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< Compulsory Question – 2 >

Select five terms from the following keyword group and explain each in about 40 words <40 points, 8 points each>

Keyword Group: Design Engineering, Natural Selection, Socio-Fugal , Algorithmic Design, Melatonin, Teaser Ad, Codec, Anatomical Position, AIC, Moment of Inertia of Area, Personal Distance, Neural Circuit, Social Constructivism, Deduction, Procedural Justice, Base of Support, Narrative Experience, Heat Cramp

Selected Keyword 1 []

Selected Keyword 2 []

Selected Keyword 3 []

Selected Keyword 4 []

Selected Keyword 5 []



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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>

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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>



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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>



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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>



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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>

1	
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7	

(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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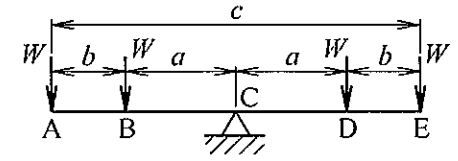
< Elective Question – 5 > Answer sheet (continued)

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

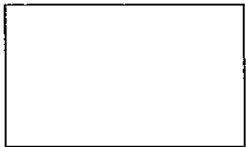
The designed seesaw (a type of playground equipment) was modeled as a beam as shown in the figure. It shows children with weight W sitting in point A, B, D and E on the seesaw. The length of the beam is as shown in the figure. Answer the following questions. Note that modulus of longitudinal elasticity (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 $P^3/3EI$ and $P^2/2EI$, respectively.

SFD					
BMD					



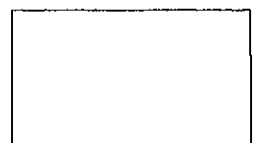
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< Elective Question – 6 > Answer sheet (continued)



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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>



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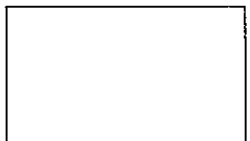
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< Elective Question – 8 >

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



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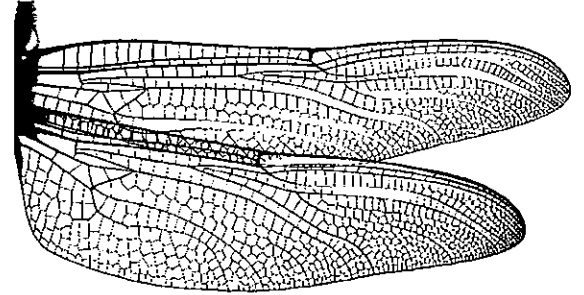
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< Elective Question – 9 >

(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>



(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>



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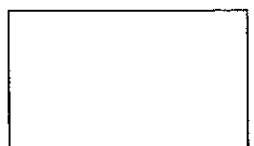
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< Elective Question – 10 >

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>



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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 .

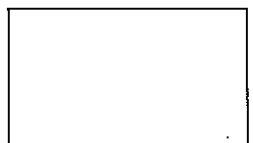
(2) An infinite number of pairs (λ, \mathbf{v}) satisfy the equation in the previous question. Find two solutions of the equation that have different values of λ .

(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.



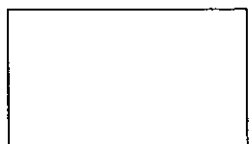
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< Elective Question – 11 > Answer sheet (continued)



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< Elective Question – 12 >

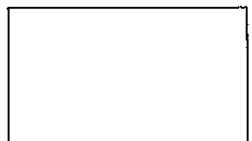
Outdoor activities in public spaces can be simply divided into three categories: necessary activities, optional activities, and social activities. Describe the conditions for each activity to occur and give specific examples, explaining their characteristics. Then, explain the relationship between the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



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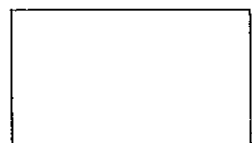
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< Elective Question – 13 >

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>



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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>:

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>.

