POLITECNICO DI MILANO





Resilience of critical infrastructure exercises

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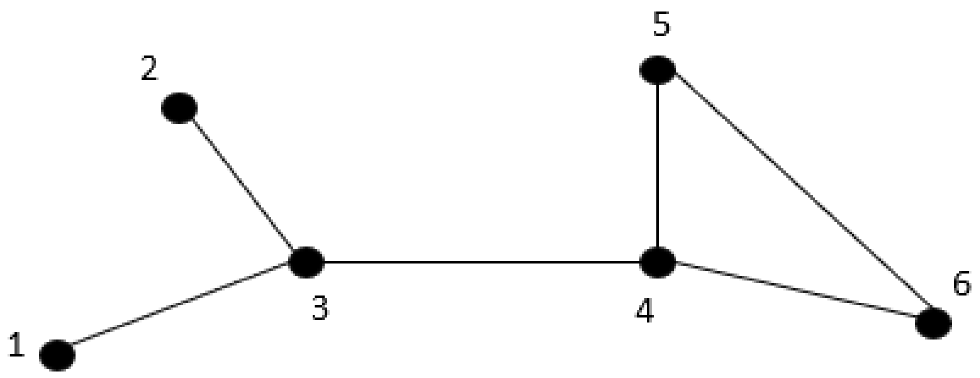
Exercise 4
Centrality Measures

In the following network, find the topological centrality measurements (C_i^D, C_i^C, C_i^B and C_i^I) of node 3.

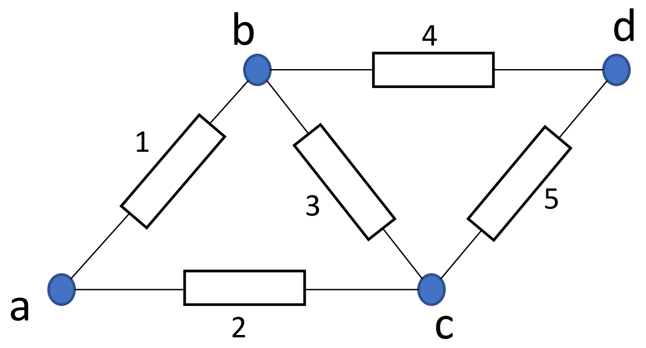


Exercise 5-D
Complexity Measurement

Consider the following network system. All the components have equal failure rate $\lambda = 10^{-4}\ days^{-1}$.

The system fails when there is no connection between node a and node d.

Find the vulnerability index of the network due to the disconnection of link **bc**.

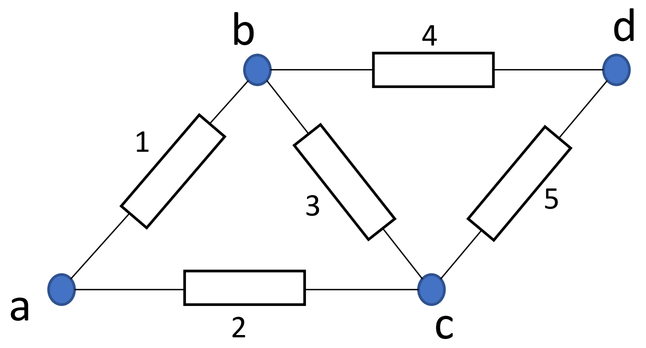


Exercise 5

Consider the following network system. All the components have equal failure rate $\lambda = 10^{-4}\ days^{-1}$.

The system fails when there is no connection between node a and node d.

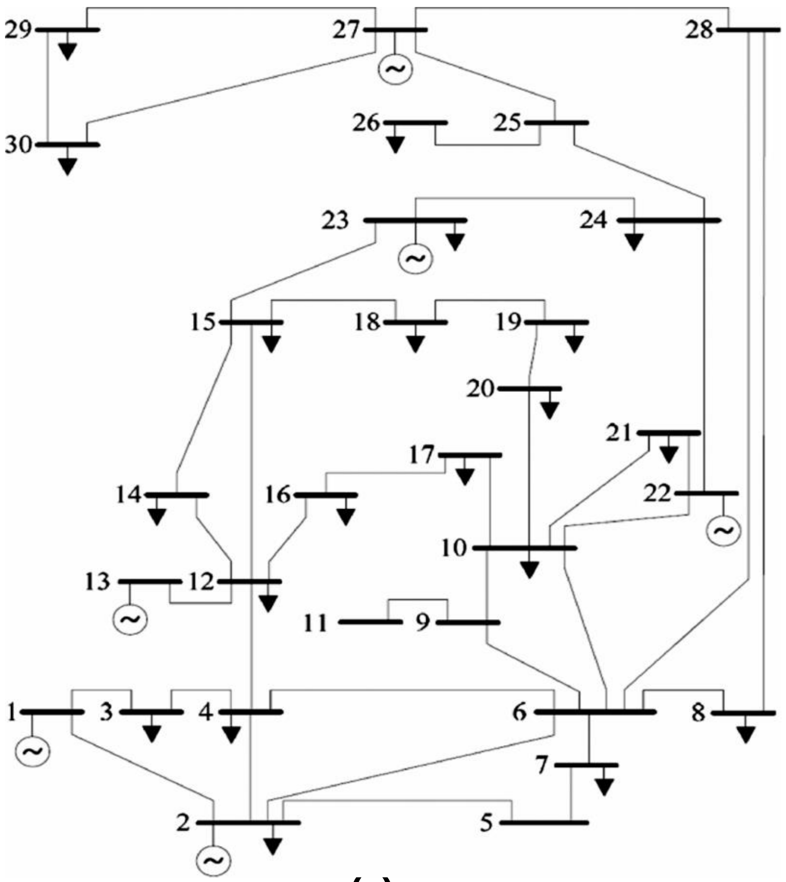
- Considering the failure rate for node **c** as $5{\times}10^{-4}\ h^{-1}$, draw the Goal Tree Success Tree for the top goal "receiving signal successfully to **d**".
- Compute the probability of the top goal for one month.



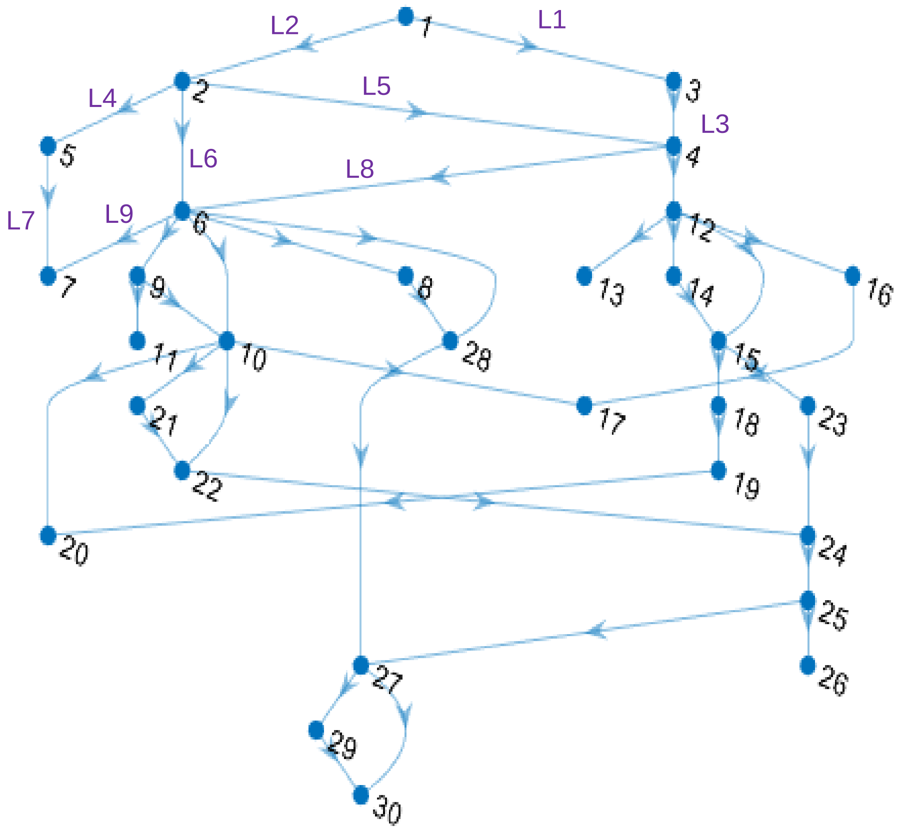
IEEE30 Bus Power Distribution System

The standard IEEE30 power distribution system is shown in the figure (a). Only the major components are to be considered: the Generators (6 generators), Loads (20 loads) and power delivery paths consisting of lines (L) and buses (B). The stochastic network is shown in figure (b).

Draw a GTST for supplying power successfully to Load 4.



(a)



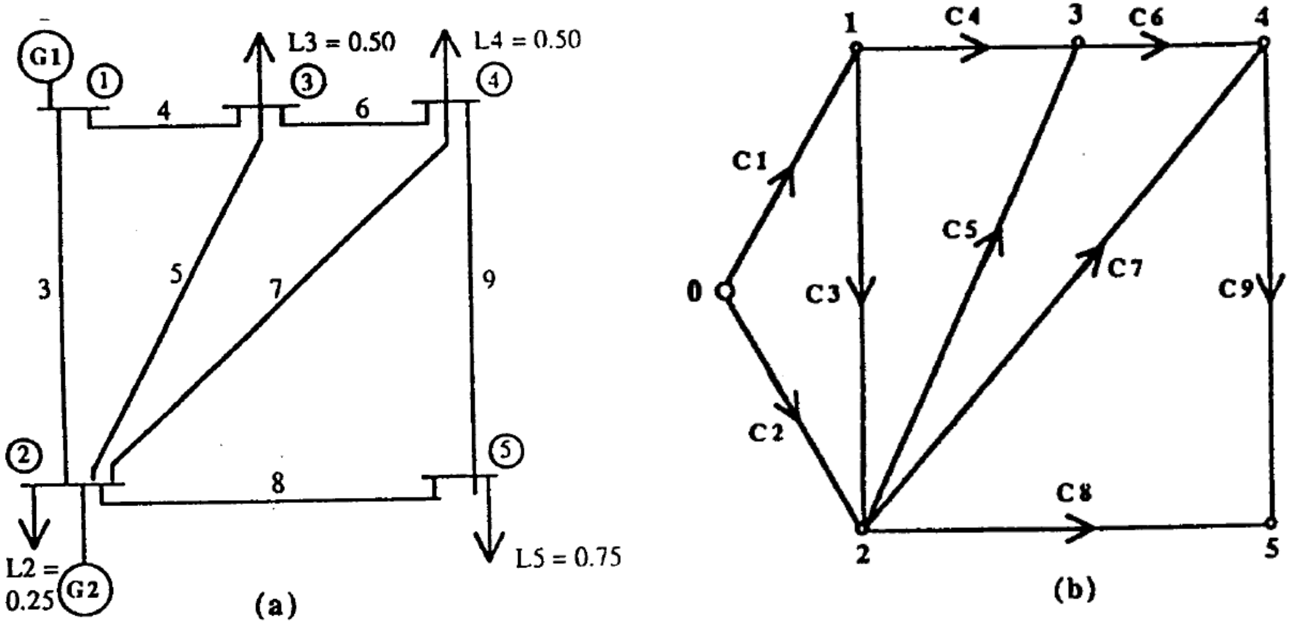
(b)

Exercise 7
Resilience Metrics

Fig. (a) shows a 5-bus system with two generators at node 1 and 2 and four load at node 2, 3, 4 and 5. The orientation of power flow in the network is shown in Fig. (b) and system operating data are given in the following table.

System performance P(t) is defined based on the cumulative power flow delivered to the loads.

At $t_0 = 2$ a disruption happens and leads to immediate disconnection of node 2 and its failure to supply power. Node 2 is fixed at $t_r = 10$, and maximum acceptable system recovery instant is $t^* = 14$. If we assume that node 2 connects at t_r but it takes $\Delta t_r = 1$ for successor nodes and loads to connect to node 2, find the resilience metric 1 (Henry), 2 (Zobel) and 3 (Bruneau) for system operation.



Element	Capacity of element (C)
1	1.5
2	0.50
3	1
4	0.5
5	0.25
6	0.25
7	0.50
8	0.75
9	0.25

THANK YOU

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