2025 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test

Media Engineering	**Answer Sheets**	**Examinee's number**

Compulsory Question (State your choice of words and their numbers in your answer.)

No. (1) technical term: Image binarization

With respect to Image binarization, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (2) technical term: Hough transform

With respect to Hough transform, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (3) technical term: Histogram equalization

With respect to Histogram equalization, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (4) technical term: Lowpass filter

With respect to Lowpass filter, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (5) technical term: Bilateral filter

With respect to Bilateral filter, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (6) technical term: Error diffusion

With respect to Error diffusion, request a comprehensive explanation of each method, its advantages and disadvantages, and applications, etc.

No. (7) technical term: Visual hull

With respect to Visual hull, request a comprehensive explanation of each method, its advantages and disadvantages,and applications, etc.

No. (8) technical term: Fine-tuning

This question assesses the understanding of the purpose and method of fine-tuning as a technique for adapting pretrained models, such as large language models, to specific tasks.

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Compulsory Question (State your choice of words and their numbers in your answer.)

No. (9) technical term Cosine similarity

This question assesses the understanding of the definition and characteristics of cosine similarity as a metric for measuring semantic similarity between word or document vectors.

No. (10) technical term Hypertext

This question assesses the understanding of the mechanism of hypertext as a structure, which enables flexible linking and referencing of information, and its application to the Web.

No. (11) technical term: Avatar

With respect to avatars, request a comprehensive explanation of their definition, specific applications, and how they function as user proxies and contribute to social interaction.

No. (12) technical term: Metaverse

With respect to the metaverse, request a comprehensive explanation of its definition, specific applications, and the value and possibilities it offers through its use.

No. (13) technical term: Social touch

With respect to social touch, request a comprehensive explanation of its definition, its importance in interpersonal communication, and how it contributes to relationship-building and emotional sharing.

No. (14) technical term: Ray tracing

With respect to ray tracing, request a comprehensive explanation of the method, its advantages and disadvantages, and applications.

No. (15) technical term: Style transfer

With respect to style transfer, request a comprehensive explanation of the method, related works, and applications.

No. (16) technical term: Digital fabrication

With respect to digital fabrication, request a comprehensive explanation of the method, related works, and applications.

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Compulsory Question (State your choice of words and their numbers in your answer.)

No. (17) technical term: Octree

With respect to Octree, request a comprehensive explanation of each method, its advantages and disadvantages,and applications, etc.

No. (18) technical term: Projection of 3D body onto 2D plane

This question requires a systematic classification of the types of projection, the name of each projection method, the characteristics of the individual projection methods and a description of the fields of use and the method of use based on them.

No. (19) technical term: Developable surface

This question requires to list the types of developable surfaces, explain the conditions under which a curved surface can be developed into a flat surface, using basic terms such as ruled surface - double curved surface, and describe the use and usefulness of developable surfaces in design.

No. (20) technical term: Gravitational potential and stability

This question requires a quantitative indication of the relationship between gravity and potential, an enumeration of the types of stability, and a description based on the relationship of restoring forces expressed in terms of gravity potentials for each type of stability.

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Elective Question [Question No.: 1]

[1] **Model answers (Desired Content of Answers):**

1) The Fourier transform is a method for examining the frequency characteristics of a signal. The frequency characteristics of an image can also be examined by performing a Fourier transform on the two-dimensional signal of the image. The content carefully explains the correspondence between the information on the frequency characteristics of the image represented in the frequency space by the Fourier transform and the image information possessed by the image before the frequency transform.
2) $G_{kl} = F_{kl}H_{kl}$
3) Mask processing using a linear filter is a convolution process in the image space. In other words, it is necessary to calculate the sum-of-products of the mask size for each pixel. On the other hand, this masking process by the linear filter is a simple multiplication in the frequency space. Based on this, the content discusses the processing time, especially when the mask size is large. In image restoration, it is also necessary to find the inverse matrix for inverse filtering in image space. The size of the matrix and the amount of computation at that time are explained. On the other hand, how this image restoration process can be performed in the frequency space and the amount of computation are explained. The contents are organized and the advantages of performing the process in the frequency space are discussed.

[2] **Model answers (Desired Content of Answers):**

1) Sampling and quantization
2) A detailed explanation of what sampling is. In particular, how the sampling interval during the sampling process changes the digital image obtained. The answer also discusses the appropriate sampling interval, based on the sampling theorem.

Do not write on the back side of this answer sheet, or your answers will not be marked.

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Media Engineering	**Answer Sheets**	**Examinee's number**

Elective Question [Question No.: 2]

[**1**] If α and β are real numbers, point P is the intersection of two lines in the figure, so the coordinates (x, y, z) of P are expressed as follows:

$$\overrightarrow{OP} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \alpha \begin{pmatrix} X_R \\ Y \\ -f \end{pmatrix} = \begin{pmatrix} -l \\ 0 \\ 0 \end{pmatrix} + \beta \begin{pmatrix} X_L \\ Y \\ -f \end{pmatrix}.$$

In this case $\alpha = \beta = l/(X_L - X_R)$, and substituting this into the above equation, we obtain the following equations:

$$x = \frac{lX_R}{X_L - X_R}, \quad y = \frac{lY}{X_L - X_R}, \quad z = -\frac{lf}{X_L - X_R}$$

[**2**] It is known that when the light source is in a general position, the isobrightness lines of the reflectance map are hyperbolic, and the distribution of the isobrightness lines also changes when the illumination direction changes. Therefore, when there are two images with different illumination directions, multiple intersections between the two isobrightness lines appear, whereas when there are three images with different illumination directions, only one intersection is determined. Hence three images with different illumination directions are needed to recover the surface direction.

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Media Engineering	**Answer Sheets**	**Examinee's number**

Elective Question [Question No.: 3]

[1] Web Page Search

1) The transition probability matrix M (rows: destination, columns: source):

$$M = \begin{bmatrix} 0 & \frac{1}{3} & 0 & \frac{1}{2} & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{3} & 0 & 0 & 1 \\ 0 & \frac{1}{3} & 0 & 0 & 0 \\ 0 & 0 & 1 & \frac{1}{2} & 0 \end{bmatrix}$$

2) At the initial state (time $t = 0$), the user is viewing page n_1: $\vec{p}_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \end{bmatrix}^{\mathsf{T}}$.
After one step: $\vec{p}_1 = M \cdot \vec{p}_0 = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \end{bmatrix}^{\mathsf{T}}$,
and then after two steps: $\vec{p}_2 = M \cdot \vec{p}_1 = \begin{bmatrix} \frac{1}{3} & 0 & \frac{1}{3} & \frac{1}{3} & 0 \end{bmatrix}^{\mathsf{T}}$.
Therefore:

$$\vec{p}_2 = \left(\frac{1}{3},\ 0,\ \frac{1}{3},\ \frac{1}{3},\ 0 \right)^T$$

3) The PageRank algorithm evaluates the importance (score) of web pages based on the random surfer model. A random surfer browses the web by following links from the current page to another. By repeatedly simulating these probabilistic transitions, we can calculate a steady-state distribution indicating how frequently each page is visited, and this is used as a measure of importance. To prevent bias from closed loops or disconnected components, a damping factor is introduced, allowing the surfer to randomly jump to any page with a certain probability. This ensures stable scores for all pages.

[2] Web Page AI Applications

1) Distributed word representation refers to a method where each word is represented as a high-dimensional continuous-valued vector, where semantically similar words are located close to each other in the vector space. This enables numerical handling of semantic relationships between words and improves the performance of many Natural Language Processing (NLP) tasks such as classification and translation. Techniques such as Word2Vec (CBOW, Skip-gram) and GloVe use neural networks or matrix factorization to obtain these vectors based on the context of words.
2) BERT uses only the encoder part of the Transformer and is a bidirectional model. It processes the entire input sentence at once and captures the meaning of each word by considering the context both before and after at the same time. It is mainly used for natural language understanding tasks such as text classification, question answering, and semantic analysis. In contrast, GPT uses only the decoder part of the Transformer and is a unidirectional model. It processes text from left to right, predicting the next word using only previous information. It excels in generation tasks such as text generation and dialogue. Thus, BERT is a "bidirectional encoder model," while GPT is an "autoregressive decoder model," each designed for different design concepts and application areas.
3) Hallucination in LLMs refers to the phenomenon where the model generates information that is not factually correct or does not exist, yet presents it as if it were true. This occurs because LLMs are probabilistic generative models that generate output that appears grammatically natural and plausible, without necessarily verifying the truthfulness of the output. For example, the model may convincingly cite non-existent academic papers or describe in detail people or products that do not actually exist.

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Media Engineering	Answer Sheets	Examinee's number

Elective Question [Question No.: 4]

[1]

1) AABB
2) In the case of two rectangular regions:

```
function intersect(a, b) {
  return (
    a.minX <= b.maxX &&
    a.maxX >= b.minX &&
    a.minY <= b.maxY &&
    a.maxY >= b.minY &&
    a.minZ <= b.maxZ &&
    a.maxZ >= b.minZ
  );
}
```

3) When an object moves at high speed, it may pass through the thickness of a wall within a single frame and end up on the other side without detecting a collision.
4) In physics-based animation, it is necessary not only to detect collisions but also to calculate the point of collision and determine the behavior of the object after the collision. This process is called collision response.

[2]

1) Non-Photorealistic Rendering
   Abbreviated as NPR. Terms such as toon shading, stylized rendering, and stylization also refer to NPR or specific techniques within it, despite slight differences. While realistic rendering techniques like ray tracing are referred to as photorealistic rendering, NPR is a general term for techniques that generate non-photorealistic images. These include expressions that mimic traditional media such as oil painting and watercolor, styles similar to anime and illustrations, and techniques used for visualization or visual emphasis for specific purposes. In painterly approaches, the synthesis of brush strokes based on the medium is often fundamental. In such techniques, maintaining frame-to-frame coherence becomes an issue when generating animations, potentially causing visual flickering. It is desirable to mention as many related topics as possible.
2) Global Illumination Calculation
   A lighting calculation that considers not only direct light but also indirect light resulting from interreflections between surrounding objects. Also referred to as global illumination. It is desirable to include as many related concepts as possible.
3) Triangulation
   The process of dividing an arbitrary shape into triangles. Delaunay triangulation is commonly used. However, Delaunay triangulation does not always allow creating boundaries exactly where desired, and since it does not distinguish between the inside and outside of contours, constrained Delaunay triangulation is used when applying it to specific regions. The Voronoi diagram is a dual structure to Delaunay triangulation. It is desirable to mention as many related topics as possible.

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Media Engineering	Answer Sheets	Examinee's number

Elective Question [Question No.: 5]

[1] This question requires examinees to explain how "reality" is perceived in VR by illustrating the sequential processing stages from sensory input to subjective experience. Examinees are expected to clearly present this process using a flowchart or diagram with arrows, showing each stage in order. Each stage's role and function should be explained from a specialized perspective. Key processing stages include:

(1) Generation and presentation of sensory stimuli,

(2) Reception by sensory organs,

(3) Transmission of information through the nervous system,

(4) Perceptual integration and interpretation in the brain.

Examinees are expected to logically and systematically describe how each stage collaborates with each other to construct a subjective experience of reality in VR, using appropriate technical terminology and conceptual understanding.

[2]

A. Examinees are expected to clearly define each of the following concepts –"transformation", "alter ego", and "fusion"– as forms of novel embodiment enabled through avatars. These definitions should be grounded in both social and technological perspectives. For example, "transformation" may involve visual or functional changes into another being; "alter ego" may refer to expressing multiple selves in parallel; and "fusion" may involve forming a single entity through integration with others.

B. Based on the definitions above, examinees should provide one concrete example for each concept and explain why each example corresponds to the given concept. In addition, they should discuss how each example is useful to users, such as by enhancing self-expression, enabling collaborative experiences, or expanding social connectedness in virtual environments. Logical and concise explanations are expected.

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Elective Question [Question No.: 7]

[1]

1) On the left side of the sluice, the x and y axes are horizontal and perpendicular to gravity, respectively, so $\partial p/\partial x = \partial p/\partial y = 0$. This means that the pressure acting on the face of the sluice changes only in the z direction then $\partial p/\partial z = \mathrm{d}p/\mathrm{d}z = -\rho g$.
2) The pressure on the left face of the sluice is $p = \int_0^H (\mathrm{d}p/\mathrm{d}z)\,\mathrm{d}z = -\rho g z + C$ and $p(H) = p_a$ at $z = H$ on the water surface, so $C = \rho g H + p_a$. Therefore, $p(z) = \rho g(H - z) + p_a$.
3) Since the right-hand face of the sluice is uniformly $p = p_a$, the magnitude of the force acting on the sluice F is
$$F = \int_0^H \rho g(H - z)\,\mathrm{d}z = \frac{1}{2}\rho g B H^2$$
4) The moment M generated around the x-axis by the pressure acting on the sluice face is
$$M = \int_0^H \rho g(H - z) z\, B\,\mathrm{d}z = \frac{1}{6}\rho g B H^3$$
Hence, $h = M/F = (1/3)\,H$.

[2]

1) In order to represent the geometry of an object, it is required to describe the conditions for acquiring point cloud data that is of good quality, can comprise the entire geometry that needs to be modelled without shortcomings, and can reliably align partial geometries.
2) It requires a description of the sequence of steps from point cloud data, through meshing, to the generation of surfaces by parametric CAD modelling and fitting, and the purpose and main points of each process.
3) The connections by G0, G1 and G2 should be on the basis of tangential direction, curvature and rate of change of curvature on both sides of the connecting edges of the surfaces, which are required to be described as corresponding to the displacement, bending and smooth connections of the zebra pattern at the connecting lines.