

Python 3.13.5 | packaged by Anaconda, Inc. | (main, Jun 12 2025, 16:37:03) [MSC v.1929  
64 bit (AMD64)]  
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IPython 8.30.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: %runfile C:/Users/somen/Desktop/Project/MOST\_EXTRA\_CREDIT.py --wdir

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Starting Full Analysis for: C:\Users\somen\Desktop\Project\power\_grid\_uci.txt  
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--- Initial State ---

Graph: 6,659 nodes, 8,309 edges

Initial Components: 1

--- Articulation Point (AP) Analysis ---

Found 1,655 APs.

Running 1655 independent AP removal experiments...

...tested AP 1655/1655

AP Analysis completed.

Top 10 Most Critical APs (by Fragments Created):

AP Node	Fragments	Increase	LCC Size	LCC %	Classification
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3088	13	12	6,633	99.62 %	High-Impact
1709	9	8	6,650	99.88 %	Moderate-Impact
2117	9	8	6,649	99.86 %	Moderate-Impact
735	8	7	6,645	99.80 %	Moderate-Impact
1415	8	7	6,646	99.82 %	Moderate-Impact
1373	8	7	6,648	99.85 %	Moderate-Impact
1013	8	7	6,643	99.77 %	Moderate-Impact
1658	8	7	6,651	99.89 %	Moderate-Impact
1622	8	7	6,651	99.89 %	Moderate-Impact
1975	8	7	6,648	99.85 %	Moderate-Impact

AP Summary:

- Critical Hubs (>49): 0
- High-Impact (10-49): 1
- Moderate-Impact (2-9): 645
- Low-Impact (1): 1,009
- Minor (0): 0
- Avg. LCC Size after AP removal: 99.96% of remaining nodes

--- Bridge Analysis ---

Found 2,736 Bridges.

Running 2736 independent bridge removal experiments...

...tested Bridge 2736/2736

Bridge Analysis completed.

Top 10 Most Critical Bridges (by Fragments Created):

Bridge	Fragments	Increase	LCC Size	LCC %
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(1, 5089)	2	1	6,658	99.98 %
(2852, 1200)	2	1	6,658	99.98 %
(2852, 1201)	2	1	6,658	99.98 %

(761, 5078)	2	1	6,656	99.95 %
(3051, 4071)	2	1	6,655	99.94 %
(5, 4599)	2	1	6,658	99.98 %
(5, 5100)	2	1	6,658	99.98 %
(4065, 948)	2	1	6,658	99.98 %
(8, 4067)	2	1	6,658	99.98 %
(4067, 2978)	2	1	6,658	99.98 %

#### Bridge Summary:

- Critical Link (>49): 0
- High-Impact (10-49): 0
- Moderate-Impact (2-9): 0
- Low-Impact (1): 2,736
- Minor (0): 0 (Should always be 0 for bridges)
- Avg. LCC Size after Bridge removal: 99.98% of original nodes

#### --- Multi-Point AP Failure Simulation ---

Running 100 multi-point failure simulations (3 APs each)...

...completed trial 100/100

Multi-AP Analysis completed.

Simultaneously removing 3 random APs (100 trials):

- Average Fragments Created: 6.30
- Maximum Fragments Created: 15
- Minimum Fragments Created: 4

#### --- Overall Conclusion ---

PRIMARY VULNERABILITY: High-Impact Nodes.

Several nodes exist whose failure significantly fragments the network.

Targeted hardening of these specific nodes is recommended.

Multi-Point Failures are a MODERATE CONCERN.

Simultaneous failure of 3 APs leads to significant fragmentation  
(up to 15 components observed).

Analysis complete for C:\Users\somen\Desktop\Project\power\_grid\_uci.txt.

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In [2]: