

## ASSIGNMENTS OF ALL SELECTIVE EXAMS FOR ENROLLMENT INTO MASTERS PROGRAMS FRI

Caution: Note that you should solve only the assignments with the sequential number (ID) specified on your exam sheet of your chosen study program elective exam. The solutions should be entered into the table on that exam sheet.

### 1 Mathematics

1. (1 point) Let  $A$  be a matrix of size  $10 \times 10$  whose elements are real numbers. Let  $I$  be the identity matrix of size  $10 \times 10$ . Which of the following statements is false?
  - A. If  $A^{10}$  has an eigenvalue  $1 + 2i$ , then the determinant of the matrix  $A$  is still a real number.
  - B. If the kernel of a matrix  $A$  is equal to its image, then  $A^2$  is the zero matrix.
  - C. If the matrix  $A$  has a characteristic polynomial of the form  $p(\lambda) = \lambda^{10} + a_9\lambda^9 + \dots + a_2\lambda^2 + 2\lambda$ , where all  $a_i$  are real numbers, then it is invertible.
  - D. If  $A^{10}$  is the zero matrix, then  $I - A$  has only a zero vector in the kernel.

2. (1 point) We would like to find the minimum of some continuously differentiable function  $f(x, y)$  on the unit circle  $x^2 + y^2 = 1$ . We parameterize the circle with a real variable  $t$  as

$$x(t) = \frac{t^2 - 1}{t^2 + 1}, \quad y(t) = \frac{2t}{t^2 + 1},$$

which translates the problem into finding the minimum of the function  $g(t) = f(x(t), y(t))$  of the variable  $t$  on  $\mathbb{R}$ . If no local minimum of the function  $g$  is equal to its global minimum, then the minimum of  $f(x, y)$  is attained at a specific point on the circle. Which point is this?

Hint: Which point on the circle we miss with the parametrization above?

- A.  $(1, 0)$
  - B.  $(0, 1)$
  - C.  $(-1, 0)$
  - D.  $(0, -1)$
  
3. (1 point) Let  $X$  and  $Y$  be independent random variables, having continuous uniform distribution on the interval  $(0, 1)$ . Let  $Z$  be a random variable defined as  $Z := \max(X, Y)$ . The probability of the event  $Z \geq \frac{3}{4}$  is equal to:
  - A.  $(\frac{1}{4})^2$
  - B.  $1 - (\frac{1}{4})^2$
  - C.  $(\frac{3}{4})^2$
  - D.  $1 - (\frac{3}{4})^2$

4. (1 point) Choose the correct statement about the curve  $\mathcal{C} \subseteq \mathbb{R}^2$ , which is the set of solutions of the equation

$$y^2 = x(x^2 - 1).$$

Hint: Sketch the curve  $\mathcal{C}$ .

- A.  $\mathcal{C}$  has one connected component and no self-intersections.
- B.  $\mathcal{C}$  has one connected component and one self-intersection.
- C.  $\mathcal{C}$  has two connected components, neither of which is an isolated point.
- D.  $\mathcal{C}$  has two connected components, one of them being an isolated point.

## 2 Programming

5. (1 point) How many asterisks does the following Java program print?

```
public class Program {
    public static void main(String[] args) {
        for (int i = 0; i < 8; i += 2) {
            for (int j = i; j > 0; j--) {
                int k = 1;
                while (k < j) {
                    k *= 2;
                    System.out.println("*");
                }
            }
        }
    }
}
```

- A. 17
- B. 25
- C. 34
- D. 46

6. (1 point) What does the following Java program output?

```
public class Program {
    public static int f(int a, int b, int[] t) {
        t[0] += a + b;
        if (a + b == 0) {
            return 1;
        }
        return f(a / 2, b / 3, t) + f(a / 3, b / 2, t);
    }

    public static void main(String[] args) {
        int[] t = {0};
        System.out.println(f(4, 8, t) + " " + t[0]);
    }
}
```

- A. 7 0
- B. 7 27
- C. 9 0
- D. 9 27

7. (1 point) You are given the following Java classes:

```
class Employee {
    int base() {
        return 100;
    }

    int bonus() {
        return 10;
    }

    int salary() {
        return this.base() + this.bonus();
    }
}

class Boss extends Employee {
    @Override
    int bonus() {
        return 5 * super.bonus();
    }

    @Override
    int salary() {
        return 2 * super.salary() + this.bonus();
    }
}
```

What does the following sequence of statements print?

```
Employee e = new Boss();
System.out.println(e.salary());
```

- A. Nothing, because it does not compile.
- B. 110
- C. 270
- D. 350

### 3 Algorithms

8. (1 point) In Butale, they decided to renovate the electricity network between the transformer stations as cheaply as possible, which means that they want to use as few cables as possible to connect the transformer stations. The task was entrusted to Peter, who first asked for information on the distances between transformer stations. He got (values are in km):

	$T_1$	$T_2$	$T_3$	$T_4$	$T_5$	$T_6$	$T_7$
$T_1$		9,4	6,7	6,6	2,2	5,8	4,2
$T_2$			6,0	0,4	2,5	2,0	3,7
$T_3$				8,0	7,2	9,1	7,9
$T_4$					3,3	1,0	3,7
$T_5$						9,8	8,8
$T_6$							2,6
$T_7$							

The next step is to buy cables. Peter soon found a manufacturer who sold cables in multiples of 2.5 km, and of course the more cable you buy, the more you pay. How much cable should he order to replace the cable network at the lowest price?

- A. 10,0 km
- B. 12,5 km
- C. 15,0 km
- D. 17,5 km
- E. 20,0 km
- F. 2,5 km

### 4 Computer systems

9. (1 point) A 4 KB direct cache has blocks (cache lines) of size 64 B. From the main memory a matrix of size  $32 \times 32$  is read (elements are double precision floating point numbers). The matrix is written in the row major order and the elements are read sequentially. By how much the CPI (clocks per instruction) is increased due to cache misses, assuming that the program has 480 instructions, the transfer penalty is 30 ns, and the processor frequency is 500 MHz?
- A. By 1.
  - B. By 2.
  - C. By 4.
  - D. Nothing of the above.

## 5 Multimedia

10. (1 point) What is the size of GOP (Group of Pictures) in the following sequence of video frames: I B B B P B B B I B B B B P B B B B P B B B B I?
- A. 5
  - B. 4
  - C. 10
  - D. 30
11. (1 point) Which statement from the domain of accessibility of MM content is wrong?
- A. An accessible web page has a better user experience for all users
  - B. Accessible and not accessible versions of a web page are visually quite distinctive
  - C. Accessibility requirements for web pages are legally binding
  - D. Sign language is often the first language of Deaf persons
12. (1 point) How many IP devices can we connect into the following subnet: 10.1.244.128/25?
- A. 128
  - B. 64
  - C. 126
  - D. 190
13. (1 point) An MPEG2 transport stream broadcast over DVB-T/T2 contains 3 HD (high definition) video streams and 2 SD (standard definition) video streams, all encoded using H.264 codec. Each of the video streams is accompanied by an audio stream, encoded using AAC codec. Which of the below options would be the minimum bit rate that is sufficient for broadcasting of such multiplex?
- A. 10 Mbit/s
  - B. 24 Mbit/s
  - C. 60 Mbit/s
  - D. 66 Mbit/s

**SELECTIVE EXAM**  
**FOR ENROLLMENT INTO MASTERS STUDY**  
**COMPUTER AND INFORMATION SCIENCE**  
**(Tracks: Computer and inf. science or Data science)**  
**2024/25**

First and last name: \_\_\_\_\_

Date of birth: \_\_\_\_\_

Enrollment number (if you have one): \_\_\_\_\_

**General guidelines:**

You have received a batch of assignments for *all selective exams* in which each assignment is identified by its ID-number (from 1 onward). From this batch, solve only the assignments with the IDs corresponding to the ones in the table located at the bottom of this page. Solve each assignment by writing the letter corresponding to the correct answer under the corresponding assignment ID. Duration of exam is 60 minutes.

**Write your answers in the following table under *Your answer*:**

Assignment ID	1	2	3	5	6	7	8	9
Your answer								