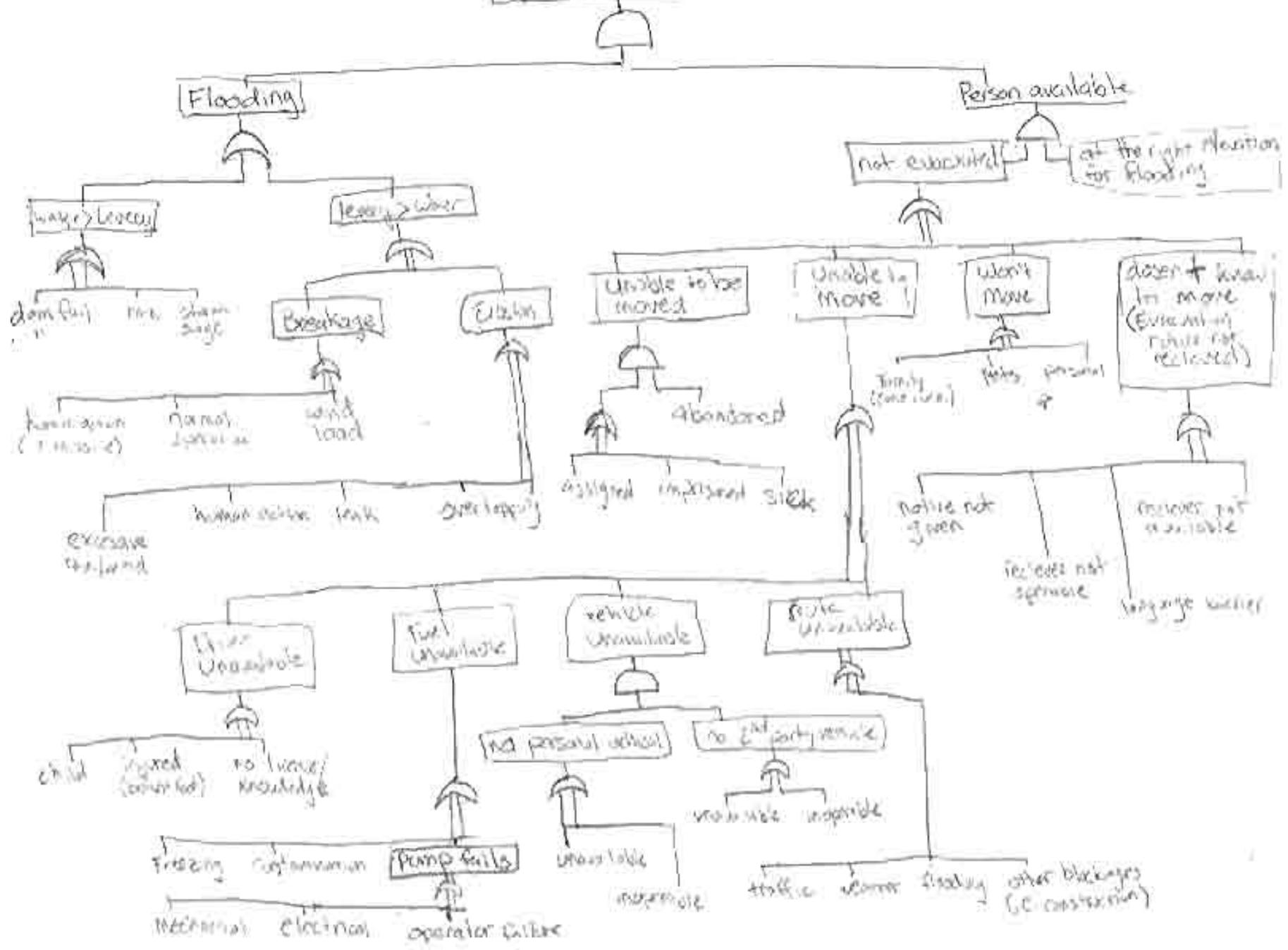


22.38: Problem Set #1 Solutions

Death by drowning in flood



Problem 1: (see previous page for fault tree)

Factors omitted in tree analysis:

- trust in evacuation notice importance
- busses available and operable that aren't being used
- Total population of city
- Wealth, education, location
- Physical capabilities
- Preparations
- Occupation
- Storm characteristics
- Levee characteristics
- Shipping locations and security
- Air temperature

Also, other forms of death having frequency amplified by flooding:

- illness
- murder
- untreated accidental injury
- fall from height
- hypothermia
- snake/alligator/dog attack

Problem 1, continued:

Minimal Cut Sets:

Any Binary Combination of A and B:

A:

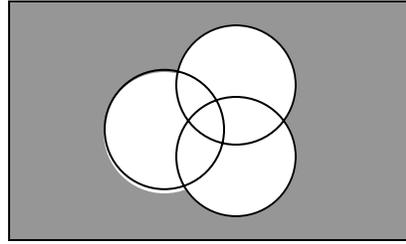
Levee break due to human action
Levee break due to normal operation
Levee break due to wind load
Excessive rain erosion
Human action erosion
Leak erosion
Overtopping erosion
Dam-failure
Rain erosion
Storm surge

B:

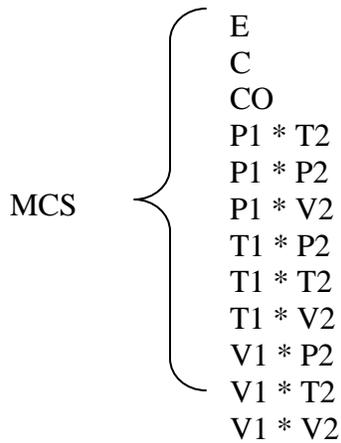
Assigned AND abandoned
Imprisoned AND abandoned
Sick AND abandoned
Child AND abandoned
Injured driver AND abandoned
No-license/knowledge driver AND abandoned
Fuel freezes
Fuel contamination
Mechanical failure of pump
No electricity for fuel pump
Operator failure
Leakage depletion of fuel
Usage depletion of fuel
Flooding of roads
Traffic
Weather bad driving conditions
2nd party vehicle inoperable AND person vehicle unavailable
2nd party vehicle inoperable AND person vehicle inoperable
2nd party vehicle unavailable AND person vehicle unavailable
2nd party vehicle unavailable AND person vehicle inoperable
Won't move – personal
Won't move – conditional (family AND pets)
Didn't receive Evacuation notice (language barrier OR not receiver OR no notice OR inoperable receiver)

Problem 2:

$$\overline{A+B+C} = \overline{A} * \overline{B} * \overline{C}$$



Problem 3:



If support systems were made redundant, there are still common-cause failures (like manufacturing defects, environmental conditions exceeding design limits, etc.) that create dependencies between two trains. There are also other common-cause failures between the two trains that are component-independent (like wrong type of fuel may have been supplied, fuel tank empty/not refilled, testing/maintenance procedures wrong, etc.)