令和７年度　（令和７年秋入学）

京都工芸繊維大学大学院 工芸科学研究科 博士後期課程

物質・材料化学専攻

一般入試（秋入学）

外国語

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１．問題冊子は、表紙を含めて４枚である。試験開始後に確認すること。

２．解答用紙は、表紙を含めて４枚、下書き用紙１枚が配られているか、確認すること。

３．配布された解答用紙の表紙に受験番号を記入すること。

４．解答は，必ず解答用紙の指定された場所(問題番号と一致した場所)に記入すること。

５．試験終了後には、解答用紙、問題冊子、下書き用紙の全てを回収する。

問 1. 次の英語を読み、(1)~(3)を解答せよ。

Secondary batteries, which can store electrical energy repeatedly, are a core technology for sustainable energy use Starting with the birth of lead-acid batteries, lithium-ion batteries have now become mainstream, and the development of next-generation batteries is actively progressing. Secondary batteries are an important field that will continue to evolve in the future as a fundamental technology that supports the mobility, electrification, and utilization of renewable energy in modern society. There are many technical and operational challenges when using secondary batteries as batteries for next-generation IoT. In the next-generation IoT where small, low-power devices are the norm, there are an increasing number of situations where conventional secondary batteries are difficult to use, and it is important to separate the roles of secondary batteries and energy harvesting. Some of the recent problems using with the secondary batteries for the next-generation IoT technologies include:

1. Achieving both small size and thinness and capacity: IoT devices are required to be ultra-small and ultra-thin, but the energy capacity of secondary batteries decreases rapidly when they are miniaturized. Battery materials and structures that achieve both long life and capacity are required.

2. Restrictions on operating temperature range: IoT devices are often used outdoors or in extreme environments, but secondary batteries are often weak at high and low temperatures, and degradation and performance degradation in extreme environments are issues.

3. Cycle life and maintainability: Ideally, IoT devices are maintenance-free, but secondary batteries deteriorate in performance with repeated use and need to be replaced when they reach the end of their life. The maintenance burden for remote locations and multiple devices increases.

4. Safety: Miniaturization can increase the risk of thermal runaway, and it is especially important to ensure safety in the event of overcharging, short circuiting, or damage with lithium-ion batteries.

5. Self-discharge and standby consumption: IoT devices are required to operate in standby for an extremely long period of time, but secondary batteries are unavoidable in self-discharge, making it difficult to maintain power for a long period of time.

In the next generation of IoT, secondary batteries alone have many issues, such as cycle life, miniaturization, and safety, making it difficult to use them in all situations. On the other hand, energy harvesting consumes extremely little power, so it is effective when IoT power consumption is reduced to the limit. In the future, it will be important to design hybrid systems that utilize secondary batteries and environmental power generation in a complementary manner. Selecting the optimal power supply configuration according to the application and environmental conditions is thought to be key to supporting the sustainability of the next generation IoT society, as are hybrid power supply systems, optimal design for each application, event-driven operation, etc.

(1) Answer in English that the definition of secondary battery including difference of primary battery.
(2) 2 次電池を次世代 IoT に利用するための 5 つの課題の中で 2 つを選択し、それぞれ 2~5 文程度で和文要約せよ。
(3) 5 つの課題を受けて、エネルギーハーベスティング(環境発電)との役割分担により、次世代 IoT に利用するための自分なりの対策方法などアイディアを英語で簡潔に述べよ。(100~300 words)

問 2. 次の英語を読み、(1)、(2)を解答せよ。

In the next generation of IoT, a huge number of devices will be required to continue to operate stably for long periods of time. For this reason, the use of energy harvesting has been attracting attention as an alternative to conventional battery power, but there are currently several technical and practical challenges as follows:

1. Unstable power generation: Power generation sources that depend on the environment (light, vibration, heat, radio waves, etc.) vary greatly in power generation depending on the environment, time of day, and location of use, making it difficult to provide a stable power supply. Power generation efficiency drops significantly especially indoors, underground, in dark places, and in enclosed spaces.

2. The need for ultra-low power consumption devices: The energy obtained from harvesting is very small, so it is essential to design ultra-low power consumption circuits and devices. Optimization of operating modes (switching between sleep and operation) and efficient power management circuits (PMICs) are required.

3. Issues with power management and energy storage technology: To deal with irregular power generation, power leveling and temporary storage using capacitors, high-performance capacitors, and secondary batteries are necessary, but the deterioration and temperature dependency of storage devices are also issues. The development of ultra-compact and highly efficient power conversion circuits is also essential.

4. Power balance with communication: Communication (especially wireless) consumes a lot of power, so the use of low power consumption communication technologies (LPWA, BLE, back scattering, etc.) is required. It is also important to develop data compression and communication-saving protocols that minimize communication intervals and data volumes.

5. Reliability and long-term operation: Battery-less and energy harvesting IoT aim to be maintenance-free, but there are challenges in terms of resistance to environmental changes and deterioration of parts over time, and in ensuring long-term operation.

To utilize energy harvesting in next-generation IoT, a complex range of technological developments is required, including ultra-low power consumption, highly efficient power supply management, the introduction of power-saving communication technologies, environmentally adaptive design, and ensuring long-term reliability. Energy harvesting is the key to a sustainable, maintenance-free IoT society, but many practical issues remain to be resolved, and comprehensive research at the materials, device, circuit, communication, and system levels will be required in the future.

(1) 現時点で、次世代の IoT 機器を、現在のバッテリー駆動からエネルギーハーベスティング（環境発電）に代替するには、いくつかの技術的・実用的課題ある。この課題が英語で述べられた 5 つから最も重要と考える課題を 1 つ選択し、2～5 文程度で和文要約せよ。
(2) 結論として、環境発電で駆動する次世代 IoT 機器には、どの様な未来がもたらされるか簡潔に英語で述べよ。(100~300 words)

問 3. 次の(1)～(3)文章に従って日本語で解答せよ。

(1) Write an itemize the program algorithm that calculates "n!" factorial (KAIJYO in Japanese) using the "While" statement. And then, Write the program as defended a function of "kaijyo(n)" in C language or Python language.

(2) The analytical solution of the differential equation can be theoretically found through integration. Differential equations often cannot be solved analytically, so an "approximate solution" can be found through numerical calculation. When integrating a function, an approximate solution is found using a technique called numerical integration. Numerical integration divides the integration interval into small parts, calculates the area using the function value for each interval, and finds an approximate integral value for the entire equation.
The basic method is the rectangular method, which adds up the areas of rectangles whose heights are the function values at the start points of each interval (It is called the piecewise quadrature method: as you can be seen the example in Fig. 1). However, this piecewise quadrature method has low accuracy. A slightly improved version of the piecewise quadrature method (: [あ] rule) uses the function values at both ends of each interval to linearly approximate the function, which allows for a solution with slightly higher accuracy.

Write an itemized program algorithm to compute and display the improved piecewise quadrature method ([あ] rule) to find an approximate integral solution of a function :f(x), $(0 \leqq x \leqq n)$?

(3) (2)文章中にある[[あ] rule] を日本語で何と呼ぶか解答せよ。

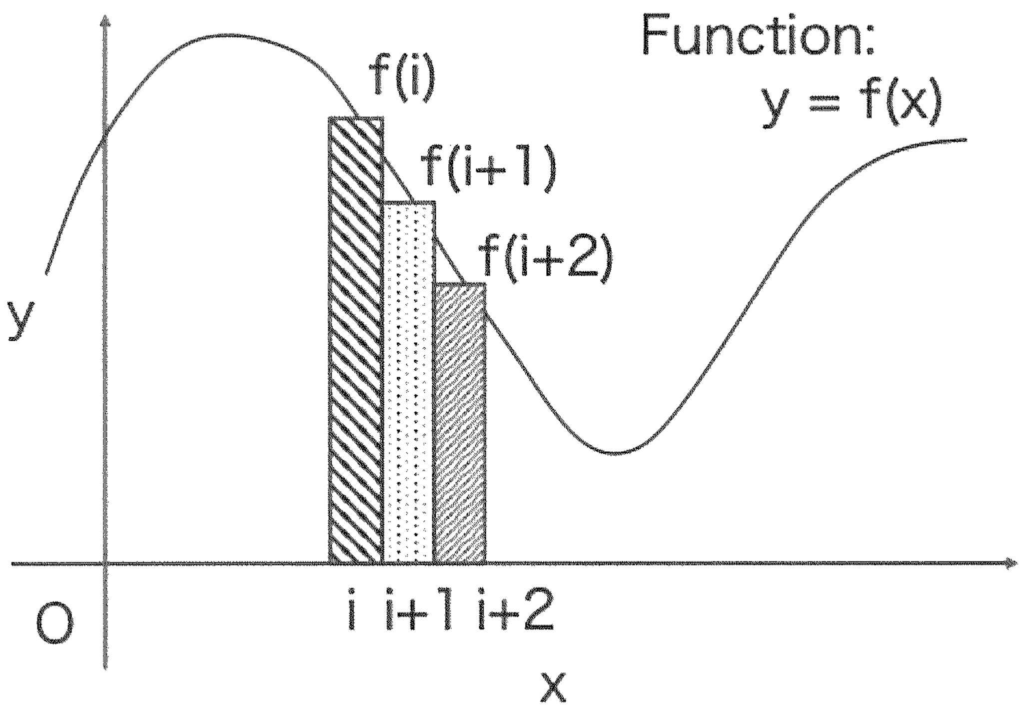

Fig. 1. The schematic image of the piecewise quadrature method.

出題意図

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　受験者が本学博士後期課程で研究する専門分野に関する研究背景を述べた英文の一部を日本語、またその研究背景に内在する研究課題を英文で要約して説明させ、専門分野における語学力と課題解決能力を確認した。また、今後の研究テーマに必要な予備知識の英文で問い説明させた。