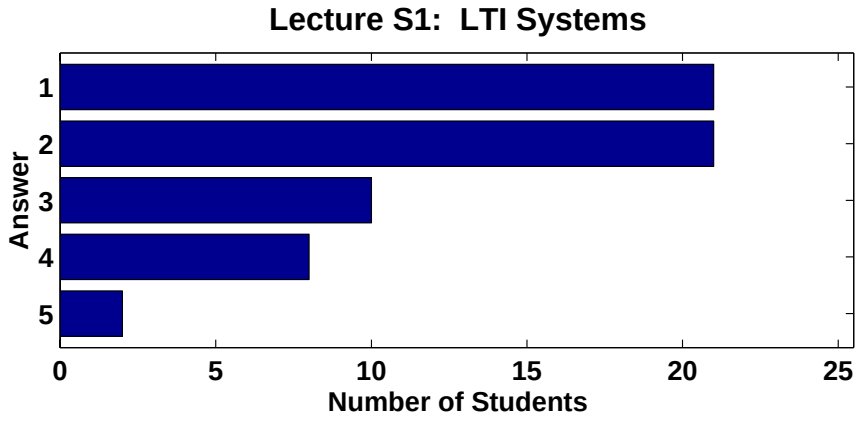
LTI Systems

An aircraft can be considered a system, with the flight control positions as the inputs, and the speed, altitude, etc., as the outputs. An aircraft is best modeled as

1. Linear and time invariant
2. Nonlinear and time invariant
3. Linear and time varying
4. Nonlinear and time varying
5. I don’t know

Lecture S1 Concept Test
LTI Systems Solution



This one is a little tricky, with more than one possible defensible answer.

To begin, the system is nonlinear. If one increases the elevator deflection a small amount, the angle of attack of the wing will increase a little, thus increasing the lift a little. If the elevator angle is increased a lot, the angle of attack will increase a lot, causing the wing to stall, and the lift will *decrease*. Linearity requires that the lift increase in direct proportion to the elevator angle, no matter how large the elevator angle.

It's tougher to decide whether the system is time-invariant. At first glance, it might seem that the system is time invariant — the aircraft behaves the same tomorrow as it does today. However, during the course of a given flight, the mass of the aircraft will change. As the aircraft burns fuel, its mass decreases, and that changes the dynamics of the aircraft. If the mass change is small, the change in the dynamics is small enough that we might call the system time invariant. If the mass change is large enough to worry about in the modeling, then we should say that the system is time-varying.

From another perspective, the decrease in mass is a predictable response of the system to the inputs, such as throttle setting. If we treat the mass of the aircraft as a state of the system, then we can say that the system is in fact time invariant. However, this reasoning is a trap — by this logic, *all* systems are time invariant. Indeed, the laws that describe the physical world are time invariant.

So, the best answer is probably (4), although a case can be made for (2). Even so, there are certainly times when the system can be modeled as linear and time-invariant.