed-loop system performance.
7. After stability, performance is everything. Command following, disturbance rejection, insensitivity to modeling errors, and insensitivity to unmodeled high-frequency dynamics and high-frequency noise are the main reasons for using feedback control, once a system is guaranteed to be closed-loop stable.
8. Time delays can be deadly. Always conserve phase, the equivalent of time delay. Integral control adds 90° of phase lag at every frequency and digital control adds time delay primarily due to D/A conversion. Imagine trying to make decisions using old information.
9. High control gain has lots of benefits, e.g., good command tracking and good disturbance rejection. However, there are three areas of concern: roll-off, saturation, and noise.
10. People's lives may be at stake. Real control systems must be extremely reliable, especially if people's lives depend on them.