# Electrical Tutorial for 1st and 2nd years

Brainstorm:

* 1. Electrical theory (beginner)
     1. Ohm’s law
     2. Power in terms of voltage and current
     3. Current as transmission of energy
     4. Power vs energy
     5. What a circuit is
     6. What a load is
     7. Voltage dividing vs voltage regulating
     8. Current availability
     9. Power loss
  2. Small Parts (beginner)
     1. Resistor
     2. Inductor
     3. Capacitor
     4. Relay
     5. Transistor
     6. Amplifier
     7. Potentiometer
     8. Heat sink
     9. Diode
     10. Zener diode
  3. Wire gauge (beginner)
     1. What a fuse is
     2. Gauge of wire
     3. Picking the right gauge (more intermediate)
     4. Power loss as heat
     5. How a wire acts like a pipe
     6. Current carrying capacity
  4. Soldering and crimping (beginner)
     1. What solder is
     2. What to keep in mind when soldering
     3. How to crimp properly
  5. Power Transmission (intermediate)
     1. Duty cycle
     2. Average vs RMS
     3. Importance of maximum current
     4. What a motor is (electrically)
     5. Inrush current for motors
     6. Phases
     7. Free-wheeling diode
     8. Current splitting
     9. Imaginary power
     10. Transformers
  6. PCB lingo (intermediate)
     1. IC (integrated circuit)
     2. SMD (surface mount)
     3. Through hole
     4. Via
     5. Layers
     6. Substrate
     7. Active vs passive component
     8. EMC (electromagnetic compatibility)
     9. ESD (electrostatic discharge)
     10. Gerber file
     11. Header
     12. Pitch
     13. Pad
     14. Pin
     15. Silkscreen
     16. Trace/track
  7. Cable/connector (intermediate)
     1. Pin
     2. Socket
     3. Plug
     4. Receptacle
     5. Cable gland
     6. Male/female
     7. Multiconductor cable (air core vs filled core)
     8. Stranded vs solid core
     9. Skin effect
     10. Heat dissipation
     11. Insulation (polymers, rubbers, thermoplastic)
     12. Enclosures (fiberglass, steel, standard sizing, etc)
     13. Ratings (FR, IP, NEMA, CEC, etc)
     14. Teck vs normal cable
     15. Proper wire gauge
  8. Electrical schematics (intermediate)
     1. How to read a schematic
     2. How lines represent abstract wiring, not reality
     3. Electrical symbols
  9. Signal processing and transmission for cables (advanced)
     1. Attenuation
     2. Noise
     3. Cross-talk
     4. Shielding
     5. Bandwidth
     6. Filters
     7. Parasitic capacitance/inductance
     8. Decoupling capacitor/bypass capacitor
     9. Amplification/ use of op-amp
     10. Clock (synchronous vs asynchronous)
  10. Transmission using microwaves (Advanced)
      1. Attenuation
      2. Noise
      3. Interference
      4. Reflection and absorption
      5. Characteristic impedance
      6. Parasitic capacitance/inductance due to size of processing circuit
      7. Power transmission
      8. Power loss
      9. Decibels vs dbi
      10. Antennas (directional vs omni directional)
  11. Grounding/Protection circuitry (Advanced)
      1. Why it’s important
      2. RF signal generation from outside forces
      3. Harmonic generation (motors, large amperage changes, switching, high frequency communication, etc)
      4. Transients
      5. Zener diode in practice as voltage clamps
      6. Overload
      7. Overcurrent
      8. Overtemp
      9. Over voltage
      10. Undervoltage (brownout)
      11. Short circuit
  12. Electrical System Design (expert)
      1. Develop plan (list of questions)
         1. Start with high level questions
         2. Work to details last
      2. Documentation (BOM, wiring diagrams, schematics, etc) and sketches
      3. Develop a list of all necessary components based on requirements (environmental, competition, etc)
         1. What voltages are required?
         2. How much current is required? You will need to look at datasheets for this
      4. Based on above, choose a power source (highest voltage and highest current)
         1. Always remember to design protection system for power source (fuse, relay, grounding, etc)
         2. Size cables appropriately
      5. Based on power requirements of components, choose appropriate cable sizes
         1. Protection for cables
      6. For lower voltages, choose an appropriate power supply based on current requirements of that circuit
      7. Develop mechanical requirements (layout of components, where to place them, electrical box specifications, etc)
      8. Search for components, adjust design as required
      9. Order test/trial run
      10. Adjust design
      11. Order final parts
      12. Assemble and implement