1. Relaxation Oscillators
   1.1 Frequency easily driven, amplitude invariant
   1.2 Van der Pol Oscillator: unforced, damped, nonlinear
   1.3 $v$ is voltage (e.g. across a resistor), $t$ is time, $\alpha$ (damping) and $\omega$ (restoring) are constants that determine the behavior of the circuit

\[ \frac{d^2v}{dt^2} + \alpha(v^2 - 1) \frac{dv}{dt} + \omega^2 v = 0 \]

Van der Pol Oscillator $\omega = 1$:

2. Principle 1: Neurons are relaxation oscillators
   2.1 Level 1 oscillators
   2.2 FitzHugh-Nagumo equations as prototype
   2.3 Capture major features of Hodgkin-Huxley and other model neurons

3. FitzHugh-Nagumo Model Neuron Equations
   3.1 Van der Pol oscillator with $\omega = 1$
   3.2 Forcing input $z$, $v$ fast voltage, $w$ slow voltage
   3.3 $\alpha > 1$ damping, $a, b$ recovery rate constants

\[ \frac{dv}{dt} = \alpha \left( w + v - \frac{v^3}{3} + z \right) \]
$$\frac{dw}{dt} = -\frac{(v - a + bw)}{\alpha}$$

Chaotic FitzHugh-Nagumo

4. Principle 2: Fast Synchronization

Two-coupled

400 coupled

5. Principle 3: Local vs global

5.1 Local excitatory pulse-coupling leads to rapid synchronization
5.2 Global inhibitory mechanism can induce rapid de-synchronization
5.3 Result in automatic segregation of synchronous groups of neurons representing stimuli on the receptors
Evolution of Synchrony from a Visual Scene

6. Principle 4: Level 2 Oscillators
   6.1 Formed by groups of synchronously firing Level 1 oscillators (neurons)
   6.2 Modification of the Terman-Wang oscillator is used
   6.3 Sensory representation of a stimulus consists of a Level 2 oscillator

\[ \frac{d\nu}{dt} = I\nu - \nu^3 - w \]

\[ \frac{dw}{dt} = \varepsilon (8\nu^3 + 5 - w) \]
7. Principle 5: Periodic forcing
   7.1 Relaxation oscillators also phase lock to periodic forcing
   7.2 I use this as model for interaction of level-2 oscillators

8. Principle 6: Synchrony of relaxation oscillators is ubiquitous; achievable in many ways

9. Principle 7: Dynamic core of consciousness is a Level-3 oscillator composed of synchronously interacting Level-2 oscillators
   9.1 Tononi et al binocular rivalry experiment: MEG coherence