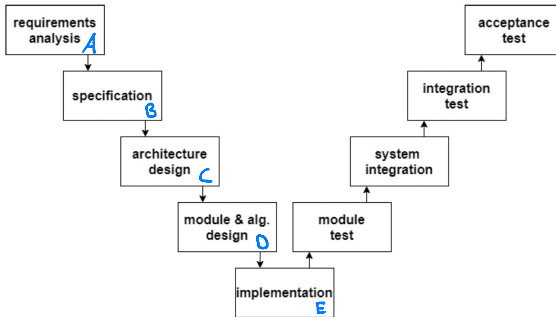# Exercise Sheet 5 - Embedded Software Development & Design
Exercise 1: V-Model
Name the missing steps of the V-Model, denoted by the letters A-E in the following graphic.


```
requirements                                          acceptance
  analysis   A                                          test

      specification                          integration
             B                                   test

          architecture              system
            design   C             integration

              module & alg.    module
                design   D       test

                  implementation
                       E
```

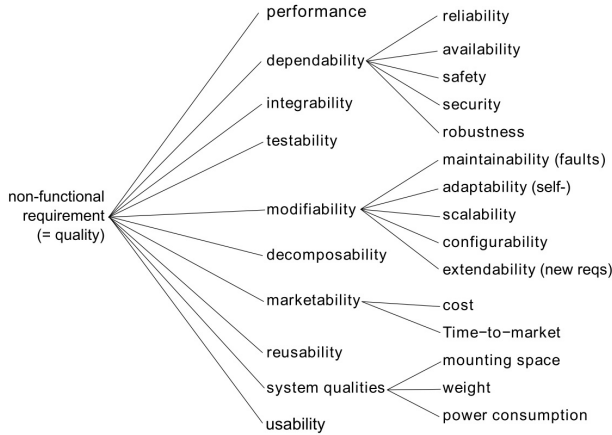Has to be known by heart for the exam.

For the remaining three exercises imagine the following scenario:
You are a startup that wants to manufacture an innovative luxury car. However, you are limited in budget and thus cannot afford an assembly line for the production of your vehicle as well as the required parts. Since you firmly believe in the success of your car and want to be able to scale easily with higher demand you start looking for alternative production line designs (Referred to as "System" further on).

Exercise 2: Types of Requirements
Decide whether the following requirements are functional or non-functional. And if they are non-functional, characterize them based on the following quality tree.

Qualitytree:

```
                              performance        reliability
                                                 availability
                         dependability          safety
                              integrability      security
                              testability        robustness
                                                 maintainability (faults)
                                                 adaptability (self-)
non-functional                modifiability      scalability
requirement                                      configurability
(= quality)                   decomposability    extendability (new reqs)
                              marketability       cost
                                                  Time-to-market
                              reusability         mounting space
                              system qualities    weight
                              usability           power consumption
```

▽
○

Will be provided in the exam!

- The System must fit in an area of 20x20m. *Non-functional (mounting space)*

- The Assembly-System should not require an up-front payment higher than 3 million$. *Non-functional (cost)*

- Switching the production to a different vehicle model should take less than 24 manhours and no additional capital investment. *Non-functional (configurability)*

- Increasing the Systems capacity twofold should not exceed 100 manhours. *Non-functional (scalability)*

- Reducing the Systems footprint to an area of 10x10m at the cost of a 60% lower production rate should be doable with less than 100 thousand$ in capital investment. *Non-functional (adaptability)*

- The Assembly of a car chassis should take at most 60 minutes. *Non-functional (performance)*

- The System must be able to produce parts out of Titanium and Aluminium. *Functional*

- The incorporation of additional metal alloys into your production line should be doable in less than 80 manhours. *Non-functional (extendability)*

- The assembly should have tolerances of less than 0.05 millimeters. *Non-functional (reliability)*

- The System must be able to assemble a chassis, all mechanical parts and all body *functional* panels of a car.

Functional: Any requirement that covers „what" the System does and not „how" (good).

General remark: Answers can vary, especially when it comes to determining to which quality the requirement refers to.

Exercise 3: Good Requirements

Check whether the following requirements for an assembly system can be considered as well defined according to the basic requirement issues from the lecture:

- The requirement proposes a solution
- The requirement is not checkable
- The requirement is not understandable by an average programmer

- The Assembly-System should use 4 robotic arms. *Proposes a solution*
- The System should be able to produce parts meeting the ISO 134866-1:1999 standard. *Not understandable*
- The System should be able to adapt to other metals. *Not checkable*
- The System should be able to be sold as a product. *Not checkable*
- The Systems operation should not require human interaction 99.99% of time. ✓ *(Availability)*
- The metal parts should be 3D-printed. *Proposes a solution*
- The Levy should be less than half of the liquid assets available. *Not understandable*
- Production should take less than a week. *Not checkable*
- The parts should be assembled in the center of the machine, one piece at a time. *Proposes a solution*
- The System should be operational in temperatures between -10°C and 50°C as well as ✓ *(Robustness)* humidities between 10% and 60%.