

Systems and Software Engineering

Examination WT 2012/2013



Institut für Technik der Informationsverarbeitung – ITIV
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Systems and Software Engineering

Date: 05.04.2013

Name:

Matriculation ID:

Lecture Hall:

Seat No.:

Prerequisites for the examination

Aids

- Allowed aids for the examination are writing utensils and a single sheet of A4 paper with self- and hand-written notes. Writing may be on both sides of the paper. The use of own concept paper is not allowed.
- Use only indelible ink - use of pencils and red ink is prohibited.
- Other material than that mentioned above, is strictly forbidden. This includes any type of communication to other people.

Duration of the examination

120 minutes

Examination documents

The examination comprises 22 pages (including title page). Answers may be given in English or German. A mix of language within a single (sub)-task is not allowed. In your solution mark clearly which part of the task you are solving. Do not write on the backside of the solution sheets. If additional paper is needed ask the examination supervisor.

You will not be allowed to hand in your examination and leave the lecture hall in the last 30 minutes of the examination.

At the end of the examination: Stay at your seat and put all sheets into the envelope. Only sheets in the envelope will be corrected. We will collect the examination.

		Page	Points	Result
Task 1	General Questions	2	11	
Task 2	House of Quality	4	8	
Task 3	Petri Nets	6	8	
Task 4	State Charts	8	8	
Task 5	Scheduling	11	17	
Task 6	Reliability	14	8	
Task 7	UML Diagrams	15	18	
Task 8	Other diagrams	19	10	
			89	

1 General Questions

1.a Lifecycle models

/3

Briefly describe the Waterfall Lifecycle model.

In what ways is the Waterfall Lifecycle model different to other Lifecycle models?

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1.b V-model

/2

Name the four sub models of the V-Model.

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1.c Reliability

/1

$f(t)$ is the failure function (probability density function) of a system. How can the Reliability $R(t)$ be computed from f ?

.....

Multiple choice

You get plus 0.5 points for a right answer and minus 0.5 points for a wrong answer. In total you cannot get a negative number of points for each subtask. More than one answer could be true.

1.d More than Moore

/1.5

What does 'More than Moore' means?

true	false	
<input type="checkbox"/>	<input type="checkbox"/>	The number of transistors on integrated circuits more than doubles every two years.
<input type="checkbox"/>	<input type="checkbox"/>	Diverse Technologies and Functions are implemented on a Single Chip or a system-in-Package.
<input type="checkbox"/>	<input type="checkbox"/>	Moore machine which is extended by concurrency.

1.e Watchdog timer

/1.5

Which statements could be made for software watchdog timer and hardware watchdog timer?

true	false	
<input type="checkbox"/>	<input type="checkbox"/>	It is not possible to implement both, hardware and software timer in one system.
<input type="checkbox"/>	<input type="checkbox"/>	Timer in software runs much slower than the system clock.
<input type="checkbox"/>	<input type="checkbox"/>	Time resolution of the hardware timer has the same resolution as the system clock.

1.f Reliability

/2

The reliability function of a system is defined as $R(t) = R_1(t) + R_2(t) - R_1(t) \cdot R_2(t)$. What statements could be made about the two elements E1 and E2?

true	false	
<input type="checkbox"/>	<input type="checkbox"/>	Elements E1 and E2 are serially connected.
<input type="checkbox"/>	<input type="checkbox"/>	Elements E1 and E2 are connected in parallel.
<input type="checkbox"/>	<input type="checkbox"/>	The failure rates of E1 and E2 are considered as being constant.
<input type="checkbox"/>	<input type="checkbox"/>	Elements E1 and E2 are stochastically independent.

2 House of Quality



Your task is to do an analysis of a new digital camera. Thus, you decide to determine important design characteristics and critical system components of the new device. For this task you do the Quality Function Deployment and create a "House of Quality". Implement the quality deployment in Figure 1.

From a public-opinion poll you know that the most important things which people want in a camera are "Image Quality" (100%), "Usability" (90%), "Portability" (60%) and "Movies" (40%). The technical design characteristics you want to evaluate are "CCD quality" (sensor for recording the images), "Size/Weight", "Display quality" and "Battery quality".

Table 1 shows a feature comparison between your old camera model and the actual camera of your main competitor.

Feature	Own previous model	Competitors model
Resolution	8.0 Mio Pixel	6.0 Mio Pixel
LCD size	1.5 inch	2.0 inch
Optical zoom	3x	3x
Weight	160g	130g
Size	88mm x 60.5mm x 32.7mm	86,0mm x 53,0mm x 20,7mm
Shutter speeds	15s – 1/2000s	1/8s - 1/2000s
Lens focal width	39 mm – 117 mm	36mm - 108 mm
Battery charging time	6h	8h
Video	640x200, 30 frames/s	320x200, 30 frames/s
Connectors	USB 2.0	USB 3.0, Video
Accessories	Software, Cables, AC adapter kit, bag	Cables, AC adapter kit

Table 1: Digital camera model comparison

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Figure 1: House of quality

3 Petri nets



A petri net is formally described by $N = (P, T, F, M_0)$.

$$P = \{p_1, p_2, p_3, p_4, p_5\}$$

$$T = \{t_1, t_2, t_3, t_4\}$$

$$F = W^+ \cup W^-$$

$$W^+ = \begin{bmatrix} & t_1 & t_2 & t_3 & t_4 \\ p_1 & 1 & 0 & 0 & 0 \\ p_2 & 1 & 0 & 0 & 0 \\ p_3 & 0 & 2 & 0 & 0 \\ p_4 & 0 & 0 & 0 & 1 \\ p_5 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$W^- = \begin{bmatrix} & t_1 & t_2 & t_3 & t_4 \\ p_1 & 0 & 1 & 0 & 0 \\ p_2 & 0 & 1 & 0 & 0 \\ p_3 & 0 & 0 & 1 & 0 \\ p_4 & 1 & 1 & 0 & 0 \\ p_5 & 2 & 0 & 0 & 0 \end{bmatrix}$$

$$M_0[2 \quad 1 \quad 0 \quad 0 \quad 1]$$

3.a Graphical representation

/3

Draw the graphical representation of the formally described net above, including as much as possible information.

3.b Analysis of the net

/2

Is the formally described Petri net conservative? Explain your answer.

3.c Reversibility

/3

Draw two Petri nets, one which is reversible and the other one that is not reversible.



4 State charts

Figure 2 shows a state chart of an mp3-Player with battery and shock control.

Functional description:

The player could only perform a function if a battery voltage from at least 3 Volt is measured. During the operation a hard disk is accessed. In case a shock is detected, the hard disk read heads are parked. Track number, title, time and artist could be displayed. For operation the buttons start, stop, play, pause and mode could be used.

The simulation input values are given in Figure 3.

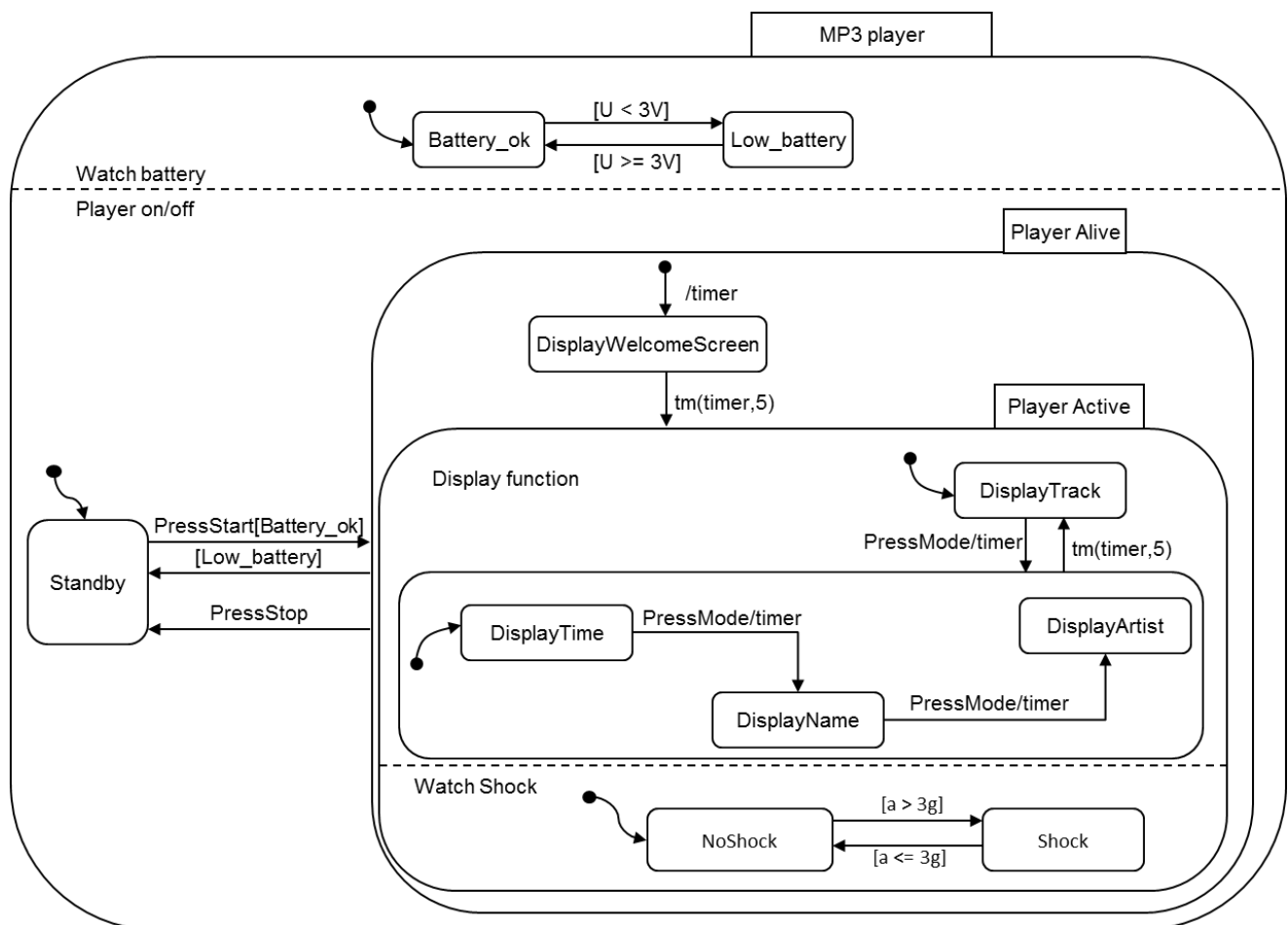


Figure 2: State chart of an mp3-player

4.a Basic states

/2

How many states are necessary if you transform the state chart in Figure 2 into a state chart containing only basic states? Write down the solution steps!

.....

.....

.....

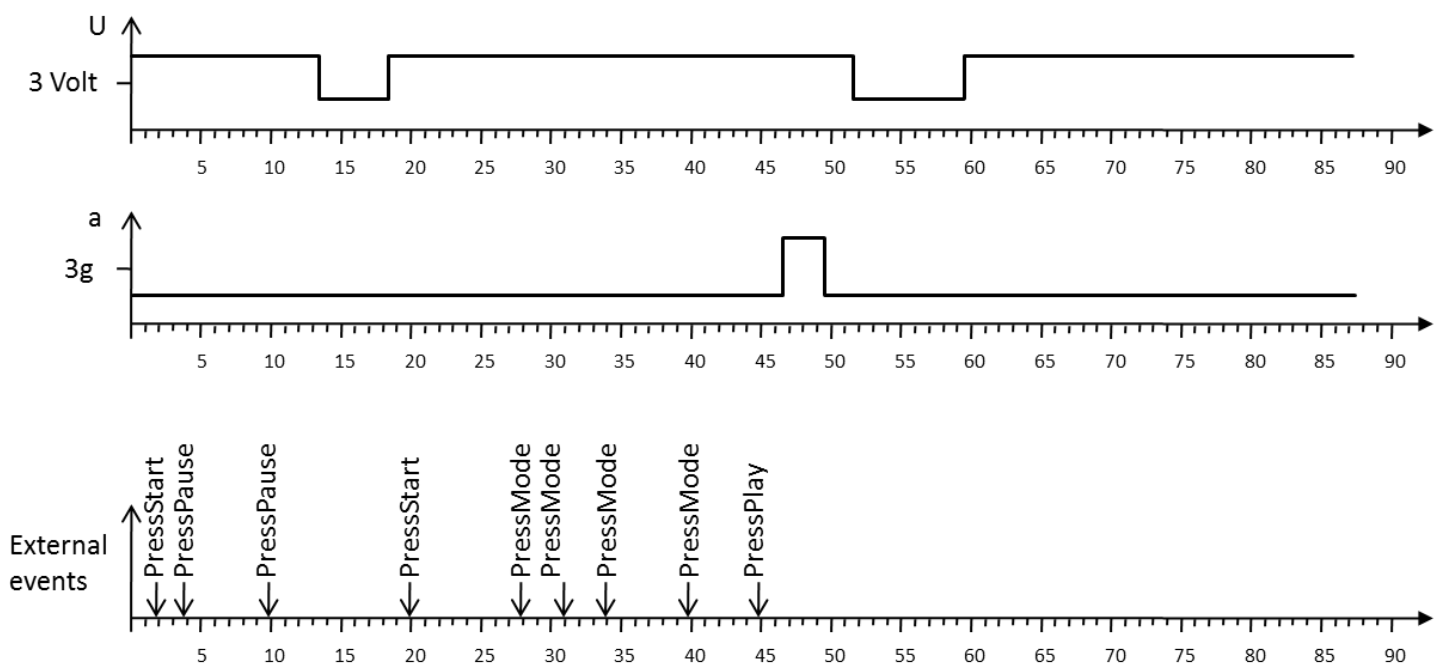


Figure 3: Simulation Inputs

5 Scheduling

5.a Scheduling-strategies for tasks

/9

Five tasks with different priority should be executed on one processor. Table 3 shows the features of these tasks.

Task	Processing Time	Priority (0 is highest)	Arrival time	Deadline
A	17	2	T + 0 ms	T + 160 ms
B	33	3	T + 7 ms	T + 120 ms
C	49	1	T + 11 ms	T + 110 ms
D	25	0	T + 18 ms	T + 70 ms
E	31	4	T + 9 ms	T + 95 ms

Table 3: Tasks

You are at a certain point in time T, all tasks request processor-time at this point in time. Plot the processing of the given tasks into the following diagram (see Figure 4 next page) under consideration of the scheduling methods named below.

- Round Robin (time slice 15ms) (Task Queue)
- TDMA (time slice 10ms) (Cycle A-B-C-D-E, A starts at T)
- Priority Scheduling
- Deadline Scheduling

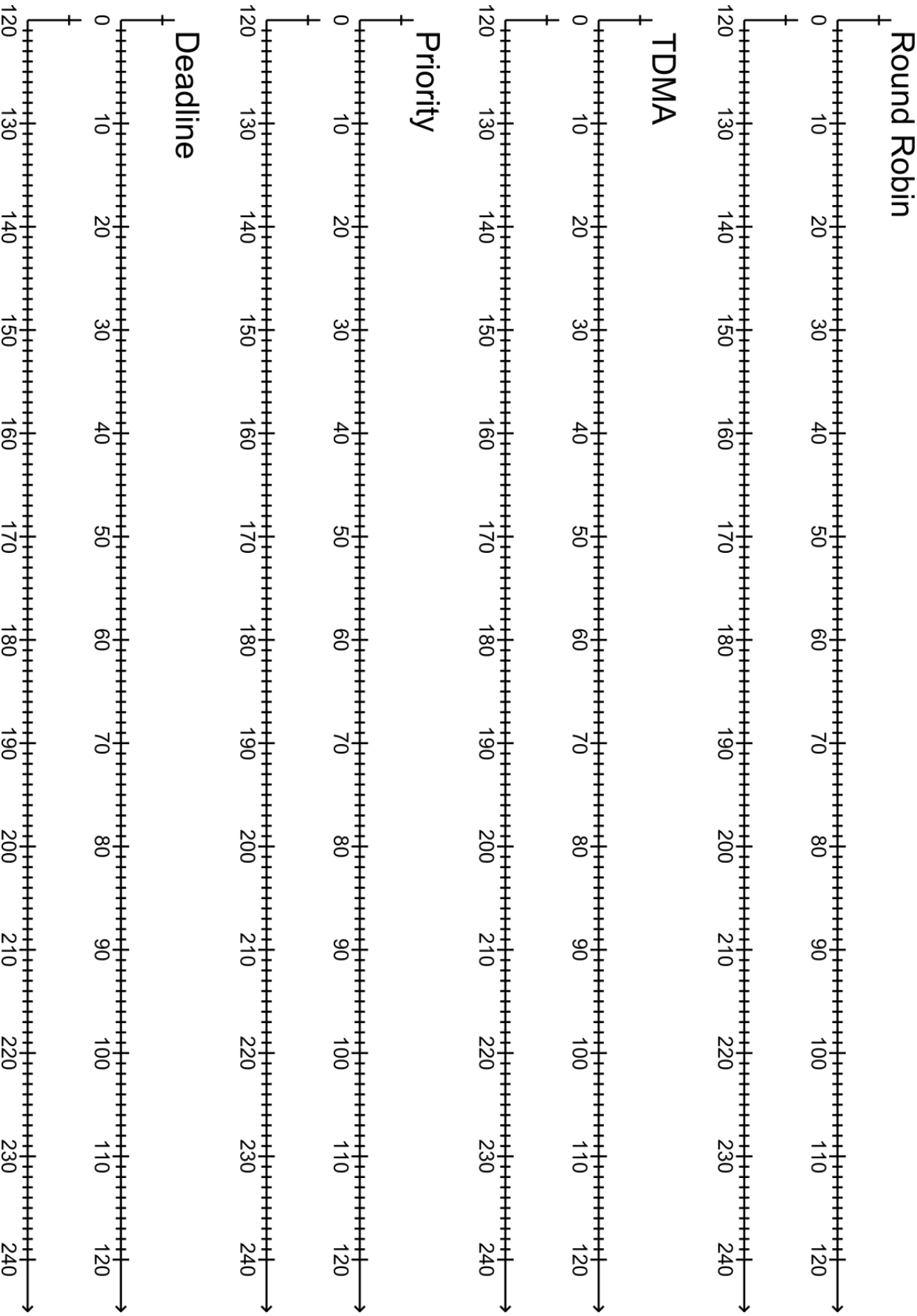


Figure 4: Scheduling strategies

/4

5.b Response time

Calculate the maximal and the average response time of the Round Robin and TDMA scheduling methods.

/1

5.c Scheduling strategy

Which scheduling strategy has to be implemented if you want to obtain a minimal average response time. Take into account all scheduling strategies which have been discussed in the lecture and assume that all tasks arrive at the same time.

/3

5.d Calculation of CPU usage

Give a formula for the CPU-usage for Round-Robin scheduling as the ratio between the time used for actual task processing and the overall time (task processing plus time for switches). Assume that there are always tasks ready to be executed.

Which CPU-usage is obtained if the time slice leans toward zero?

6 Reliability

6.a TMR

/3

Sketch a diagram of a TMR system and explain the functionality of this system.

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6.b Terms

/3

Explain the three terms error, failure and fault.

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6.c Mean time to failure

/2

Give the general equation for the MTTF and determine the MTTF for a system with a constant failure rate of 0.0002.

.....

.....

7 UML Diagrams

7.a Use case diagram

/4

Draw a use case diagram for university courses.

In particular, assume that courses are taught by professors, while an assistant can enroll or remove students from a course. Students take a course, provided they are enrolled in it.

7.b Class diagram

/5



Flug Flight	nach to	über via	planmäßig scheduled	verzög. estimated	Gate	Check-In
LH 4916	Birmingham		15:20		639	Lufthansa
LH 714	Tokio		15:25		H28	Lufthansa
LH 1156	Münster/Osnabr.		15:25		609	Lufthansa
LH 1276	Köln/Bonn		15:25		601	Lufthansa
LH 474	Montreal/YUL		15:30		H38	Lufthansa
LH 3494	Zagreb		15:30		H35	Lufthansa
LH 3642	Brax		15:30		664	Lufthansa
LH 3938	Verona		15:30		661	Lufthansa
LH 4342	Bordeaux		15:30		666	Lufthansa
LH 4386	Toulouse		15:30		662	Lufthansa
LH 366	Bremen		15:35		631	Lufthansa
LH 052	Hamburg		15:40		632	Lufthansa
LH 979	Frankfurt/Main		15:40		630	Lufthansa
LH 3652	Bern		15:40		641	Lufthansa

Figure 5: Airport display

You are working for a company designing a display system for an airport similar to the one in the picture above. Its task is to show information on departing flights, their status, departure times, airline and boarding gates. Design a class model that is capable of storing all the information needed by the display system. Adhere to the following constraints:

- One airport can provide any number of flights.
- A flight has a scheduled departure time but can be delayed.
- Each flight has a target Airport and a flight number.
- Each flight can have the status “not boarding”, “boarding”, “last call” or “departed”.
- Each gate of an Airport can be used to board several flights.
- Each flight is served by one Airline.

Design a class diagram of the described airport display system. Add associations, multiplicities and attributes with fitting data types.

7.c Sequence diagram

/5

Convert the UML Communication diagram in Figure 6 into a UML Sequence Diagram using as much information as possible.

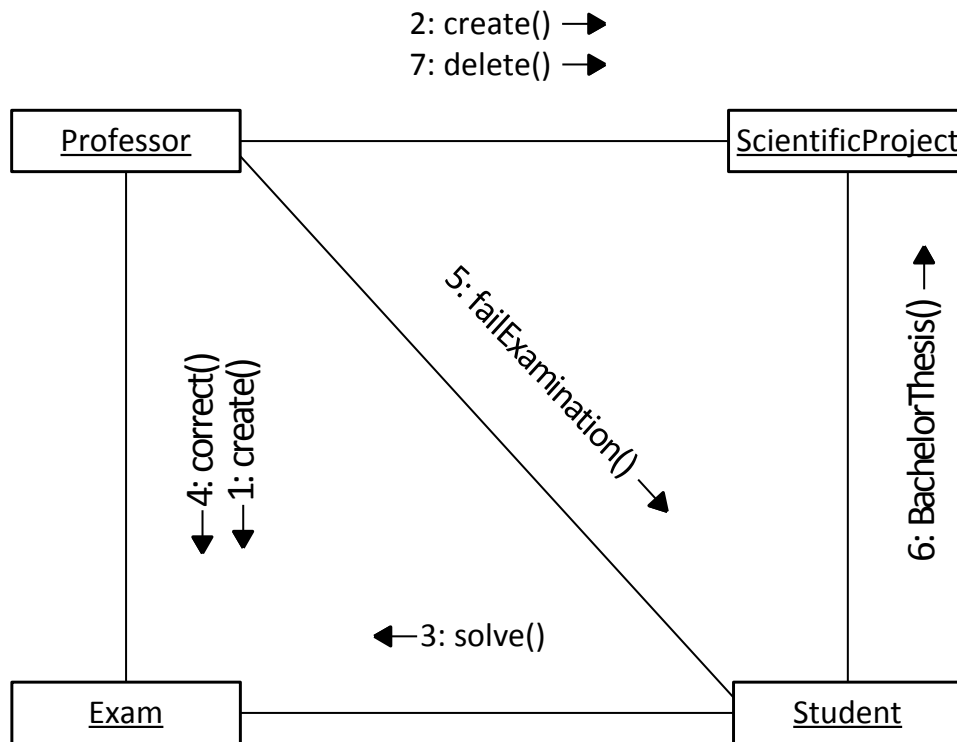


Figure 6: UML Communication diagram

7.d Visibility

/4

Given the UML Class Diagram in

Figure 7 draw an UML Communication Diagram with all possible messages (operation calls).

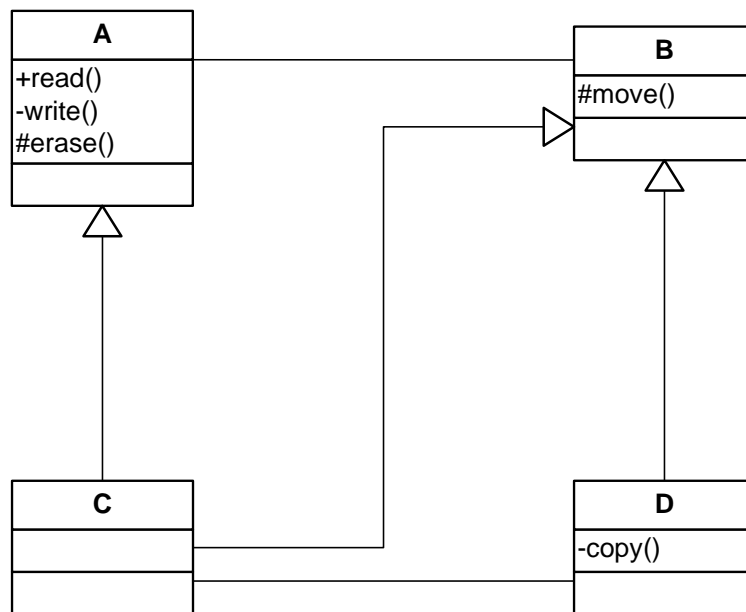


Figure 7: UML Class diagram

8 EBNF

8.a Backus-Naur-Form

/2

Write down the following EBNF expressions in BNF.

expression ::= term { ('Plus' | 'Minus') term }

term ::= factor { ('Mult' | 'Div') factor }

factor ::= 'Number' | 'Minus' 'Number'

.....

.....

.....

.....

.....

8.b Extended Backus-Naur-Form

/4

Design an EBNF expression which only defines floating point numbers. Examples for producible expressions are shown below.

1.234
+50000
-9.3021
+1.432E4
0
1E10
-4932E-13

.....

.....

.....

.....

.....

8.c Nassi-Shneiderman diagram

/4

Analyze the following program written in C++/Java by drawing a Nassi-Shneiderman diagram.

```
void func(int x[], int y) {  
    for (int i = 0; i < y-1; i++) {  
        for (int j = 0; j < y-i-1; j++) {  
            if ( x[j] > x[j+1] ) {  
                int z = x[j];  
                x[j] = x[j+1];  
                x[j+1] = z;  
            }  
        }  
    }  
}
```

Student ID:

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Additional working sheet:

Exercise number: _____

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Exercise number: _____