

## Questionnaire

Name:	_____
Matriculation number:	_____
Study code:	_____
Signature:	_____

### EVALUATION

You can score 120 points on this test. Documents and electronic aids (except simple calculators) are not allowed!

The following questions include True-false statements, single-choice questions, and multiple-choice questions. For true-false statements and multiple-choice questions: Correctly marked answers result in plus points, falsely marked answers result in negative points. For single-choice questions, there are no negative points for false selections. For a question where no answer option was marked, you get 0 points. Questions with negative points have an indication of this. **Attention:** Minus points are global. Furthermore, if you tick every answer in a question with negative points, you always get 0 points. For the arithmetic questions: **NO** calculations have to be presented on the questionnaires and only the answer sheet has to be handed in at the end.

### HELP FOR FILLING IN THE ANSWER SHEET

#### How do I mark correctly?

For this test, you will receive a questionnaire and an answer sheet. The answers must be marked on the answer sheet. This will be evaluated automatically, handwritten comments will not be taken into account. Tick marks on the questionnaire will not be evaluated! Only use a black or blue ballpoint pen of normal font thickness for your markings. The markings must be made clearly and accurately positioned by a cross. If you want to correct a tick, fill in the box completely, this mark will be evaluated as an empty box. Any further corrections are not possible!

#### Filling in the matriculation number:

At the beginning of the exam, enter your 8-digit matriculation number in the space provided on the answer sheet. Then transfer your matriculation number with crosses into the boxes below, numbered from 0 to 9. The first column corresponds to the 1st digit of your matriculation number, the second column corresponds to the 2nd digit of your matriculation number, etc.

**Good luck with the exam!**

## 1 Category: Image acquisition (8 Points) D

**Question: (1)** Computer vision deals, among other things, with the extraction of semantic information from images. (1 point, negative points: yes)

- (A) True (B) False

**Question: (2)** The imaging geometry of the pinhole camera is different from that of the thin lens model. (1 point, negative points: yes)

- (A) False (B) True

**Question: (3)** The lower the sensor resolution, the smaller the depth of field range. (1 point, negative points: yes)

- (A) False (B) True

**Question: (4)** A CCD image capture chip has active pixel sensors, each pixel can be read out individually, the voltage corresponding to the brightness is always applied. This sensor has a non-linear (logarithmic) output due to the independent observation of the neighbors of each pixel. (1 point, negative points: yes)

- (A) True (B) False

**Question: (5)** White Balancing is used to optimally adjust the brightness in the image. (1 point, negative points: yes)

- (A) True (B) False

**Question: (6)** Suppose an image is captured with a Bayer Pattern (Color Filter Array). There are 144 blue pixels. How many green pixels are there in the image? (1 point)

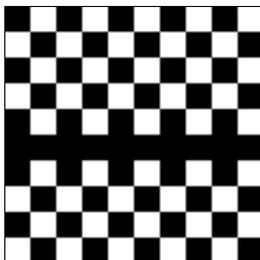
- (A) 144 (D) 576  
(B) 72 (E) 120  
(C) 160 (F) 288

**Question: (7)** For white balancing of an image, a white reference object is used and its color in the image is determined as  $R=0.6$ ,  $G=0.8$  and  $B=0.8$ . What is the color value of a pixel with the color value  $R=0.3$ ,  $G=0.5$ ,  $B=0.6$ ? (2 Points)

- (A)  $R=2, G=1.6, B=1.33$  (D)  $R=0.5, G=0.625, B=0.75$   
(B)  $R=0.3, G=0.7, B=0.75$  (E)  $R=0.5, G=0.7, B=0.8$   
(C)  $R=0.4, G=0.65, B=0.8$  (F)  $R=0.18, G=0.4, B=0.48$

## 2 Category: Image encoding and compression (12 Points) D

Given is the following 10x10 8-bit gray value image, where the white pixels have a gray value of 255 and the black pixels have a gray value of 0:



**Question: (8)** How much memory is needed to store all pixel values in uncompressed form? **(2 Points)**

- |              |              |
|--------------|--------------|
| (A) 10 Byte  | (F) 189 Byte |
| (B) 200 Byte | (G) 180 Byte |
| (C) 90 Byte  | (H) 100 Byte |
| (D) 181 Byte | (I) 182 Byte |
| (E) 192 Byte | (J) 89 Byte  |

**Question: (9)** How much memory is required for run-length encoding of all pixel values if 8 bits are used for each element of the run-length encoding? (Each line is encoded individually) **(2 Points)**

- |              |              |
|--------------|--------------|
| (A) 181 Byte | (F) 180 Byte |
| (B) 189 Byte | (G) 100 Byte |
| (C) 200 Byte | (H) 192 Byte |
| (D) 182 Byte | (I) 89 Byte  |
| (E) 10 Byte  | (J) 90 Byte  |

**Question: (10)** The degree of compression of a JPEG image depends, among other things, on the image content. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (11)** Vector image formats were specifically developed for high-resolution photographs. **(1 point, negative points: yes)**

- |          |           |
|----------|-----------|
| (A) True | (B) False |
|----------|-----------|

**Question: (12)** In JPEG, the discrete cosine transform is applied once to the whole image for encoding. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (13)** In JPEG, the values in the quantization matrix for low frequencies are smaller than those for high frequencies. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (14)** Radiometric resolution is described by the number of gray scale levels or bits. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (15)** Which of these terms describe lossy compression methods? (3 Points, negative points: yes, 3 correct answers)

- |                |                |
|----------------|----------------|
| (A) JPEG       | (D) Run-Length |
| (B) MPEG       | (E) MP3        |
| (C) Lempel Ziv | (F) Huffman    |

### 3 Category: Point operations (16 Points) D

In Figure 1 four functions are shown that represent different point operations. Assign the respective operation to the transformations and answer the following questions.

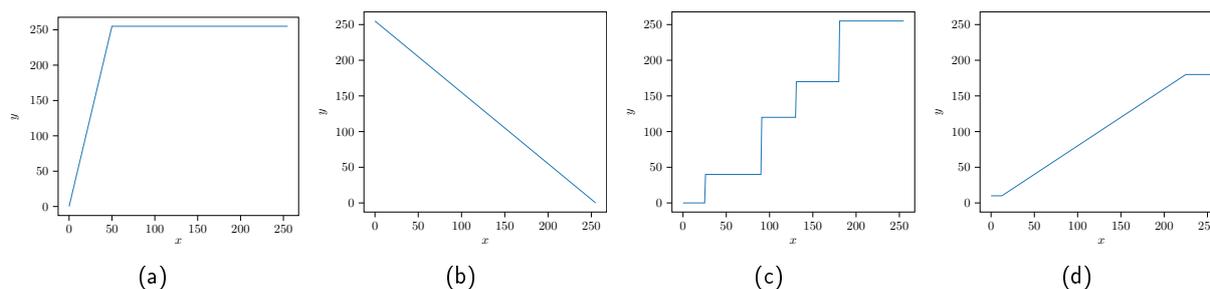


Figure 1: Question 16 - 19: Tranformations

**Question: (16)** Figure 1a describes a(n): (1 point)

- |                          |                         |
|--------------------------|-------------------------|
| (A) Inversion            | (C) Threshold operation |
| (B) Contrast enhancement | (D) Contrast reduction  |

**Question: (17)** Figure 1b describes a(n): (1 point)

- |                          |                        |
|--------------------------|------------------------|
| (A) Contrast enhancement | (C) Contrast reduction |
| (B) Threshold operation  | (D) Inversion          |

**Question: (18)** Figure 1c describes a(n): (1 point)

- |                          |                         |
|--------------------------|-------------------------|
| (A) Contrast enhancement | (C) Contrast reduction  |
| (B) Inversion            | (D) Threshold operation |

**Question: (19)** Figure 1d describes a(n): (1 point)

- |                          |                         |
|--------------------------|-------------------------|
| (A) Contrast enhancement | (C) Threshold operation |
| (B) Inversion            | (D) Contrast reduction  |

**Question: (20)** Assume an image whose brightness takes all values between  $[0, 255]$ . Which transformations, described by the Figures 1 a) - d) shown, reduce the range of values of the image? (2 Points, negative points: yes)

- |               |               |
|---------------|---------------|
| (A) Figure d) | (C) Figure c) |
| (B) Figure a) | (D) Figure b) |

**Question: (21)** Which of the transformations  $f_i$ , described by the Figures 1 a) - d) shown, are reversible, i.e. the original image can be exactly computed again by a function  $f_i^{-1}$ ? (2 Points, negative points: yes)

- |               |               |
|---------------|---------------|
| (A) Figure d) | (C) Figure c) |
| (B) Figure b) | (D) Figure a) |

**Question: (22)** Given the brightness histogram of an 8-bit image. Specify the coefficient  $k$  of the linear function  $f(x) = kx + d$  to maximize the contrast of the image. Let the minimum value of the image be  $x_{min} = 15$ , and the maximum value  $x_{max} = 160$ . **(2 Points)**

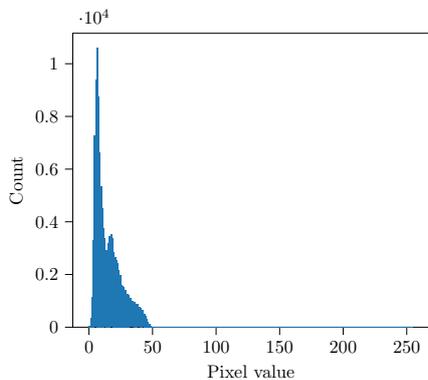
- (A) -1.15
- (B) 1.59
- (C) 0.68
- (D) -1.76
- (E) 1.76
- (F) 2.11

**Question: (23)** Given the brightness histogram of an 8-bit image. Specify the coefficient  $d$  of the linear function  $f(x) = kx + d$  to maximize the contrast of the image. Let the minimum value of the image be  $x_{min} = 15$ , and the maximum value  $x_{max} = 160$ . **(2 Points)**

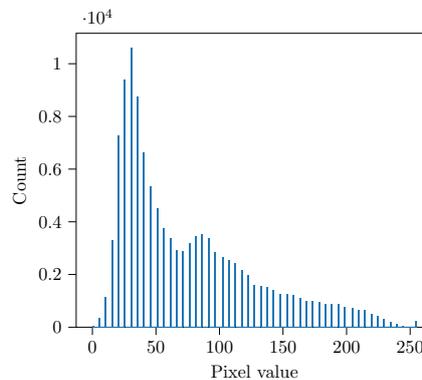
- (A) 11.20
- (B) -5.68
- (C) 5.68
- (D) -26.38
- (E) 15.00
- (F) 0

**Question: (24)** Which operation was used to transform the histogram (Figure 2)? **(2 Points)**

- (A) Contrast reduction
- (B) Contrast enhancement
- (C) Histogram equalization
- (D) Gamma correction



(a) Input



(b) Output

Figure 2: Question 24: Histogramm

**Question: (25)** Tick the correct statements regarding histogram equalization. **(2 Points, negative points: yes, 2 correct answers )**

- (A) The output values of the histogram are either 0 or 1.
- (B) The contrast is degraded at minima.
- (C) Histogram equalization especially spreads brightness values that are often contained in the image.
- (D) Histogram equalization uses gamma correction for contrast enhancement.

## 4 Category: Local operations and edge filters (24 Points) D

Given is a 5x5 grayscale image and a 3x3 mean filter kernel.

	0	1	2	3	4
0	50	50	50	50	50
1	100	100	75	50	50
2	100	100	<b>100</b>	50	50
3	100	100	100	50	50
4	50	50	50	50	50

$$F_{mean} = \frac{1}{9} * \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Figure 3: Question 26, 27, 28: Local operations

**Question: (26)** For the bold pixel (2,2) in Figure 3, calculate the result of applying the 3x3 mean filter (rounded to 2 decimal places). **(2 Points)**

- |           |           |
|-----------|-----------|
| (A) 80.56 | (F) 61.11 |
| (B) 58.33 | (G) 72.22 |
| (C) 83.33 | (H) 69.44 |
| (D) 63.88 | (I) 75    |
| (E) 100   | (J) 50    |

**Question: (27)** For the bold pixel (2,2) in Figure 3, calculate the result of applying a 3x3 median filter (rounded to 2 decimal places). **(2 Points)**

- |           |           |
|-----------|-----------|
| (A) 63.88 | (F) 72.22 |
| (B) 61.11 | (G) 69.44 |
| (C) 58.33 | (H) 100   |
| (D) 75    | (I) 50    |
| (E) 80.56 | (J) 83.33 |

**Question: (28)** Given are the Prewitt filters in x and y direction.

$$F_{Prewitt_x} = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}, \quad F_{Prewitt_y} = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} \quad (1)$$

Calculate the gradient for the bold pixel (2,2) in Figure 3. **(2 Points)**

- |                 |                  |
|-----------------|------------------|
| (A) (100, 100)  | (E) (-150, 25)   |
| (B) (-25, -125) | (F) (-100, 25)   |
| (C) (150, -75)  | (G) (150, -25)   |
| (D) (125, -50)  | (H) (-100, -100) |

**Question: (29)** Assume the gradient was (-1.6, 0.3). Calculate the edge strength. **(2 Points)**

- |            |           |
|------------|-----------|
| (A) -1.628 | (E) 1.628 |
| (B) -1.140 | (F) 1.140 |
| (C) 1.9    | (G) -0.65 |
| (D) 0.65   | (H) -1.9  |

Given is the following 8-bit gray scale image. Assign the 8 result images below to the respective image operation a)-h) that was applied to this image. Each image belongs to exactly one of the 8 image operations.



Question: (30) The following image is the result of? (2 Points)



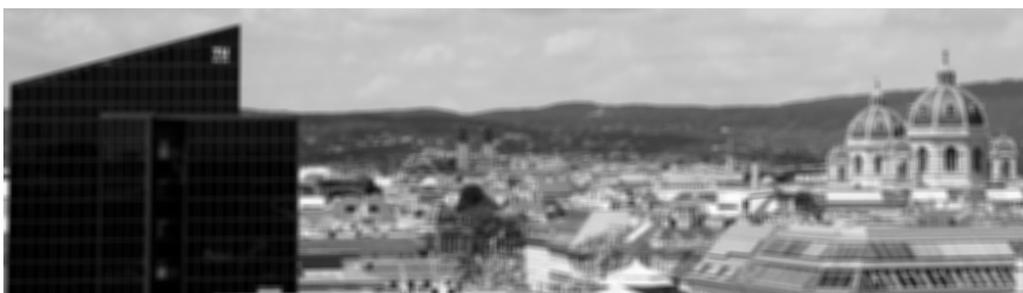
- |   |   |
|---|---|
| (A) 15x15 mean filter                                     | (E) 5x5 median filter                           |
| (B) Canny operator  | (F) Point operation: $I'(u, v) = 255 - I(u, v)$ |
| (C) Point operation: $I'(u, v) = 255 \cdot (I(u, v)/100)$ | (G) Quantization of gray values                 |
| (D) 7x7 mean filter                                       | (H) Sobel-y filter                              |

Question: (31) The following image is the result of? (2 Points)



- |   |   |
|---|---|
| (A) 5x5 median filter                           | (E) Point operation: $I'(u, v) = 255 \cdot (I(u, v)/100)$ |
| (B) Sobel-y filter                              | (F) 7x7 mean filter                                       |
| (C) Point operation: $I'(u, v) = 255 - I(u, v)$ | (G) 15x15 mean filter                                     |
| (D) Canny operator                              | (H) Quantization of gray values                           |

**Question: (32)** The following image is the result of? (2 Points)



- |   |   |
|---|---|
| (A) Sobel-y filter                              | (E) Quantization of gray values                           |
| (B) 7x7 mean filter                             | (F) Canny operator  |
| (C) Point operation: $I'(u, v) = 255 - I(u, v)$ | (G) Point operation: $I'(u, v) = 255 \cdot (I(u, v)/100)$ |
| (D) 5x5 median filter                           | (H) 15x15 mean filter                                     |

**Question: (33)** The following image is the result of? (2 Points)



- |   |                       |
|---|-----------------------|
| (A) Point operation: $I'(u, v) = 255 - I(u, v)$           | (E) 7x7 mean filter   |
| (B) Sobel-y filter  | (F) 15x15 mean filter |
| (C) Quantization of gray values                           | (G) Canny operator    |
| (D) Point operation: $I'(u, v) = 255 \cdot (I(u, v)/100)$ | (H) 5x5 median filter |

**Question: (34)** The following image is the result of? (2 Points)



- |   |   |
|---|---|
| (A) 5x5 median filter                                     | (E) 7x7 mean filter                             |
| (B) Quantization of gray values                           | (F) 15x15 mean filter                           |
| (C) Canny operator  | (G) Point operation: $I'(u, v) = 255 - I(u, v)$ |
| (D) Point operation: $I'(u, v) = 255 \cdot (I(u, v)/100)$ | (H) Sobel-y filter                              |

Question: (35) The following image is the result of? (2 Points)



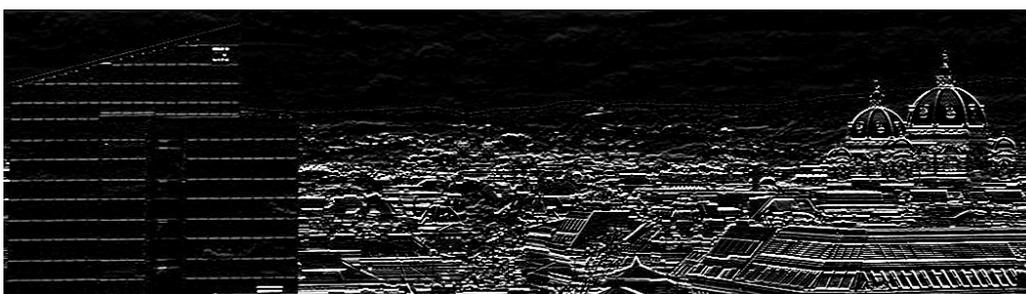
- (A) 7x7 mean filter
- (B) Sobel-y filter
- (C) Quantization of gray values
- (D) Canny operator
- (E) 15x15 mean filter
- (F) Point operation:  $I'(u, v) = 255 - I(u, v)$
- (G) Point operation:  $I'(u, v) = 255 \cdot (I(u, v)/100)$
- (H) 5x5 median filter

Question: (36) The following image is the result of? (2 Points)



- (A) 7x7 mean filter
- (B) Sobel-y filter
- (C) 15x15 mean value filter
- (D) Canny operator
- (E) Quantization of gray values
- (F) 5x5 median filter
- (G) Point operation:  $I'(u, v) = 255 - I(u, v)$
- (H) Point operation:  $I'(u, v) = 255 \cdot (I(u, v)/100)$

Question: (37) The following image is the result of? (2 Points)



- (A) Sobel-y filter
- (B) Canny operator
- (C) 15x15 mean filter
- (D) Point operation:  $I'(u, v) = 255 - I(u, v)$
- (E) 5x5 median filter
- (F) Quantization of gray values
- (G) Point operation:  $I'(u, v) = 255 \cdot (I(u, v)/100)$
- (H) 7x7 mean filter

## 5 Category: Color (8 Points) D

**Question: (38)** Less than 2 percent of all men are at least mildly colorblind. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (39)** The human eye is less sensitive to blue light than to red light. **(1 point, negative points: yes)**

- (A) False (B) True

**Question: (40)** The CMY color model is based on additive color mixing, that is why it is mainly used for printing, where ink is added to the paper. **(1 point, negative points: yes)**

- (A) False (B) True

**Question: (41)** The HSV and HSL color models are especially well suited to help humans describes colors. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (42)** The frequency of red light is higher than the frequency of blue light. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (43)** In the CIE 1931 XYZ model, the spectral colors are located along the u-shaped outer border. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (44)** The RGB color model is used for example in monitors. It assigns one coordinate to red green and blue, whereas  $[0, 0, 0]$  is white. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (45)** RGB to CMY conversion is done as follows:  $[C, M, Y] = [1, 1, 1] - [R, G, B]$ . **(1 point, negative points: yes)**

- (A) True (B) False

## 6 Category: Geometric transformations (12 Points) D

Let the matrices A, B and C be given:

$$A = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (2)$$

**Question: (46)** Which simple transformation is represented in matrix A in Equation 2? **(2 Points)**

- |  |   |
|--|---|
| (A) Rotation by $90^\circ$ around the y-axis | (E) Displacement around the vector $(1, -1, 0)^T$ |
| (B) Displacement about vector $(-1, 0, 1)^T$ | (F) Reflection around the xz-plane                |
| (C) Rotation by $90^\circ$ around z-axis     | (G) Reflection around the xy-plane                |
| (D) Rotation by $90^\circ$ around the x-axis | (H) Reflection around the yz-plane                |

**Question: (47)** Which simple transformation is represented in matrix B in Equation 2? **(2 Points)**

- |   |  |
|---|--|
| (A) Rotation by $90^\circ$ around the x-axis      | (E) Reflection around the xy-plane               |
| (B) Rotation by $90^\circ$ around the y-axis      | (F) Rotation by $90^\circ$ around the z-axis     |
| (C) Displacement around the vector $(1, -1, 0)^T$ | (G) Translation around the vector $(-1, 0, 1)^T$ |
| (D) Reflection around the yz-plane                | (H) Reflection around the xz-plane               |

**Question: (48)** Which simple transformation is represented in matrix C in Equation 2? **(2 Points)**

- |   |  |
|---|--|
| (A) Displacement around vector $(-1, 0, 1)^T$ | (E) Rotation by $90^\circ$ around the x-axis |
| (B) Rotation by $90^\circ$ around the y-axis  | (F) Reflection around the xy-plane           |
| (C) Reflection around the yz-plane            | (G) Translation around vector $(1, -1, 0)^T$ |
| (D) Reflection around the xz-plane            | (H) Rotation by $90^\circ$ around the z-axis |

Assume transformation matrices  $T(t_x, t_y)$ ,  $R(\theta)$ ,  $S(s_x, s_y)$ , representing translation, rotation and scaling respectively. Which of the following statements are correct?

**Question: (49)** To rotate an object around the point  $(x, y)$  by the angle  $\theta$ , the matrices can be concatenated as follows:  $M(x, y, \theta) = T(-x, -y) \cdot R(\theta) \cdot T(x, y)$ . **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (50)**  $T(x, y) \cdot T(-x, -y) = T(0, 0)$  applies. **(1 point, negative points: yes)**

- |          |           |
|----------|-----------|
| (A) True | (B) False |
|----------|-----------|

**Question: (51)**  $R^{-1}(\theta) = R(\theta^{-1})$  applies. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (52)**  $S^{-1}(x, y) = S(1/x, 1/y)$  applies. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (53)** All affine transformations can be composed of rotation, translation and scaling. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

**Question: (54)** For translation in 2-dimensional space,  $2 \times 2$  matrices are needed. **(1 point, negative points: yes)**

- |           |          |
|-----------|----------|
| (A) False | (B) True |
|-----------|----------|

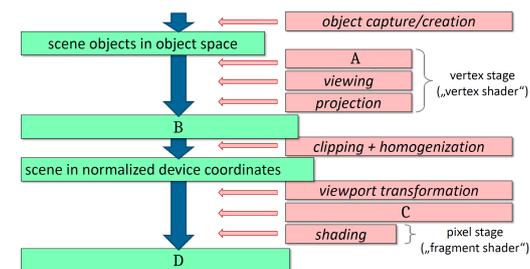


Figure 4: Grafikpipeline

## 7 Category: Graphics pipeline (14 Points) D

**Question: (55)** Which step of the rendering pipeline is A in Figure 4. (2 Points)

- (A) Vector image in RGB color space
- (B) Transformed points in clip space
- (C) Vertices in world coordinates
- (D) Rasterization
- (E) Homogenization
- (F) Modeling transform
- (G) Raster image in pixel coordinates
- (H) Ray tracing

**Question: (56)** Which step of the rendering pipeline is B in Figure 4. (2 Points)

- (A) Rasterization
- (B) Vector image in RGB color space
- (C) Homogenization
- (D) Ray tracing
- (E) Raster image in pixel coordinates
- (F) Vertices in world coordinates
- (G) Transformed points in clip space
- (H) Modeling transform

**Question: (57)** Which step of the rendering pipeline is C in Figure 4. (2 Points)

- (A) Transformed points in clip space
- (B) Vector image in RGB color space
- (C) Ray tracing
- (D) Modeling transform
- (E) Rasterization
- (F) Raster image in pixel coordinates
- (G) Homogenization
- (H) Vertices in world coordinates

**Question: (58)** Which step of the rendering pipeline is D in Figure 4. (2 Points)

- (A) Ray tracing
- (B) Transformed points in clip space
- (C) Raster image in pixel coordinates
- (D) Homogenization
- (E) Rasterization
- (F) Vertices in world coordinates
- (G) Modeling transformation
- (H) Vector image in RGB color space

**Question: (59)** Every node in an octree has exactly 8 children. (1 point, negative points: yes)

- (A) False
- (B) True

**Question: (60)** Set operations can be computed easily due to the structure of octrees. (1 point, negative points: yes)

- (A) False
- (B) True

**Question: (61)** To apply geometric transformations, octrees often need to be rebuilt completely. (1 point, negative points: yes)

- (A) False
- (B) True

**Question: (62)** The intersection of two elements in a CSG tree can be inconsistent (i.e. can contain holes in the surface). **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (63)** The exact representation of objects in a CSG tree makes the memory consumption of such data structures enormous. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (64)** For rendering CSG objects ray casting is used, where for every pixel in the viewing direction a ray is cast which is intersect with every object in the scene. **(1 point, negative points: yes)**

- (A) True (B) False

## 8 Category: Rasterization (18 Points) D

**Question: (65)** Assume the following triangle in 2D space:  $P_0 = (3, 2)$ ,  $P_1 = (1, -3)$ ,  $P_2 = (-3, -1)$  as well as the point  $P = (1, 1)$ . Which statements are correct? **(12 Points, negative points: yes, 4 correct answers)**

- (A) P lies on an edge of the triangle. (E) A pixel with coordinates P has to be treated individually.  
 (B) A pixel at P would belong inside the triangle because  $(0 < \alpha < 1, 0 < \beta < 1, 0 < \gamma < 1)$ . (F) A pixel at P would belong outside the triangle because  $(0 < \alpha < 1, 0 < \beta < 1, 0 < \gamma < 1)$  verletzt ist.  
 (C) The weighted center of the triangle is  $(\frac{1}{3}, -\frac{2}{3})$ . (G) The weighted center of the triangle is  $(\frac{1}{3}, \frac{2}{3})$ .  
 (D) P is the weighted center of the triangle. (H) The weighted center of the triangle is  $(1, -1)$ .

**Question: (66)** The DDA algorithm only uses integer arithmetic. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (67)** The Bresenham algorithm is hard to apply to curves like circles and ellipses. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (68)** The Bresenham algorithm produces the same result as the DDA algorithm. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (69)** A polygon is called convex when all inner angles are less than  $180^\circ$  otherwise it is called concave. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (70)** The Nonzero-Winding-Number rule is used to determine if a surface is inside or outside a closed curve. **(1 point, negative points: yes)**

- (A) True (B) False

**Question: (71)** The All-In rule is the most used rule for polygon filling. **(1 point, negative points: yes)**

- (A) True (B) False

## 9 Category: Viewingpipeline (8 Points) D

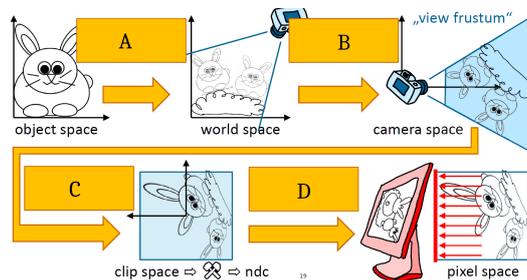


Figure 5: Viewingpipeline

**Question: (72)** Which step of the viewing pipeline is A in Figure 5. (2 Points)

- |                             |                             |
|-----------------------------|-----------------------------|
| (A) Viewport transformation | (E) Shading transformation  |
| (B) Object creation         | (F) Clipping transformation |
| (C) Camera transformation   | (G) Modeling transformation |
| (D) Project transformation  | (H) Raster transformation   |

**Question: (73)** Which step of the viewing pipeline is B in Figure 5. (2 Points)

- |                             |                             |
|-----------------------------|-----------------------------|
| (A) Project transformation  | (E) Modeling transformation |
| (B) Viewport transformation | (F) Camera transformation   |
| (C) Shading transformation  | (G) Object creation         |
| (D) Raster transformation   | (H) Clipping transformation |

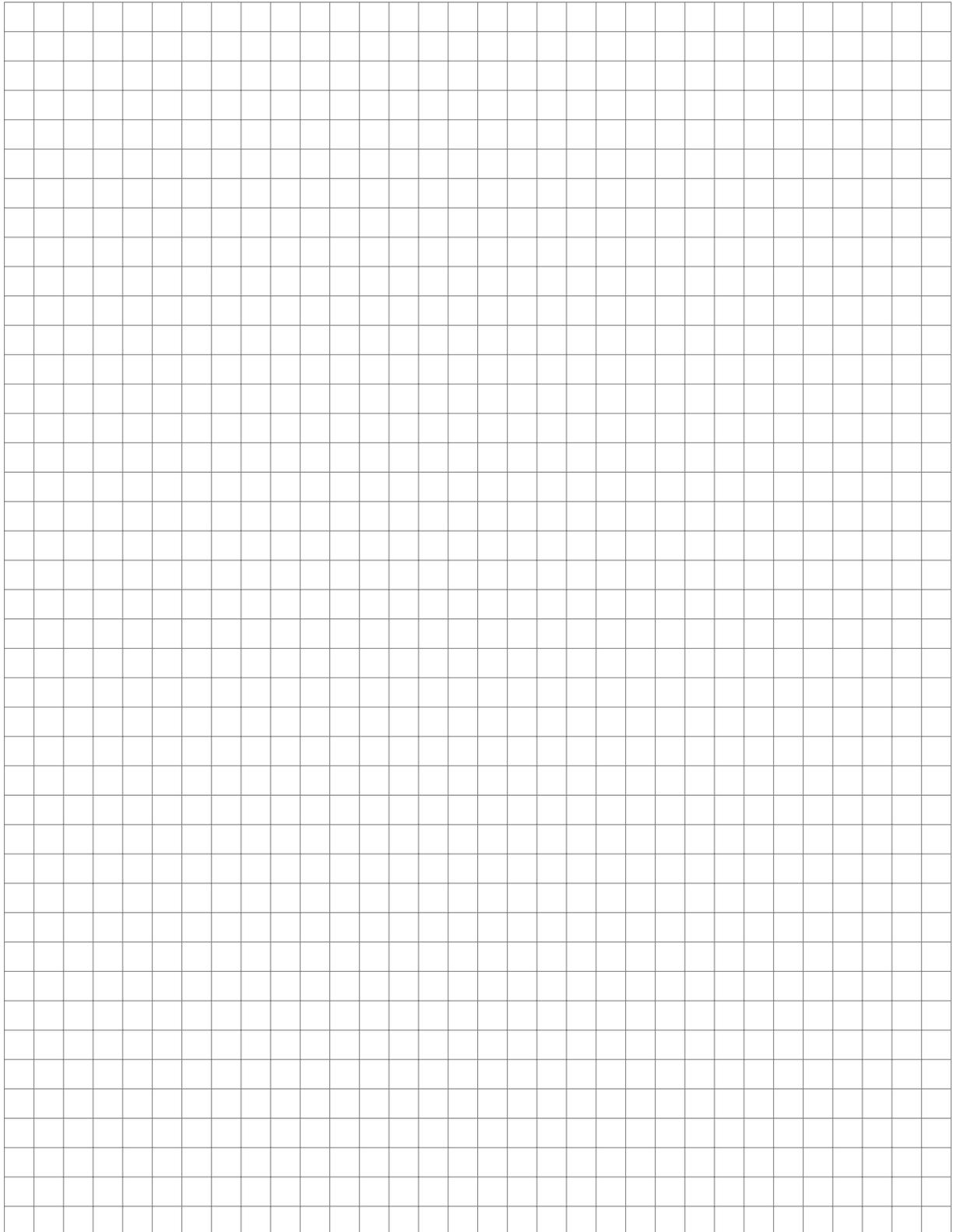
**Question: (74)** Which step of the viewing pipeline is C in Figure 5. (2 Points)

- |                             |                             |
|-----------------------------|-----------------------------|
| (A) Object creation         | (E) Project transformation  |
| (B) Viewport transformation | (F) Modeling transformation |
| (C) Raster transformation   | (G) Shading transformation  |
| (D) Clipping transformation | (H) Camera transformation   |

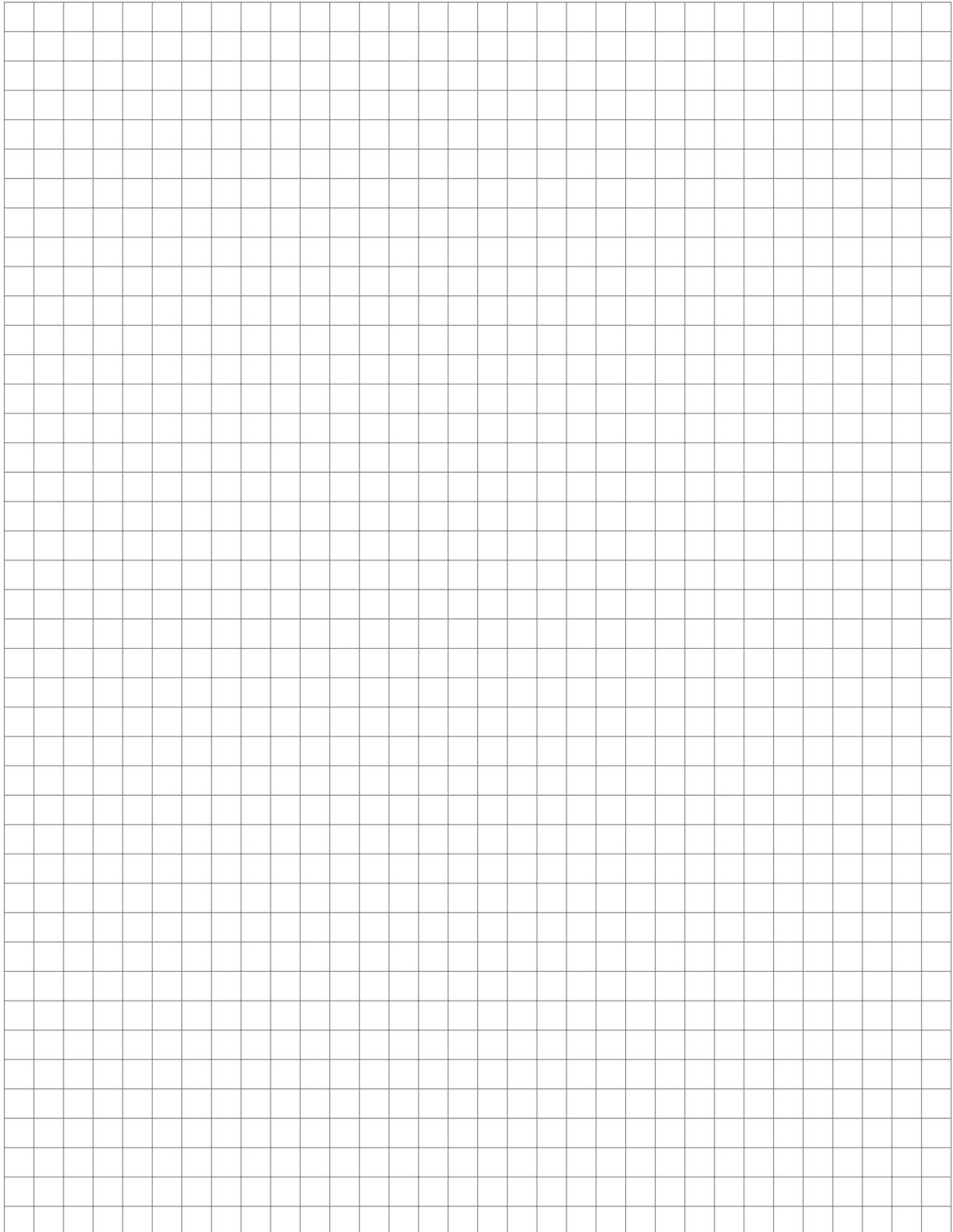
**Question: (75)** Which step of the viewing pipeline is D in Figure 5. (2 Points)

- |                             |                             |
|-----------------------------|-----------------------------|
| (A) Raster transformation   | (E) Project transformation  |
| (B) Object creation         | (F) Camera transformation   |
| (C) Modeling transformation | (G) Clipping transformation |
| (D) Shading transformation  | (H) Viewport transformation |

For calculations:



For calculations:



# Antwortbogen

Zur automatischen Prüfungsauswertung

Vorname:
Nachname:
Unterschrift:

Saalaufsicht
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Matrikelnummer

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0	<input type="checkbox"/>	0								
1	<input type="checkbox"/>	1								
2	<input type="checkbox"/>	2								
3	<input type="checkbox"/>	3								
4	<input type="checkbox"/>	4								
5	<input type="checkbox"/>	5								
6	<input type="checkbox"/>	6								
7	<input type="checkbox"/>	7								
8	<input type="checkbox"/>	8								
9	<input type="checkbox"/>	9								

Gruppe: A  B  C  D  E  F

Dieser Antwortbogen wird maschinell gelesen. Bitte nicht falten, nicht knicken und nicht beschmutzen. Verwenden Sie zum Markieren einen blauen oder schwarzen Kugelschreiber von normaler Stärke. Bitte markieren Sie sorgsam durch Ankreuzen:



Nur deutlich erkennbare positionsgenaue Markierungen werden ausgewertet! Wenn Sie eine Ankreuzung korrigieren möchten, füllen Sie das Kästchen mit der Falsch-Markierung mit Ihrem Stift vollkommen aus, dadurch wird diese Ankreuzung wie ein leeres Kästchen gewertet:



Ausstreichungen können nicht noch mal korrigiert werden. Markierungen und Beschriftungen außerhalb der Kästchenfelder können die Auswertung behindern.

a b c d e f g h i j

1)

2)

3)

4)

5)

6)

7)

8)

a b c d e f g h i j

9)

10)

11)

12)

13)

14)

15)

16)

a b c d e f g h i j

17)

18)

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21)

22)

23)

24)

a b c d e f g h i j

25)

26)

27)

28)

29)

30)

31)

32)

a b c d e f g h i j

33)

34)

35)

36)

37)

38)

39)

40)

a b c d e f g h i j

41)

42)

43)

44)

45)

46)

47)

48)



# Antwortbogen

Zur automatischen Prüfungsauswertung

Vorname:
Nachname:
Unterschrift:

Saalaufsicht
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Matrikelnummer

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0	<input type="checkbox"/>	0								
1	<input type="checkbox"/>	1								
2	<input type="checkbox"/>	2								
3	<input type="checkbox"/>	3								
4	<input type="checkbox"/>	4								
5	<input type="checkbox"/>	5								
6	<input type="checkbox"/>	6								
7	<input type="checkbox"/>	7								
8	<input type="checkbox"/>	8								
9	<input type="checkbox"/>	9								

Gruppe: A  B  C  D  E  F

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Ausstreichungen können nicht noch mal korrigiert werden. Markierungen und Beschriftungen außerhalb der Kästchenfelder können die Auswertung behindern.

a b c d e f g h i j

49)

50)

51)

52)

53)

54)

55)

56)

a b c d e f g h i j

57)

58)

59)

60)

61)

62)

63)

64)

a b c d e f g h i j

65)

66)

67)

68)

69)

70)

71)

72)

a b c d e f g h i j

73)

74)

75)

