ECE 313 (Section B)
In-Class Project - Thursday, September 12

Write the names and NetIDs of your group members here:

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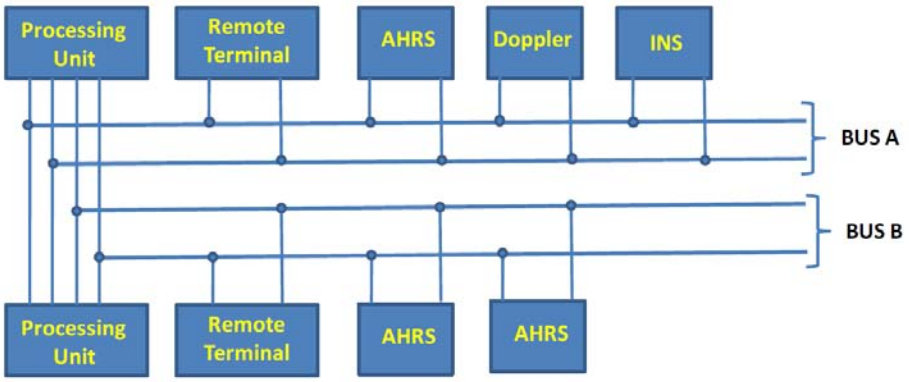
The system shown in the figure below is a processing system for a helicopter. The system has dual-redundant processors and dual-redundant remote terminals. Two buses are used in the system, and each bus is also dual-redundant. The interesting part of the system is the navigation equipment. The aircraft can be completely navigated using the Inertial Navigation System (INS). If the INS fails, the aircraft can be navigated using the combination of the Doppler and the attitude heading and reference system (AHRS). The system contains three AHRS units, of which only one is needed. This is an example of functional redundancy where the data from the AHRS and the Doppler can be used to replace the INS, if the INS fails. Because of the other sensors and instrumentation, both buses are required for the system to function properly regardless of which navigation mode is being employed.



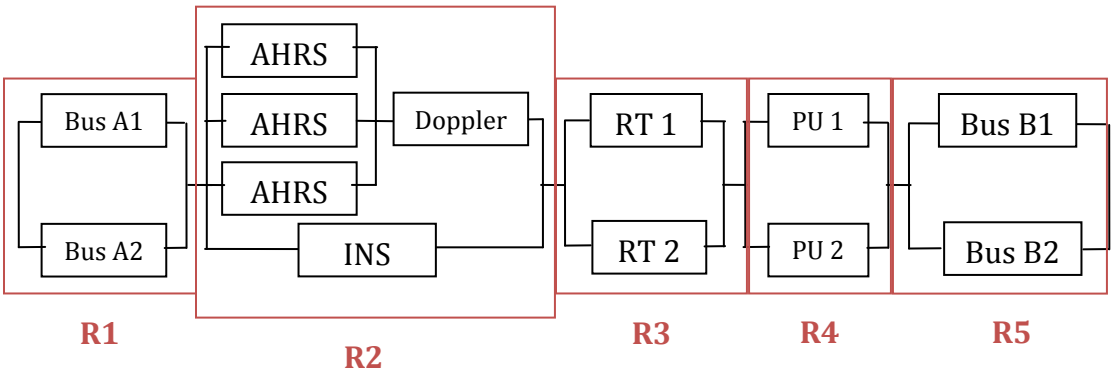
1. Identify the components that are in series and those that are in parallel.
2. Draw the reliability block diagram of the system.
3. Calculate the reliability of the system using the information given in the table below:

Component Reliability	
Processing Unit (R_{PU})	0.92
Remote Terminal (R_{RT})	0.95
AHRS (R_{AHRS})	0.88
INS (R_{INS})	0.85
Doppler (R_{DOP})	0.90
Bus (R_{BUS})	0.88

Solution:

1) Based on the problem description, we know that for the system to work, we need to have both the Buses A and B, the remote terminal (RT), the processing unit (PU), as well as the navigation system. The navigation system can work by either INS working or one AHRS and Doppler working.

2) The reliability block diagram of the system can be drawn as follows:



3) At the high-level we can consider the system as the series of 5 main components shown above: Bus A, INS/AHR, RT, PU, and Bus B. So we can write the high-level reliability formula as:

$$R_{System} = R1.R2.R3.R4.R5$$

Then we can write the reliability formula for each of R1, R2, R3, R4, and R5 blocks to get the reliability of system based on the reliability of the components. R1, R3, R4, and R5 blocks are each a parallel system, while R2 is a series-parallel system itself:

$$\begin{aligned} R_{System} = {} & [1-(1-R_{BusA})^2]. \\ & \{1-[(1-R_{INS}).(1-R_{DOP}.(1-(1-R_{AHRS})^3))]\}. \\ & [1-(1-R_{RT})^2]. \\ & [1-(1-R_{PU})^2]. \\ & [1-(1-R_{BusB})^2] \end{aligned}$$

Finally, we just plug-in the reliability numbers given for each component from the table:

$$\begin{aligned} R_{System} = {} & [1-(1-0.88)^2]. \\ & \{1-[(1-0.85).(1-0.9(1-(1-0.88)^3))]\}. \\ & [1-(1-0.95)^2]. \\ & [1-(1-0.92)^2]. \\ & [1-(1-0.88)^2] \\ = {} & 0.94811 \end{aligned}$$

Hint: You can check your answer by typing the formula in http://www.wolframalpha.com.