CIRCUIT LAB C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Participants will complete **hands-on** tasks and answer questions about electricity and **electronics**.

   A TEAM OF UP TO: 2

   APPROXIMATE TIME: 50 minutes

   CALCULATOR: Class III

2. **EVENT PARAMETERS:**
   a. Each team may bring writing utensils.
   b. Each team may bring two Class III calculators for use during any part of the event.
   c. Each team may bring a collection of notes and resources, written/printed on paper, of any size containing information in any form and from any source. Binders, **books**, notebooks, folders, sheet protectors, lamination, tabs, and labels are permitted. Participants are responsible for organizing and containing their notes efficiently. They may separate or remove the pages from containers for use during any part of the event.
   d. Event Supervisors must provide all supplies and measurement devices required for the hands-on tasks.
   e. Participants may bring their own basic multimeters for use in place of provided ones at the discretion of the Event Supervisor.

3. **THE COMPETITION:**

   Part I: Written Test
   a. The written test will assess the team's knowledge of electricity and **electronics**.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   c. The test will consist of at least one question from each of the following areas only:
      i. Historical perspective of the electricity discoveries made by Ampere, Coulomb, Kirchhoff, Volta, Ohm, **Hertz, and Boole**
      ii. Properties of electric charges/fields, sources/hazards of static electricity, and Coulomb's Law
      iii. Characteristics, sources, uses, and hazards of direct current (DC) and alternating current (AC)
      iv. Concepts, **calculations,** and units of current, voltage, resistance, power, and energy
      v. Calculations, constructions, and configurations of **DC circuits** and individual components, **including series and parallel circuits, open and short circuits, Ohm's Law,** and circuit schematics
      vi. Fundamental electrical characteristics of silicon PN junctions and **uses of single-junction devices** (e.g., diodes, LEDs)
      vii. Circuit analysis using Kirchhoff's Voltage & Current Laws
      viii. **Digital logic gates, truth tables, universal gate sets, boolean expressions, De Morgan's Law, and combinational logic circuits (e.g., multiplexers, adders)**
      ix. **States/Nationals only: Clock signals, timing diagrams, propagation delay, rise and fall times, race conditions, operation and applications of flip-flops**
      x. **States/National only: DC biasing and gain of PNP/NPN bipolar junction transistors and the implementation of up to 2-input logic gates with transistor-level circuits**
      xi. **States/Nationals only:** Ideal operating principles and applications of operational amplifiers
   d. Topics not included in the competition are: semiconductors (beyond those listed above), AC circuit theory, frequency analysis, **capacitance**, inductance, non-linear devices **(beyond those listed above)**, 3 phase power, **Norton/Thevenin equivalents,** and oscilloscopes.
   e. **Questions will be limited to the following mathematical content:**
      i. **Functions, algebraic manipulations, and systems of equations**
      ii. **Geometry and trigonometry required for resolving vectors into component parts**
      iii. **Representation of whole numbers in binary and the addition of binary numbers, not including negative numbers, floating point representations, or any arithmetic operations other than addition**
      iv. **Logical operations as boolean expressions, including De Morgan's Law and truth tables**
      v. **No questions may require the use of complex numbers, matrix algebra, or calculus**

   Part II: Hands-On Tasks
   a. The hands-on portion will consist of at least one task for the teams to complete.
   b. Participants must be familiar with the operation of breadboards and multimeters and how to use them. Participants may ask event supervisors for details of the internal wiring of any breadboards used for the tasks.

c. The hands-on tasks, or stations, may include but are not limited to:
   i. Determine the value of a mystery resistor in a circuit using only voltage measurements.
   ii. Calculate the power supplied to a circuit.
   iii. Given some wires, batteries, resistors, and 2 LEDs, hook them up so the LEDs are equally bright.
   iv. Given a USB charger, read the label and provide details of the various output power levels it can provide and calculate how long it would take to charge a specific battery.
   v. **Construct a logic circuit to mimic a given truth table.**
   vi. **Troubleshoot a faulty circuit.**
   vii. **Wire a 3-way switch using SPDT switches.**
   viii. **Create a specified equivalent resistance from given individual resistors.**
d. **Participants must not be exposed to hazardous conditions including soldering, high power circuits, and AC circuits.**

4. **SCORING:**
   a. High Score wins.
   b. Points will be awarded for correct answers, measurements, calculations, and data analysis.
   c. The written portion of the competition will account for 50-75% of each team's score. The hands-on portion of the competition will account for the remaining 25-50% of each team's score.
   d. Preselected questions will be used as tiebreakers.

This event is supported by the Kinder Morgan Foundation