Consider a server composed of 2 CPUs and a variable number of GPUs. The MTTFCPU = 350days and MTTFGPU = 250days. Given that the server to work requires that at least 1 CPU and 1 GPU are properly working, what is the minimum number of GPUs that is needed to achieve a reliability value at t = 80days greater than 0.85? Use at least 4 decimal digits for all the intermediate calculations. **[2 GPU]**

A temperature monitoring system within each rack of a Data Center is composed of two redundant sensors, a microcontroller board, and a network device. All components are repairable. We know that each component has an MTTR of 3 days, the MTTF of the sensors is MTTFsen = 29days and the MTTF of the other two components is MTTFmicro = MTTFnetwork = 19days, what is the system availability? Use at least 4 decimal digits for all the intermediate calculations. **[73,9%]**

The analysis of the failure behavior of a two components system reveals that the system is down only when both its components are down. The two components A and B have the following characteristics: MTTFA = 180days, MTTRA = 1day, MTTFB = 12days and MTTRB = 1hour. What is the reliability of the system at t = 8 days? **[97,88%]**

You have in charge to design a computer system to control the power grid for the NorthEast region of Italy. The effect of a period with your system unavailable creates a lot of problems not only because the lights go off but also considering the block of the productivity of the area and possible civil disorders. Thus, you have set a goal of having a system with an availability level greater than 99.9999. You are constrained to use building block units for your control system having a MTTF of 800 hours and a MTTR of 14 min. How many parallel instances do you have to arrange to meet your goal? Use at least 9 decimal digits for all the intermediate calculations. **[2]**

A scientific computation uses a server composed of 2 CPUs and 4 GPUs. Knowing that:

• The MTTFCPU = 450days and MTTFGPU = 310days.

• The computation to work requires both CPUs and one GPU within the server to be properly working.

What is the reliability value after 2 years, R(2y)? Notes: (i) Use at least 4 decimal digits for all the intermediate calculations; (ii) All the other components within the server can be considered as ideal.

**[0,0128]**

You have in charge to design a computer system to do a long and extremely critical computation that takes 4 days to run. The system is composed by 500 servers and the computation is executed in parallel on all of them. All the servers should be up and running otherwise the computation fails. Considering that we want to achieve a reliability of 0.9 at T=4days, what should be the MTTF for a server that I have to consider during the system procurement/acquisition phase? **[18982 days]**

The analysis of the failure behavior of a three-component system (A, B and C) reveals that the system is down when both B and C are down, or A is down. The three components have the following characteristics: MTTFA = 80days, MTTRA = 1day, MTTFB = 12days and MTTRB = 12hour, MTTFC = 120days, MTTRC = 2days. What is the average availability of the system? **[0,9870]**

Suppose we have a computer system consisting of 2 critical components (C1 and C2), both of which must work for the whole system to work. They have the same cost and their reliability after 1 year is RC1 = 0.8, RC2 = 0.92.

• What is the availability ASY S of the whole system if the MTTR of both components is 1

day? Use 4 decimal digits for all calculations. **[0,9992]**

• If the objective is to increase the availability of the system, and there is a budget to add

two components to the system, would it be better to (A) replace component C1 with three

components in parallel, or (B) replace components C1 and C2 each with simple parallel

systems (one extra each)? **[B]**

The PoliMi data center has two simultaneously active (redundant) cooling distribution systems. Knowing that the availability of the cooling system should be 99.96% and the MTTR of a single distribution system is 15 days, what is the minimum MTTF needed to reach the required availability value? Use at least 4 decimal digits for all the intermediate calculations**. [735 days]**

The PoliMi data center has two simultaneously active (redundant) cooling distribution systems. Knowing that the availability of the cooling system should be 99.99% and the MTTF of a single distribution system is 150 days, what is the maximum MTTR needed to reach the required availability value? Use at least 4 decimal digits for all the intermediate calculations. **[1,515 days]**

A scientific computation uses a server composed of 2 CPUs and one TPU. Knowing that:

• The computation requires 12 days to complete.

• The computation to work requires both CPUs and the TPU within the server to be properly working.

• The MTTFCPU = 80days and MTTFTPU = 40days.

How many instances of the computation should be executed to have a probability of 98% to have at least one instance producing the results? Notes: (i) Use at least 4 decimal digits for all the intermediate calculations; (ii) All the other components within the server can be considered as ideal. **[5]**

During the procurement of a server for an important scientific calculation, 3 different solutions have been offered.

• Server A allows to complete the target calculation in 400 hours, it has a MTTF of 1200 hours, and a MTTR of 3 hours;

• Server B allows to complete the target calculation in 500 hours, it has a MTTF of 1300 hours, and a MTTR of 4 hours.

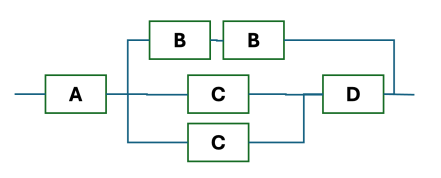
• Server C allows to complete the target calculation in 600 hours, and it has a MTTR of 5 hours.

We know that the decision on which solution to buy depends on which server has the higher probability of completing the calculation before failure, once the calculation it is started. What should be the minimum MTTF for Server C to be selected as the system to buy? Use at least 4 decimal digit for each intermediate calculation. **[1800h]**

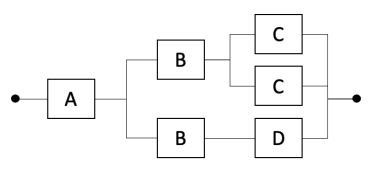
Given a system composed of N redundant modules, what is the minimum value of N to use if I want to have a system availability of at least 0,98 considering that each component has an avbailability of 0,7? **[4]**

A server manufacturer designed a system with a MTTF = 14 years. How long should be the maximum warranty considering that they want to receive back during this period less than 10% of the devices? **[1,475years = 18 months]**

Suppose we have a computer system composed of 6 different components, and designed to have an RBD as shown in the image below. The four types of components (A, B, C, and D) have different reliability characteristics. We know that after 2 years the reliability of components B, C, and D are respectively RB(2y) = 0.8, RC(2y) = 0.6, and RD(2y) = 0.9. What should be the MTTF for component A, if we want to have a Reliability of the whole system after 2 years equal to Rsys(2y) = 0.82? Use always at least 3 decimal digits for each calculation.

**[18,777y]**

Suppose we have a computer system composed of 6 different components, and designed to have an RBD as shown in the image below. The four types of components (A, B, C, and D) have different reliability characteristics. We know that after 2 years the reliability of components B, C, and D are respectively RB(2y) = 0.8, RC(2y) = 0.75, and RD(2y) = 0.9. What should be the MTTF for component A, if we want to have a Reliability of the whole system after 2 years equal to Rsys(2y) = 0.85?

**[22,235y]**

A system is composed of two components in parallel. The reliability for a single component measured at t=5 days is R(5 days)=0.98. What is the maximum number of consecutive days for which the system has a probability higher than 0.85 to work without faults? **[121 days]**

The analysis of the failure behavior of a three-component system (A, B and C) reveals that the system is down when one between A and B is down, and C is down. The three components have the following characteristics: MTTFA = 80days, MTTRA = 1day, MTTFB = 12days and MTTRB = 12hour, MTTFC = 120days, MTTRC = 2.5days. What is the average availability of the system? **[0,99894]**