

Question and Answer Sheets

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Human Life Design and Science

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< Elective Question – 1 >

Please answer the following questions about analogy. <35 points + 15 points = 50 points>

(1) Explain the process of analogical thinking by giving concrete examples of problem-solving and idea development in product design. Additionally, discuss the differences between analogy and acts such as plagiarism or imitation, which involve copying others' ideas as they are. In your discussion, focus on the differences in purpose, characteristics, and the relationship between the reference source and the design object. <35 points>

(2) What do you think is the significance and potential of using analogy in product design? Discuss your thoughts. <15 points>

Intent of the question

This question aims to assess whether examinees understand analogy as a thinking method in product design, including its fundamental concepts and practical applications. By examining how they consider the relationship between a reference source and a design target, and how the use of analogy can enable the expansion of ideas and the creation of new value, the question evaluates their ability to develop ideas logically and coherently.

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< Elective Question – 2 >

What is the mirror neuron system? Discuss what kind of experiments can be used to clarify its existence and function.

(at least 300 words) <50 points>

Intent of the question

This question aims to assess fundamental knowledge of brain functions related to human behavior, as well as understanding and creative thinking regarding specific measurement methods and research approaches.



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< Elective Question – 3 >

Explain the acquisition method of surface electromyography (sEMG). Then, describe the relevant techniques used to analyze sEMG data. (at least 250 words) <50 points>

Intent of the question

This question is designed to evaluate whether candidates understand the measurement methods and fundamental analysis techniques of bioelectrical signals (EMG).



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< Elective Question – 4 >

Explain in detail the role of the autonomic nervous system in the physiological response to a cold environment, including its regulatory mechanisms. (at least 300 words) <50 points>

Intent of the question

This question tests basic knowledge of human physiology, especially autonomic nervous system and whole body regulatory mechanisms, regarding physiological responses to cold stress.



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< Elective Question – 5 > (You may also use the following sheet to answer. Do not use the back side.)

A single video recording has been made of a discussion involving three people seated face-to-face for observational purposes. Based on the conditions described below, answer the following questions regarding how to obtain time-series data of the head orientation of the central person. <50 points>

Conditions

- The target data for head orientation consists of three categories: “left,” “right,” and “other.”
- Throughout the video, the three individuals remain stationary, and their relative positions do not change.
- The faces are not obscured by masks, glasses, or hair.
- The video has a resolution of Full HD (1920×1080) and a frame rate of 60 frames per second (fps).
- The total duration of the video is 30 minutes.
- The video was recorded under proper lighting and camera settings, with no overexposure, underexposure, or defocus.
- No information other than the video (e.g., audio) may be used.
- There is ample time available for analysis; therefore, processing speed is not a concern.

(1) State the total number of frames in this video. <10 points>

(2) Suppose you choose to build a custom training dataset and apply machine learning to estimate head orientation. List and describe five specific challenges or concerns associated with this approach. You do not need to provide countermeasures or solutions. If two listed items are highly similar in nature, they will be counted as one. If more than six items are listed, only the five most relevant or insightful will be graded <20 points>

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(3) Markerless motion capture libraries can be broadly categorized into two approaches: top-down and bottom-up. Describe both approaches and then state which one should be selected in this case, including your reasoning. <20 points>

(You may use the next page for your answer. Do not write on the back of this sheet.)

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< Elective Question – 5 > Answer sheet (continued)

(1) Sample answer: $30 \text{ fps} \times 60 \text{ minutes} \times 60 \text{ seconds} = 108,000 \text{ frames}$

(2) Grading criteria:

If the response includes any of the items below, award points for each. Also award points for appropriate items not listed below.

[5 points]

- Content related to selecting or deciding on a policy for Classification or Tracking
- Content related to countermeasures against false detections involving the central person (the analysis target) and the other two people or background objects
- Concerns about class boundaries, face-angle thresholds, or evaluation of accuracy
- Content related to research ethics or handling of personal information
- Other observations raised based on a strong understanding of the prerequisites, the nature of the project, and the characteristics of machine learning

[4 points]

- Risks related to requirements definition, external design, or application/productization (however, add +1 if there is a specific mention)
- Selection of libraries or equipment to use (however, add +1 if specific technologies or methods are named)
- Other useful observations that are somewhat general in nature

[3 points]

- Content that applies to any project, e.g., the difficulty of annotation work; securing time for training and development; data storage; workload/effort; skills, etc.
- Issues or concerns that assume the respondent's personal circumstances or skill level

(3) Grading criteria:

If the response includes any of the items below, award 4 points for each. Also award points for appropriate items not listed below.

- Explains that in the top-down approach, processing proceeds in the order of “person detection → pose estimation.”
- Explains that in the bottom-up approach, processing proceeds in the order of “key point detection → grouping.”
- Mentions that the top-down approach (generally) achieves higher estimation accuracy but has a higher computational cost
- Mentions that the bottom-up approach (generally) is faster but tends to produce more misclassifications when multiple people are crowded together
- Provides a logical explanation, based on accurate information, of which approach should be adopted
- Additionally proposes model-based pose estimation as an alternative option

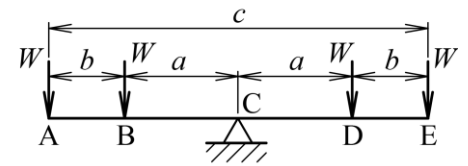
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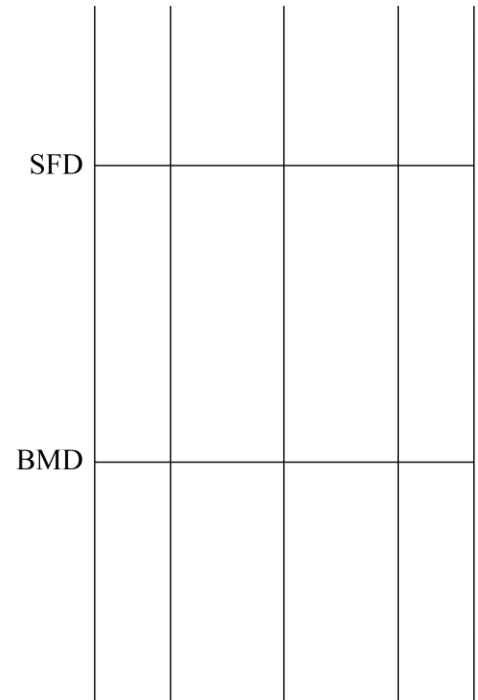
< Elective Question – 6 > (You may also use the following sheet to answer. Do not use the back side.)

The designed seesaw (a type of playground equipment) was modeled as a beam as shown in the figure. It shows children with weight W sitting in point A, B, D and E on the seesaw. The length of the beam is as shown in the figure. Answer the following questions. Note that modulus of longitudinal elasticity (Young's modulus) is E , the cross-sectional area is A , the moment of inertia of area is I , and the section modulus is Z (not all of these variables may be necessary for the answer). In addition, neglect the weight of the beam.



<50 points>

- (1) Determine the size of the reaction force R_C at point C and their directions.
- (2) Draw the shearing force diagram (SFD) and bending moment diagram (BMD), and find the maximum absolute value of bending moment M_{max} between A and E. In addition, show the derivation process.
- (3) Determine the maximum absolute value of stress σ_{max} in the beam and its location with as much detail as possible.
- (4) Determine the downward deflection δ of point E relative to point C. Here, the deflection and the slope at the tip of the cantilever beam when the concentrated load P is acting at the tip of a cantilever beam of length l are $Pl^3/3EI$ and $Pl^2/2EI$, respectively.



Intent of the question

This question assesses your ability to determine and draw the shearing force diagram (SFD) and bending moment diagram (BMD) due to loads acting on a statically determinate structure, as well as your understanding and ability to analyze stress distribution in structures. In particular, we emphasize the ability to identify the location of maximum bending moment and the corresponding location of maximum stress. Through this question, we aim to confirm whether you have acquired the fundamental mechanical knowledge necessary for evaluating the safety of structures in practical design and analysis.



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< Elective Question – 6 > Answer sheet (continued)



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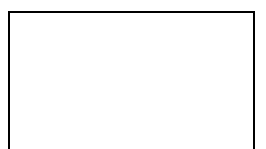
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< Elective Question – 7 >

Explain “Activities of Daily Living (ADL).” In addition, elaborate how aging influences on the ADL and their factors behind. (at least 250 words) <50 points>

Intent of the question

This question examines knowledge of the mechanisms of human movement and age-related changes that are essential for considering assistive devices and environments, using activities of daily living as the context.



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< Elective Question – 8 >

Please describe your thoughts on the challenges and potential of using AI in advertising creative development, with specific examples. <50 points>

Intent of the question

This question asks respondents to demonstrate a basic understanding of advertising that uses AI and to think logically about its challenges and possibilities. It also evaluates their ability to write clearly and persuasively, and to present an original perspective.



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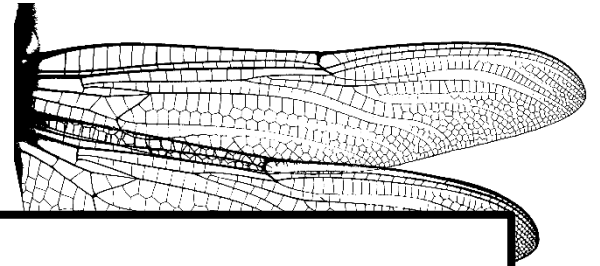
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< Elective Question – 9 >

(1) The figure on the right shows the wing of a dragonfly (*Anotogaster sieboldii*). Describe the geometric characteristics observed in the vein patterns of the wing. Also, give examples of similar patterns with such characteristics found in nature. (within 120 words) <20 points>



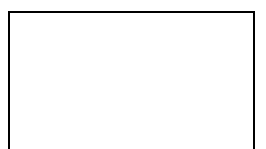
Intent of the question

This question aims to assess fundamental understanding of three-dimensional geometry related to regular polyhedra and the ability to grasp spatial structures. It evaluates whether students can, based on the symmetry of the figure, independently derive the radii of the circumscribed and inscribed spheres from the given edge length, thereby demonstrating their understanding of spatial structure and their logical computational skills.

(2) For a regular octahedron with edge length 1, derive (a) the radius of the circumscribed sphere, and (b) the radius of the inscribed sphere. <30 points>

Intent of the question

This question examines whether students can interpret biological form not merely as a beautiful pattern, but as the outcome of geometric principles, mechanics, and growth laws. It assesses not simply familiarity with terminology, but the depth of understanding required to explain the geometric characteristics of wing venation and their functional significance, and to logically relate them to analogous patterns found in natural systems and engineered structures, thereby demonstrating intellectual insight and analytical depth.



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< Elective Question – 10 >

Explain and elaborate how you would investigate the quantity and quality of sleep in healthy adults using polysomnography, detailing the measurement procedures and the indices you would analyze. (at least 300 words)
<50 points>

Intent of the question

This question assesses whether you understand the objective measurement methods for sleep using polysomnography and the fundamental analytical techniques.
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< Elective Question – 11 > (You may also use the following sheet to answer. Do not use the back side.)

Let $\mathbf{x}(t) = \begin{pmatrix} x_1(t) \\ x_2(t) \end{pmatrix}$ be a two-dimensional real function of a real variable t . The following differential equation

$$\frac{d\mathbf{x}(t)}{dt} = A\mathbf{x}(t), A = \begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix} \quad \dots (*)$$

is satisfied. Answer the following questions. <50 points>

(1) One of the solutions of Equation (*) can be written as

$$\mathbf{x}(t) = \mathbf{v}e^{\lambda t},$$

where λ and \mathbf{v} are a real variable and a two-dimensional real vector, respectively. Derive an equation that λ and \mathbf{v} should satisfy and is independent of t .

(2) An infinite number of pairs (λ, \mathbf{v}) satisfy the equation in the previous question. Find two solutions of the equation that have different values of λ .

(3) Let $(\lambda_1, \mathbf{v}_1)$, $(\lambda_2, \mathbf{v}_2)$ be the solutions found in the previous question. The general solution of Equation (*) can be written as

$$\mathbf{x}(t) = \alpha_1 \mathbf{v}_1 e^{\lambda_1 t} + \alpha_2 \mathbf{v}_2 e^{\lambda_2 t}, \quad \dots (*)$$

where α_1, α_2 are arbitrary constants. Find the solution of Equation (*) for $\mathbf{x}(0) = \begin{pmatrix} 2 \\ -2 \end{pmatrix}$.

(4) Regard Equation (*) as a model that represents the temporal changes in the population sizes of two species from time $t = 0$. Then, given that $x_1(t)$ and $x_2(t)$ are always positive if $t \geq 0$, find the condition that the parameters α_1, α_2 in the general solution (*) satisfy.

Intent of the question

This question tests fundamental knowledge of differential equations and the ability to apply them as mathematical models. Emphasis is also placed on the capacity for mathematical communication throughout the derivation process.

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< Elective Question – 11 > Answer sheet (continued)



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< Elective Question – 12 >

Outdoor activities in public spaces can be simply divided into three categories: necessary activities, optional activities, and social activities. Describe the conditions for each activity to occur and give specific examples, explaining their characteristics. Then, explain the relationship between the quality of outdoor spaces and necessary activities and optional activities. <50 points>

necessary activities

optional activities

social activities

the relationship between the quality of outdoor spaces and necessary activities and optional activities

Intent of the question

This question assesses basic knowledge of activities conducted in public spaces and evaluates understanding, including the relationships between these activities. It aims to gauge comprehension and interest in this design field, as well as the level of knowledge acquisition necessary for design practice.

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< Elective Question – 13 >

Explain the ethnic differences in adaptation to high-altitude environments and the individual differences among lowland people, including the regulatory mechanisms. (at least 300 words) <50 points>

Intent of the question

This question tests basic knowledge of high-altitude adaptation as one of human environmental adaptation, focusing on ethnic differences and individual variability within lowland populations. It further examines whether, more specifically, the mechanisms through which ethnic differences arise, as well as the acclimatization processes observed when lowland populations stay at high altitude, can be theoretically explained from physiological and genetic perspectives.



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< Elective Question – 14 >

Tajfel et al. demonstrated through Minimal Condition Group*¹ experiments that Ingroup Favoritism*² arises simply from the distinction between one's own group and other groups, and explained this phenomenon through Social Identity*³.

*1: A group situation where members do not know each other and have no interaction with one another

*2: A tendency to behave cooperatively or favorably toward members of one's own group compared to members of other groups

*3: Self-perception that defines and understands oneself through group membership

(1) Discuss the *Buddy System**⁴ in Mechelen, Belgium, a well-known example of successful immigrant integration policy, from the perspectives of both immigrants and existing residents, in relation to the above human characteristics.

*4: A policy that matches immigrants and existing residents with similar social attributes, such as family structure, as *buddies* to promote their acceptance as community members. At the time, terrorist attacks claiming affiliation with Religion X were frequent, and in Mechelen, which had a large immigrant population from Religion X, there was severe tension between existing residents and immigrants, leading to deteriorating public safety. The Buddy System is evaluated as having significantly improved the situation.

From the perspective of immigrants <20 points>:

Intent of the question

This question assesses the ability to understand the presented abstract concepts and mechanisms, as well as the ability to accurately apply the given hypotheses to specific situations.

From the perspective of existing residents <20 points>:

(2) Discuss possible reasons in case the Buddy System does not function effectively in relation to the above human characteristics <10 points>.

Intent of the question

This question assesses the ability to logically examine the limitations of the hypothesis.