ECE 313 (Section G)
Homework 3

Due Date: Wednesday, Feb 22, 11:00 AM in the class

Write your name and NetID on top of all the pages. Show your work to get partial credit.

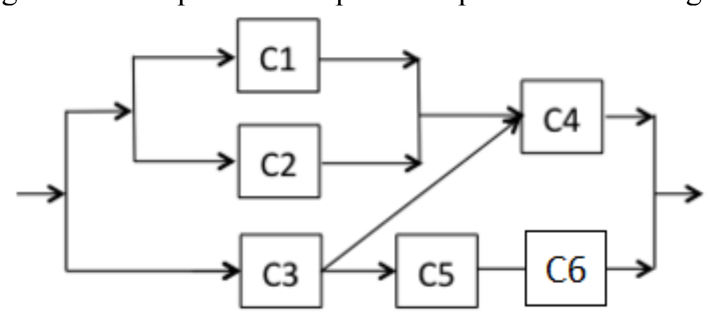
Problem 1 – An e-commerce company uses quadcopters for delivering items purchased online. A failure of the quadcopter will result in the item not being delivered. Failure can occur because of faults in navigation system (A), wing rotors (B) or rotor controller (C), which occur with probabilities 0.05, 0.08 and 0.01 respectively. Assume that the faults are mutually independent. What is the probability that a randomly chosen item purchased online:

a) Gets delivered?

b) (i) Does not get delivered?
(ii) Has faults B and C only?

c) Given that the item did not get delivered, the quadcopter had all three faults?
d) Draw a reliability block diagram for the quadcopter.

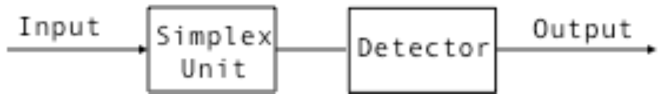
Problem 2 – Consider the non-series-parallel system of six independent components shown in the following figure. The system is considered to be functioning properly if all components along at least one path from input to output are functioning properly.



Determine an expression for system reliability as a function of component reliabilities (R).

Problem 3 – A biased coin with probability of heads being p is tossed 5 times.
Compute the probabilities that:
a) No heads occur
b) One head occurs
c) At least one head occurs
d) Exactly two heads occur. For what range of values of p would this event occur with probability > 0.2 .

Problem 4 – A detector-redundant (DR) system is composed of a number of parallel unit-detector pairs that operate simultaneously using identical inputs. Each unit-detector pair (shown in the figure below) is a series combination of a simplex unit and its associated detector. The outputs from unit-detector pairs are fed into a checking circuit. The checking circuit will check the outputs from the pairs and identifies the correct output. If there are multiple pairs with correct output, one will be selected randomly. Assume that each of the detectors and the checking circuit may themselves fail. The system is said to have failed when all unit-detector pairs or the checking circuit have failed.



A unit-detector pair (DR1)

a) Draw the reliability block diagram for a three-unit detector-redundant (DR3) system.

b) Derive the reliability formula for the three-unit detector-redundant system (DR3). Assume the reliability of a simplex unit is r, the reliability of a detector is d, the reliability of the checking circuit is v.

c) Draw the reliability graphs of the following systems vs. the component reliability (r), and compare them:

- The Simplex system ($R_{simplex} = r$),
- The DR3 system with $v = 0.95$ and $d = 0.95$,
- The DR3 system with $v = 0.97$, $d = 0.95$,
- The DR3 system with $v = 0.97$, $d = 0.97$,
- The DR3 system with $v = 1$, $d = 1$.
- Same system **operating as a TMR (now with the checking circuit acting as a voter)** with a backup unit-detector module (refer to in class activity 3), with detector reliability of $d = 1$ and checking circuit reliability of $v = 1$.

Use MATLAB, EXCEL, or any other tool to generate these 6 graphs. Highlight the graph for each system by generating legends. Refer to Lecture 6 to see a similar diagram that shows TMR vs. Simplex reliability.

Problem 5 - Two factories A and B manufacture clocks. Factory A produces on the average one defective item out of 100, and B produces on the average one bad clock out of 200. A retail marketing shop, which markets clocks under its brand name, regularly orders clocks without any manufacturer label from both factories A and B. One day, the retailer receives a container of clocks, but he does not know which company has sent it. So a personnel opens the box and takes out the first clock and checks, turns out that it is functioning well!
a) What is the probability that the second clock in the lot is also good?
b) Given that the second clock is good, what is the probability that the container came from factory A?