Midterm Examination 1
GEM 1501: Problem Solving for Computing

20.02.2008, 12.00-12.30h

Matriculation Number: _____

Rules
Each correct question, 1 mark. Maximum score: 12 marks.
Programming Language for Questions 8–12 is Java Script.

Question 1. Computers are used for problem solving. One of such problems is find solutions to logical conditions. In the following problem, the logical variables $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8$ occur. Find a solution such that all statements listed are true. For example, if x_1, x_2, x_4 are true and x_3, x_5, x_6, x_7, x_8 are false, then this would not be a solution since the second condition is false. Recall, $\wedge$ means "and", $\vee$ means "or" and $\neg$ means "not". Here are the conditions.

- $x_1 \vee x_2 \vee x_3 \vee x_4 \vee x_5$;
- $\neg x_2 \vee \neg x_4$;
- $(x_1 \wedge x_2) \vee x_4$;
- $x_6 \wedge x_7 \wedge x_8$;
- $\neg x_5 \vee \neg x_6 \vee \neg x_7$;
- $\neg(x_1 \wedge x_2 \wedge x_3)$;
- $\neg x_2 \vee \neg x_6 \vee \neg x_8$;
- $(x_1 \wedge x_2) \vee (x_2 \wedge x_3) \vee (x_3 \wedge x_4)$;
- $\neg x_1 \vee \neg x_4$.

Give the solution here:
The following variables are true: x_3, x_4, x_6, x_7, x_8 ;
the following variables are false: x_1, x_2, x_5 .

Question 2. Computers calculate in the binary system instead of the decimal system, so "10" means "two", "11" means "three" and "100" means "four". Complete the following binary addition, do not use the digits $2, 3, 4, \ldots, 9$.

```
    1 1 0 0 1
    1 0 1 0 0
+ 1 0 1 0 1 1
-------------
1 0 1 1 0 0 0
=============
```

Question 3. Tick the right statements (2 out of 4).

[x] Usually a compiler translates a computer program into machine code.

[ ] A Java Script program is translated into a code for a Java Script Virtual Machine and runs on a Sun Workstation.

[x] Programs like "Internet Explorer", "Mozilla" and "Firefox" are called browsers and used to view webpages.

[ ] "Interpreter" and "compiler" are two words for the same thing.

Question 4. Tick the right statements (2 out of 4).

[ ] The programming language Pascal is named after a Indian mathematician and is a programming language specialized on string operations.

[x] "APL" stands for "A Programming Language"; this programming language is terse and specialized on tensor operations.

[ ] Common languages to program webpages are Basic, C and Fortran.

[x] The programming language Fortran is older than Basic and Pascal.

Question 5. In which programming language is the following program written:

```
10 PROGRAM SUM
20 I = 0
30 J = 0
40 I = I+1
50 J = J+I
60 IF (I-100) 70,70,40
70 PRINT *,20HSum from 1 to 100 is ,J
```

[ ] Basic [ ] C [x] Fortran [ ] Java Script [ ] Pascal

Question 6. Consider the function

$$f(n) = 25n + \log(n) \cdot (17 + 4\log(n)) + 3n^2 + 11n\log(n) + \sqrt{n+2} + 24242424.$$

Which of the following statements are true (tick 1):

☐ $O(f) = O(1)$; ☐ $O(f) = O(\log^2(n))$; ☐ $O(f) = O(n)$;
☐ $O(f) = O(n\log(n))$; ☒ $O(f) = O(n^2)$; ☐ $O(f) = O(n^2\log(n))$.

Question 7. What is the verification of a program? Tick one answer.

☐ Specifying what a program should do.
☐ Writing the code of a program in a standard programming language.
☒ Proving that a program does what is written in the specification.
☐ Compiling a program from one programming language into another one.
☐ Translating a program into machine code.

Question 8. Tick the correct error report for this program.

```
function factorial(input)
  { var value = 1; var loopvar;
    for (loopvar=input:loopvar>1:loopvar=loopvar-1)
      { value = value*loopvar; }
    return(value); }
```

☐ The program is correct;
☐ The program does not have declarations for all variables;
☒ The colons in the third line should be semicolons;
☐ The initial value "1" cannot be fixed at the variable declaration;
☐ The program has correct syntax but does not terminate for input 3.5.

Question 9. Write a function which computes $5^0 + 5^1 + 5^2 + \ldots + 5^n$ on input n.

```
function sum(n)
  { var m; var p; var k;

------------
    m=1; p=1;
    for (k=1;k<n;k=k+1)
      { p = p*5;
        m = m+p; }

------------

    return(m); }
```

Question 10. Write a program which finds the maximum of a number in a list with name "ar" using the method "divide and conquer".

```
var ar = new Array(23,1,54,6,12,908,...,1,13);

function maximumfind(i,j)
  { if (i+2>j) { return(ar[____i____]); }

    var k = Math.floor(_____(i+j)/2____);
    var x = maximumfind(i,k); var y = maximumfind(k,j);

    if (x>y) { return(___x___); } else { return(___y___); } }

document.write("The maximum is "+maximumfind(0,ar.length)+".<br>");
```

Question 11. Which is the formula for the following function $ff(n)$? Note that ff is a function from natural numbers to natural numbers, negative and non-integer inputs are not permitted.

```
function ff(n)
  { if (n<1) { return(1); }
    else { return(ff(n-1)+ff(n-1)+ff(n-1)+ff(n-1)); }
```

☐ 1; ☐ $2n$; ☐ $4n$; ☐ n^2; ☐ n^4; ☐ 2^n; ☒ 4^n; ☐ n^n.

Question 12. Complete the following function to find the least expensive travel from town number `0` to town number `n`. `cost[i][j]` with `i<j` is the cost to go from `i` to `j` directly. The arrays `next` and `allcost` have to be filled.

```
function dynamicprogram(n)
  { var m; var k; var u; next[n]=n; allcost[n]=0;
    for (m=n-1;m>=0;m=m-1)
      { allcost[m]=cost[m][n]; next[m]=n;
        for (k=m+1;k<n;k=k+1)

          { u = _______cost[m][k]_______ + ______allcost[k]______;

            if (u < _____allcost[m]______)

              { next[m] = _____k_______; allcost[m] = u; } } }
    return; }
```