



WRITTEN EXAM
February 13, 2017

Family Name: _____ First Name(s): _____

Immatr.No.: _____ Signature: _____

- Please write your name and immatriculation number onto every exam sheet.
- You may not use anything else than a pen, a ruler, and a set square.
- Do not use pencils or red colour.
- You may not use any calculator.
- Please provide your answers in the designated spaces.
- If you need more space, use the back side of the paper. Indicate this on the front!
- You can find blank paper at the end. Indicate on a task's page if you have used that.
- You may answer in English or German.
- Answers will be graded only if they provide adequate explanations and a detailed approach.
- Crossed- or hatched-out answers will not be graded.
- If you provide multiple alternative answers, the one achieving the least points will be graded.
- **Good luck!**

Task:	1	2	3	4	5	6	7	8	9	Total
Points:	10	10	10	12	12	12	10	12	12	100
Score:										

45 points or more are required for passing the exam.
90 points or more are required for achieving the best grade.

Final Grade: _____ Examiner: _____

Review:

Date: _____ Student: _____ Supervised: _____

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2. (10 Points) **Depth Cues**

(a) (3 Points) Describe how *stereo vision* serves as a depth cue.

(b) (2 Points) Describe how *accomodation* serves as a depth cue.

(c) (5 Points) Describe how *(con)vergence* and *accomodation* can interfere with each other in a virtual environment.

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3. (10 Points) **Field of View**

(a) (4 Points) Characterize a human's field of view at eye level:

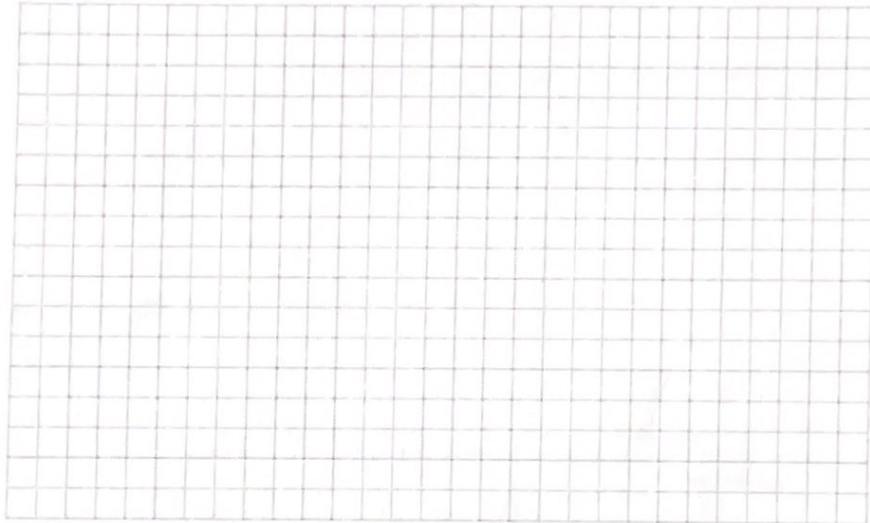
Horizontal: _____

Vertical: _____

Horizontal stereoscopic field: _____

(b) (6 Points) Discuss the *fields of view* and the *fields of regard*

- in a CAVE and
- in an HMD.



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4. (12 Points) Illumination, Shading

- (a) (6 Points) Name and describe the individual components of the Phong *reflection model*. For each component, give and explain the respective term of the overall equation.

- (b) (2 Points) Which *shading model(s)* support(s) specular highlights inside polygons?

- Flat shading
- Gouraud shading
- Phong shading

- (c) (4 Points) Compare Gouraud and Phong *shading* in terms of the number of computations to be done.

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5. (12 Points) **Technology**

- (a) (4 Points) Discuss the pros and cons of *passive stereo with polarization* and *active stereo with shutter glasses* in a projector-based VR system.

- (b) (3 Points) Compare *polarization* and *INFITEC* in terms of their colour fidelity. State why is there a difference, if one exists.

- (c) (5 Points) Compare and discuss the different requirements and results with respect to the *gain* of the screen material for *passive stereo with polarization* and *active stereo with shutter glasses*.

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7. (10 Points) **Photometry**

- (a) (2 Points) Compute an approximation of the solid angle Ω that a projection screen (4 m by 3 m) spans with respect to the projector. Let the screen be placed 6 m in front of the projector, with the projector shining orthogonally onto the screen's center.

- (b) (4 Points) In which units are the "brightness levels" of projectors and monitors specified? Comment on why there is a difference, if one exists.

- (c) (4 Points) Consider the following equation for computing the illuminance E_v at a surface patch with area A and a given luminous intensity I_v of a light source:

$$E_v = \frac{I_v \Omega}{A}$$

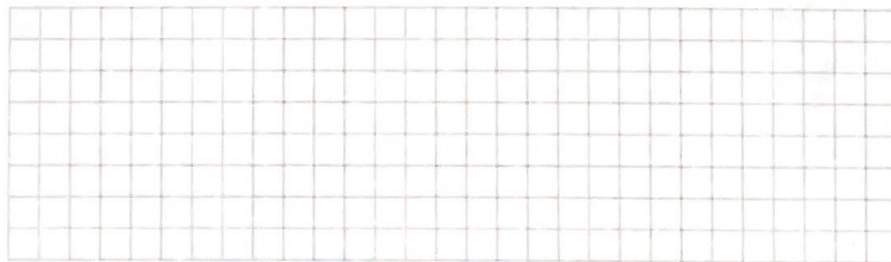
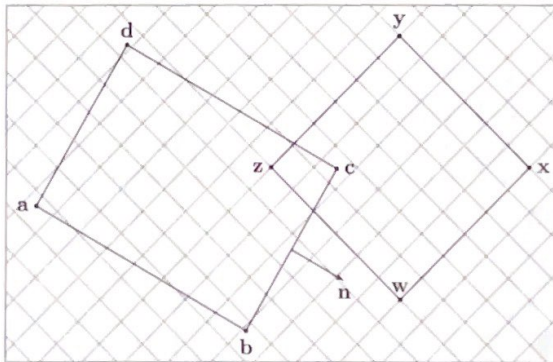
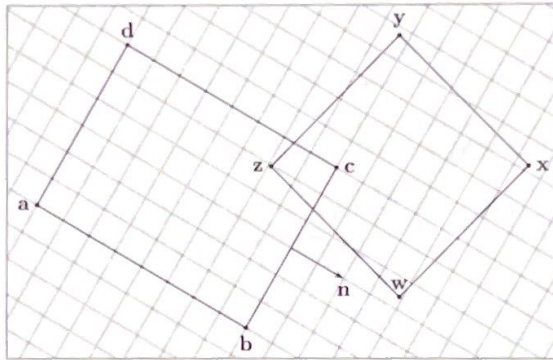
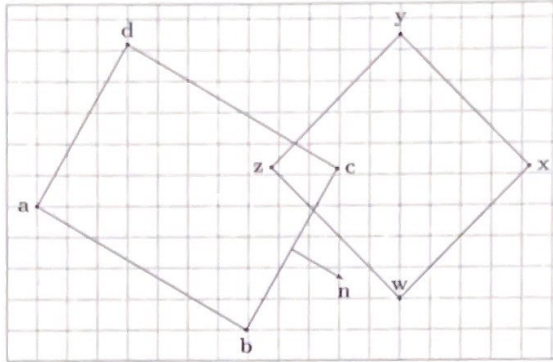
How is this equation related to the Phong reflection model?

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8. (12 Points) Collision Detection

- (a) (5 Points) Consider two oriented bounding boxes a, b, c, d and w, x, y, z . Conduct an overlap-test with respect to the normal n (arrow) on face b, c . Choose the most sensible figure to construct the test. Comment on the steps you take.



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- (b) (3 Points) How many axis tests need to be performed at most when testing two OOBs for intersection in 3D. Justify your answer.

A large grid for writing the answer to question (b). The grid is approximately 20 columns wide and 20 rows high.

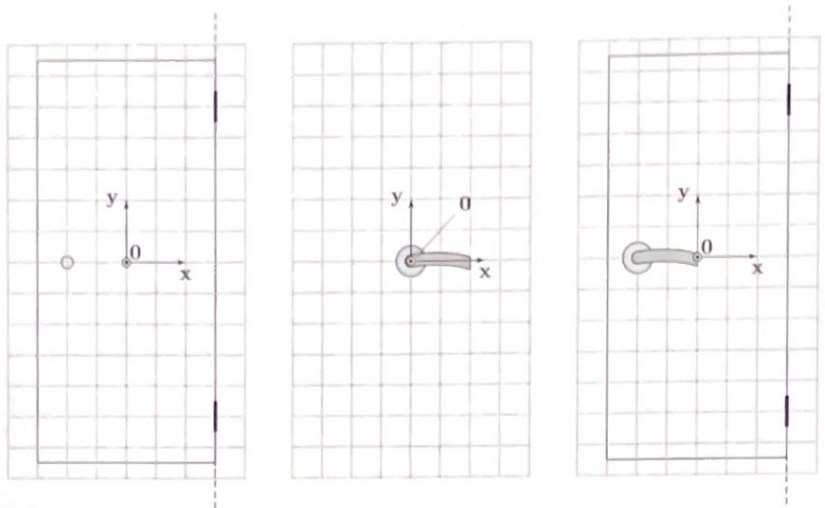
- (c) (4 Points) Describe the terms "broad phase" and "narrow phase", and their distinctions. Take into account the types of objects that are checked in each phase.

A large grid for writing the answer to question (c). The grid is approximately 20 columns wide and 20 rows high.

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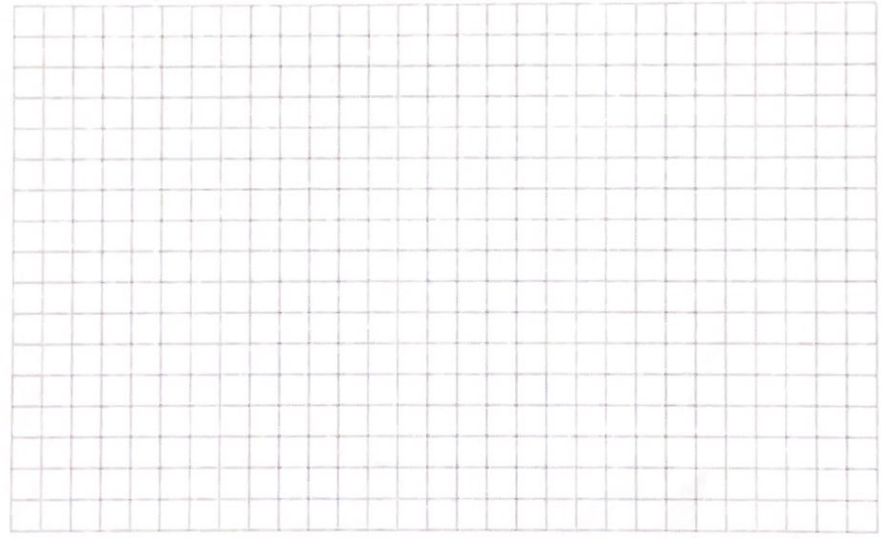
9. (12 Points) **Transformation, Scene Graph**

Consider a model of a door (left), a model of a handle (middle), each in their local coordinate space, and the final scene (right), i.e., the complete door:



1 square = 1 unit. Matrices shall multiply column vectors. Do not compute the result of any matrix product. The z-axis is pointing towards you.

(a) (4 Points) List the individual transformation steps in their correct order that are required to open/close the door with respect to its hinges (dashed line). Construct the matrix **D** that applies this transformation.

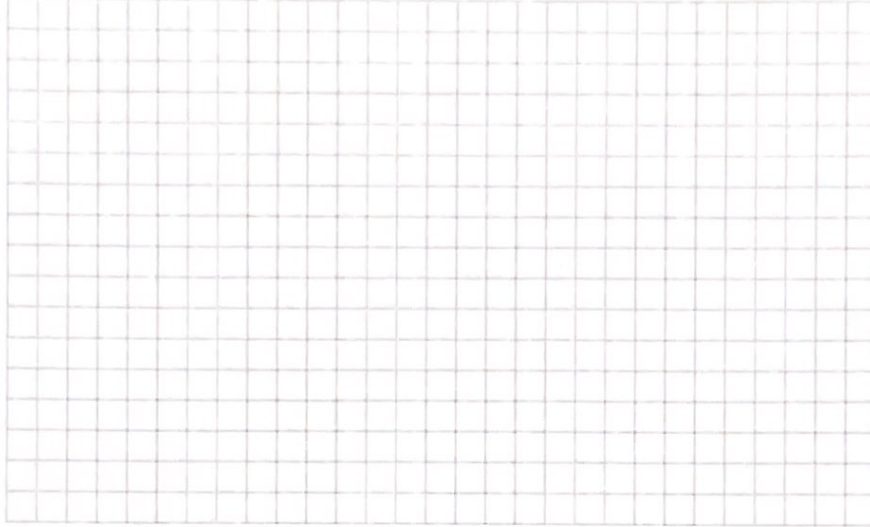


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- (b) (4 Points) List the individual transformation steps in their correct order that are required to push the handle and to bring it to its intended position on the door. Construct the matrix \mathbf{H} that applies this transformation.



- (c) (4 Points) Construct a scene graph that creates a usable door from the individual parts.

