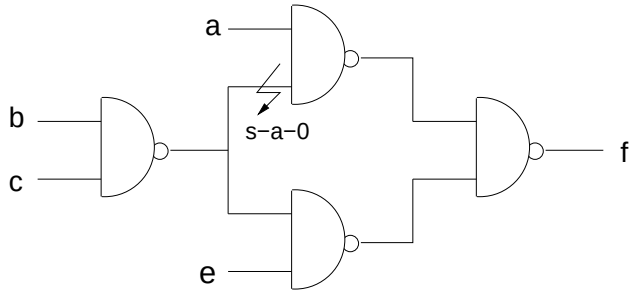
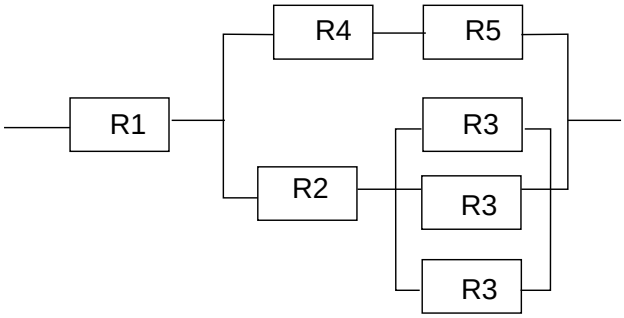
FTC Midterm Exam, April 16, 2009, 20 points

1) **(3 points)** Find **all** tests for the stuck-at-0 fault on the marked line.



$$(a,b,c,d) = \{(1,0,0,0),(1,1,0,0),(1,0,1,0)\}$$

2) **(3 points)** Write an expression for the reliability of the system shown by the reliability block diagram below.



$$R_{system} = R_1(1-(1-R_4R_5)(1-R_2(1-(1-R_3)^3)))$$

3) **(4 points)** Write an expression for the reliability of a self-purging redundancy system with 5 modules. Assume that the component's failures are independent events, the reliability of each module is R, the reliability of the voter is R_v, and switches are perfect. Assume that the voter can adopt to vote on less inputs. When only 2 modules are left, it works as a comparator.

When we say "voter fails", we mean that it starts producing an incorrect value on its output, so the system fails.

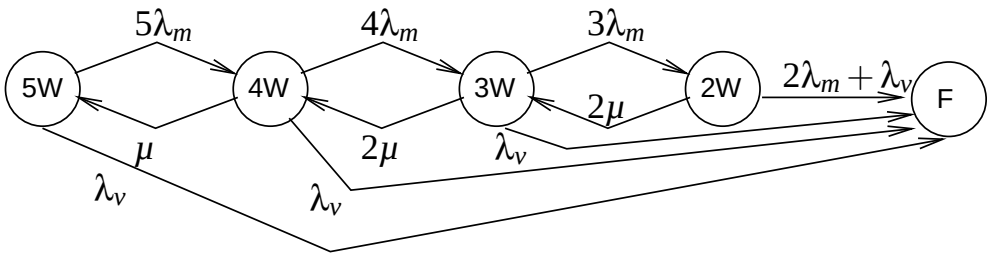
$$R_{system} = R_v(R^5 + 5R^4(1-R) + 10R^3(1-R)^2) + 10R^2(1-R)^3)$$

4) **(7 points)** Draw a Markov chain for reliability evaluation for self-purging redundancy with 5 modules. Assume that the voter can adopt to vote on less inputs. When only 2 modules are left, it works as a comparator.

When we say ”voter fails”, we mean that it starts producing an incorrect value on its output, so the system fails.

The failure rates of modules and the voter are λ_m and λ_v, respectively, and the repair rate is μ for each. There are two repair teams. Switches are perfect.

The state labeled ”XW” means ”X modules working and the voter works”.



5) **(3 points)** How many faulty modules can you tolerate in:

(a) 5-modular passive redundancy?

2

(b) standby sparing redundancy with 5 modules?

4

(c) pair-and-a-spare redundancy with 5 modules?

3