Guide to: Solenoid or coil, with or without iron core; also: any wire.

Applications: Oscillator circuits (transmitters/receivers). Transformers (mutual inductance).

Basic idea: Electrical current flow implies a magnetic field, which has energy content. This cannot be turned on/off instantly. Iron cores are magnetized by the field, and act to increase the overall field significantly (application: electromagnets).

Derivations: Faraday's law relates voltage drop (generated EMF) to magnetic flux change: $\mathcal{E} = -\frac{d\Phi_B}{dt}$.
For a solenoid (coil) the flux change comes from ramping up/down an electric current:
Solenoid of length X generates field: $B = \frac{\mu_0 N I}{X}$; Flux through ***one*** turn: $\Phi_B = BA = \frac{\mu_0 N I A}{X}$.
Thus, the voltage drop is proportional to the rate of change of current [this looks a bit unusual].
$\mathcal{E} = -\left(\frac{\mu_0 N^2 A}{X}\right)\frac{dI}{dt} \equiv -L\frac{dI}{dt}$. Extra factor of N comes from adding the loop-EMF in series.
The inductance is a 'material property' of the wire/coil/solenoid, and depends on its geometry (length X and cross sectional area A). With iron core: multiply the expression for L by the relative permeability value for the core material; variable positioning of the core in/out of coil creates a variable inductor.
A tricky aspect in an N-turn coil/solenoid: flux change in a single turn is considered, then the turns connected in series result in N times the result. Since the magnetic field from N turns was added up, and entered the flux expression, the overall result depends on the square of N.

Equations:

$$L = \frac{\mu_0 N^2 A}{X} \quad \text{with core :} \quad L = \frac{\mu_r \mu_0 N^2 A}{X} .$$

Parallel inductors: $\frac{1}{L_{\text{eq}}} = \frac{1}{L_1} + \frac{1}{L_2} + \ldots$. Time constant: $\tau = \frac{L}{R}$ exponential turn-on and off!

Unit: henry = volt.second/ampere . Voltage drop: $\Delta V_L = -L\frac{dI}{dt}$

Problems: 21.30-45 and circuit problems 21.62-66
Understand the exponential turn-on and turn-off of currents (Fig. 21.22 in Giordano).
A simple wire (not a coil) also has inductance (complicated formula, requires calculus), and has resistance; thus no circuit can be turned on or off instantly!