# College Board Topic(s):

* II. A.5. Implementation Techniques, Procedural abstraction
* III.B Debugging
* IV.E. Standard Data Structures: Arrays
* V.A. Operations on Data Structures

# Resources:

* Java files Power Class, Station Class, PwrLine Class

# Objectives:

* Implement Comparable Interface
* Extend class
* Manipulate ArrayLists
* Create algorithm
* Use control structure

# Enrichment\Challenge:

* Alter object field values in response to changed load
* Extend Station class to include renewable energy source (wind or solar), add corresponding instances to PwrLine class
* Change GUI to permit user selected trip (power station or power line), with correct system responses (changes to line losses, station outputs)

# Pedagogy:

* TBD

# Grouping:

* Students will work individually, however they may collaborate on algorithm development

# Instruction Sequence:

* NOTE: Completion of this activity will require three lab periods
  + Lab 1: changing load demand in response to user selection, printing results, implementing “toString”
  + Lab 2: build ArrayList of PowerStations, initialize their output. Instructor will provide list of stations
  + Lab 3: Change power line loss values, using provided class methods, to reflect change in demand. Also change one or more station outputs
  + Enrichment Lab Nr1: Extend station class to include a renewable, alter other program algorithms as necessary
  + Enrichment Lab Nr2 (Optional): change Station GUI to Trip, permit selection of station or power line to trip, then alter system data values and algorithms as necessary

## Lab 1: setup

* Explain line losses, how power station output must equal demand total, plus line losses
* Explain “geography” of basic system:
  + Five cities (Johnson City, Murfreesboro, Knoxville, Chattanooga, Nashville)
  + Seven stations (Bull Run, John Sevier, Kingston, Gallatin, Sequoyah, Norris, Johnsonville)
  + Power lines (3-161kv to Knoxville, 3-161kv to Chattanooga, 3-161kv to Murfreesboro, 2-161kv to Johnson City, 2-161kv to Nashville, 2-500kv to Nashville)
* Install initial java files: Power.java, Station.java, PwrLine.java
* Explain GUI

## Lab 1: Activity

* Students should first study the station class; its constructor, accessor methods, private and public variables
* Students will use provided accessor methods to respond to GUI selected demand changes
* Students will comment code as appropriate, and use debug statement
* Students will display results in GUI text area, and console as necessary
* Students will update TotalDemand variable, display on GUI and console
* Student will define test cases for program verification

## Lab 2: Activity

* Students will write Station class, constructor, accessor methods for seven stations. Class will implement Comparable Interface
* Students will create add an initialization method in Power class which initializes Station values, with values obtained from TVA website
* Students will create a TotalSupply variable, the sum of all station outputs
* Students will display results in GUI text area, and console as necessary
* Students will define test cases for program verification

## Lab 3: Setup

* Instructor describes line losses, station output must include
* Instructor review “geography” for power grid emulated in the lab: Which lines connect which stations to which loads….
* Instructor will define peaking power stations, and state requirement to source demand changes (students will decide where increased demand comes from, and must not exceed a stations maximum output)
* For Nashville, students will decide how much power is on 500 KV and 161KV lines

## Lab 3: Activity

* Students will use iteration to distribute load for each city across its power lines, will use each line’s demand portion to calculate its line losses, update PwrLine objects, sum TotalDemand, TotalLosses
* Students will alter chosen peaking plant output
* Students will display power line losses, total line losses in GUI and console
* Students will define test cases for the changes. Test case definition for this lab is more extensive than previous two.

## Enrichment Lab Nr1: Setup

* Students will research renewable energy sources, will choose a type, and *determine limitations* of its use in the Power Class lab. Sources need not be limited to wind and solar, could include biomass, OTEC (assume existing transmission lines can receive from out-of-state source)
* Students will describe chosen energy source to class (assessment task)

## Enrichment Lab Nr1: Activity

* Students will extend Station class for their source
* Students will assign source as a primary or peaking plant and modify existing Power class algorithms accordingly
* Students will define test case

## Enrichment Lab Nr2: Trip, Setup

* Students may work in groups for this effort
* Instructor will describe grid fault conditions, referencing recent blackouts. This is expected to be a full 90-minute lesson
* Instruction will include description of fault cascades; initial line losses causing station trips, etc.
* In Groups: Students will define system effect of loss of station, loss of specific line(s), code locations that need to be altered. Students will define “Blackout” condition, which occurs when power lines cannot provide power to a city.
  + Students will determine code locations that need to change if a city is dropped off the grid
* Students are required to verify test cases with instructor, prior to coding

## Enrichment Lab Nr2: Activity

* Students will alter Station GUI to permit selection of fault type
* Students will alter existing power distribution algorithm, and add new cases which recognize city-trip.
* Students will define test cases. This is expected to be very extensive, if a city can drop off the grid.

# Summary\Assessment:

* Lab 1
  + Students will verify value of TotalDemand and its response to GUI load changes using test cases
* Lab 2
  + Students will verify value of TotalSupply using test cases
* Lab 3
  + INSTRUCTOR will operate GUI and verify values
* Enrichment Lab Nr1
  + Students will describe chosen renewable energy source, and their reason for selecting it.
  + Students will verify TotalDemand, Power Line Losses, Total Supply using test cases
* Enrichment Lab Nr2
  + Students will demonstrate, to the class, system response to trips

# Homework:

* As necessary in support of classroom activities
* Research on renewable energy industrial power sources