2018 年 8 月 28 日　10 時～13 時
10:00-13:00, August 28, 2018

Ｂ　都市工学専門
B Urban Engineering Subjects

受験番号
Examination I. D.

（１）　すべての答案用紙の所定の欄に、問題番号、受験番号を記入しなさい。氏名を記入してはならない。
Write the question number and your examination I.D. on all the answer sheets. Do not write your name.

（２）　問題冊子に受験番号を記入しなさい。
Write your examination I. D. on this sheet.

（３）　Ｂ－１～Ｂ－１５の１５問の中から５問を選択し、解答しなさい。ただし、５問の解答の中で以下の条件を満たすこと。
・専攻分野として「都市環境工学」を希望するものは、Ｂ－１～Ｂ－７のうちから３問以上選択しなければならない。
・専攻分野として「都市計画」を希望するものは、Ｂ－８～Ｂ－１５のうちから３問以上選択しなければならない。
Answer five questions out of the 15 questions (B-1 to B-15) following the instruction below:
- If your major field of study is “Urban Environmental Engineering,” then select at least three questions from B-1 to B-7.
- If your major field of study is “Urban Planning,” then select at least three questions from B-8 to B-15.

（４）　答案用紙は１問につき１枚（裏を含む）とし、問題毎に用紙を変えなさい。
Use one answer sheet for each question. You may write your answers overleaf.

Ｂ－１　Water and Wastewater Engineering

Q.1　Water supply and wastewater systems emit a major proportion of the total greenhouse gas that are emitted by municipalities. In each of water supply and wastewater systems, answer two processes that emit large amounts of greenhouse gas, and measures for reduction of greenhouse gas emission in those processes.

Q.2　Explain the characteristics and drawbacks of the following (1) to (3) processes for drinking water disinfection.

(1) chlorination

(2) ultraviolet disinfection

(3) solar disinfection

Q.3　Answer the following questions about sewerage.

(1) Briefly explain the following terms.

① wastewater design flow

② SVI

③ sludge age

(2) In a wastewater treatment plant, a conventional activated sludge process is steadily operated under the following conditions; MLSS in the activated sludge reaction tank is 2,000 mg/L; the return sludge flow ratio is 20%; and the waste sludge flow ratio is 5%. Answer the concentration of the return sludge in this wastewater treatment plant.

B－2　Hydraulics

Q.1　Concisely explain the following terms. Figures can be used for the explanation.

1) Most hydraulically efficient cross section
2) Critical Reynolds number
3) Coefficient of viscosity
4) Water hammer

Q.2　A wide rectangular channel (slope 0.010, Chezy's coefficient 50 $m^{1/2}/s$) carries normal flow with 1.0 m deep. Answer whether the flow is subcritical or supercritical with the reason.

Q.3　Three tanks (Tanks 1 to 3) are connected with pipes as shown in the figure below. Assume that the tank volumes are large enough to keep the water level constant and the differences of water surface elevation are as given in the figure. The lengths of the connecting pipes (L_{AB}, L_{BC}, L_{BD}) have the relationships as $L_{AB}=L_{BC}$ and $L_{BD}=2L_{BC}$. All the pipes have the constant diameter d and are made of same materials. Friction loss should be considered and other losses due to the pipe line shape are to be neglected. Use g for gravitational acceleration and π for circumference ratio.

1) Answer the equation expressing the relationship between friction factor f ' and Manning's roughness coefficient n.
2) The friction head loss h_{AB} between A and B is expressed as $h_{AB}=k\,Q_{AB}^{2}$ using the pipe flow rate Q_{AB} between A and B. Express k using the given symbols.
3) Answer the flow direction between B and C, and explain the process of deriving the answer.

Ｂ－３　Water Environment

Q.1　Answer the following questions about enclosed water bodies.

(1)　Bottom layer dissolved oxygen was added to the environmental standards in Japan. Explain its purpose.

(2)　Recently, there are problems that arose as a result of progress in water pollution control in enclosed coastal seas in Japan. Give one of the problems and explain an example of concrete remedial actions against the problem.

Q.2　Answer the following questions about indices of water quality for organic pollution.

(1)　What are the indices of organic pollution used in the environmental standards in Japan? Answer the index for each water body.

(2)　For each index you answered in (1), explain the limitations or the problems as an index.

Q.3　Explain the following terms including their roles in water environment management.

(1)　Environmental Impact Assessment System

(2)　Rainwater infiltration facilities

(3)　Bioassay

(4)　Biotope

Ｂ－４　Environmental Microbiology

Q. 1　Concisely explain the following two terms, referring to the relation between the two terms.

(1) “Exponential growth phase” and “Doubling time”

(2) “Proton motive force” and “Adenosine triphosphate”

(3) “Eukaryote” and “Prokaryote”

(4) “Bioaugmentation” and “Biostimulation”

Q. 2　Answer the following questions related to activated sludge process.

(1) When MLSS concentration is 2,000 mg/L, estimate the number of bacteria contained in 1 mL of mixed liquor. Give appropriate values for parameters which are necessary in the calculation. Include the calculation process in the answer.

(2) Describe the potential influences of protozoa and viruses present in activated sludge on the activated-sludge bacteria, respectively.

(3) Activated sludge process utilizes the functions of complex microbial communities consisting of diverse microorganisms present in the environment. Explain the advantages and disadvantages of the use of complex microbial community functions for wastewater treatment.

(4) It is generally acknowledged that most of the bacteria existing in the environment are difficult to be isolated and cultivated. Explain the reasons for the difficulty in isolation and cultivation. In addition, give a method to study such bacteria and explain the principle of the method.

B－5　Environmental Chemistry and Reaction Kinetics

Q.1　When we mix cadmium nitrate and sodium hydroxide in aqueous solution, cadmium hydroxide will be formed. Answer the following questions. Molar mass of cadmium is 112 g/mol, and ionic product of water (K_w) is 1.0×10^{-14}.

(1) The solubility product constant of cadmium hydroxide is 3.9×10^{-14}. Develop an equation between cadmium ion concentration (mg/L) and pH. You may be able to use the following logarithm table.

x	log x	x	log x
2	0.30	11	1.04
3	0.48	12	1.08
4	0.60	13	1.11
5	0.70	14	1.15
6	0.78	15	1.18
7	0.85	16	1.20
8	0.90	17	1.23
9	0.95	18	1.26

(2) An industrial wastewater containing cadmium ion should be treated by alkaline. In actual case of industrial wastewater treatment, various inhibitors could be present in wastewater. List one typical inhibitor which potentially inhibits the reaction of the treatment.

Q.2　Adsorption isotherm experiment was conducted by pollutant X adsorbed on adsorbent M in aqueous solution. Answer the following questions.

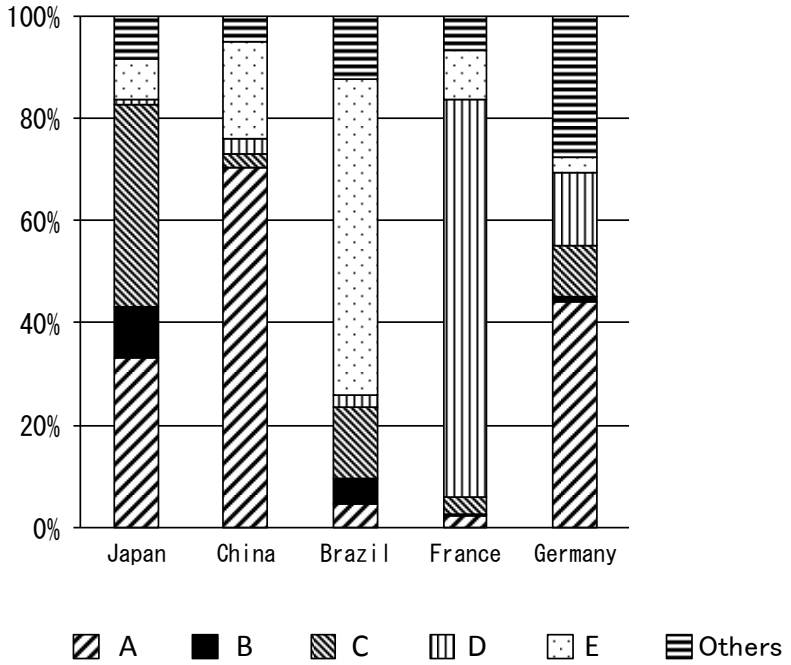
(1) Explain the principle of Langmuir adsorption isotherm model.
(2) You are requested to draw a graph to examine whether the experimental data could be expressed by Langmuir adsorption equation. Explain this method.

Q.3　Explain the following terms.

(1) Lambert-Beer law
(2) Dioxins
(3) Photochemical smog

B－6　Global Environmental Engineering

Q.1 The below figure shows the power generation ratios by energy source as of 2015.
Answer the following questions related to this figure.



(1) Choose the correct energy sources for A to E from the following five options, respectively.

Hydropower,　Natural gas,　Oil,　Coal,　Nuclear power

(2) Such source composition for electricity can become important in the case of quantifying the environmental burden reduction effect of certain environmental measure. Explain the reason in detail.

Q.2 The application of Smart Community to mixed-use blocks is considered to be effective. Explain the reason by using the word "interchange".

Q.3 Except for climate change issue, give one example where an environmental problem occurs across the national border, and explain the outline of the problem and the international policy measures to solve it.

Q.4 Explain the following terms (1) – (3), respectively, by clarifying the differences of the two terms.

(1) “Bioethanol” and “Biodiesel”
(2) “Electricity-match mode” and “Heat-match mode” for cogeneration system
(3) “Cap-and-trade systems” and “Baseline-and-credit systems” for emission trading systems

Ｂ－７　Waste Management and Material Cycles

Q.1　The following conditions are given for household waste, combustibles and incombustibles, generated in a certain city with a population of 100 thousand. Answer the questions (1) and (2) with respect to greenhouse gas emissions derived from combustion and decomposition of the household waste generated in this city in a year (hereinafter, abbreviated as “GHG emissions derived from the household waste”).

- Annual amount of combustibles generation: 200 kg/person/year
- Annual amount of incombustibles generation: 10 kg/person/year
- Complete combustion rate in an incineration plant: 100%
- Decomposition rate of kitchen waste in a landfill site: 60%
- Composition of gases generated in a landfill site: CO_2 70%, CH_4 30%

* Here, only kitchen waste is decomposed (gasified) in a landfill site, and decomposition of other waste categories is negligible.

* Energy recovery such as waste power generation is not introduced in the incineration plant.

* GHG emissions should be calculated using Global Warming Potential (GWP) for conversion into the carbon dioxide (CO_2) equivalent amount. GWP of methane (CH_4) is 25. CO_2 emissions which can be regarded as carbon-neutral should not be included in the amount of GHG emissions.

Waste category	Wet-based composition		Water content	Dry-based carbon content
	Combustibles	Incombustibles		
Kitchen waste	30%	0%	80%	40%
Papers/textiles/plants	45%	0%	20%	40%
Plastics	15%	30%	20%	75%
Metals/glass/ceramics	10%	70%	0%	0%

(1) Regarding treatment/disposal methods of the household waste, suppose that combustibles are incinerated and incombustibles are directly landfilled. Calculate the amount of GHG emissions derived from the household waste under the above conditions.

(2) Next, suppose that household waste is collectively treated/disposed by either incineration or landfilling without separation between combustibles and incombustibles. Let the total amount of household waste, 210 kg/person/year, and other conditions be unchanged. Calculate the amounts of GHG emissions derived from the household waste for cases where a) all household waste is treated by incineration, and b) all household waste is disposed by landfilling, respectively.

(To be continued)

Q.2 Spell out the following acronyms which are relevant to waste management and material cycles, and explain in five to ten lines, respectively.

(1) MSW
(2) RPF
(3) MFA
(4) EPR

Ｂ－８　Urban Planning

When a municipality presents a “land use concept (policy) map” in the city master plan (the basic policy concerning municipal city planning based on Article 18-2 of the City Planning Act), what elements should be included in the map in general?　Answer the possible elements.

Ｂ－９　Urban Design

Q.1　Explain the following terms on urban design with regard to their outlines, conducted examples, their goals in urban design, and their contributions and challenges in actual urban space in about 5 lines respectively.

(1) Land readjustment project
(2) Pattern language
(3) Preservation Districts for Groups of Traditional Buildings

Q.2　Answer the following questions on castle towns.

(1) Explain the characteristics of urban structure and space of a castle town.

(2) Take an actual urban design in a castle town as an example, and briefly explain how the design utilizes the historical context. You may choose an example either from Japan or other countries.

Ｂ－１０　Urban Housing

Q.1　Answer the following questions on Japanese new towns.

(1)　Fill respectively the name of a new town in the blanks A to D.

Name	A	B	C	Tama New Town	Chiba New Town	D
Area (ha)	1160					1341
Planned population (thousand)	150					220
Prefecture	Osaka	Osaka	Aichi	Tokyo	Chiba	Kanagawa
Construction start year	1961	1966	1964	1966	1970	1974

Source: Atsushi Kaneko (2017) *New town no shakai-shi*

(2)　The following options a) to d) are pairs of the area and planned population of the four new towns other than A and D. Select respectively the pair that represents Tama New Town and Chiba New Town, respectively.

a) 702 ha, 81,000　　b) 1557 ha, 180,000

c) 2884 ha, 300,000　　d) 1930 ha, 143,000

(3)　Some new town plans referred to Perry's Neighborhood Unit. Explain the principles of the Neighborhood Unit in a few lines.

(4)　Some new towns were developed as a *New housing and urban development project*. Explain the characteristics of the *New housing and urban development project* in a few lines by comparing the project with the *Land readjustment project*.

(5)　Why is it difficult to reconstruct multi-family condominiums? Nominate three reasons and briefly explain them.

Q.2　Answer the following questions on Contingent Valuation Method (CVM) by having a park construction project as an example.

(1)　Give an example of a question in a questionnaire conducted to residents living nearby the construction site.

(2)　Describe what should be considered to suppress possible biases when using CVM in a few lines.

Ｂ－１１　Urban Disaster Management and Planning

Answer all of the following questions.

Q.1　In general, problems on disaster prevention measures in pre-disaster reflect local characteristics. Answer the following questions.

(1) The risk of post-earthquake urban fire spreading is one of the most serious problems peculiar to large cities. Explain three main measures in urban planning to tackle the problem in about five lines.

(2) Explain another problem peculiar to large cities in about three lines.

(3) Explain a problem peculiar to depopulated regions in about three lines.

Q.2　Answer the following questions.

(1) Explain the definition of “secondary disaster” and “complex disaster”, and give a concrete example. (in about four lines)

(2) Explain the definition of “disaster-related deaths” and the causes of that. (in about three lines)

Q.3　Correct errors in the following descriptions, if they are wrong.

(1) Recurrence interval of active fault earthquake in Japan is approximately hundreds of years.

(2) Death rate of the elderly was higher than other generations in Kobe earthquake disaster in 1995. It was mostly due to the lack of physical ability.

Ｂ－１２　Urban Analysis

Answer all the following questions.

Q. 1　Clark's equation is a classical equation to represent the population density in a city with the distance from the city center. Clark's equation can be defined as

$$D(x) = ae^{-bx}$$

where x is the distance from the city center, $D(x)$ is the population density at location x, a and b are positive constant parameters. Answer the following questions by assuming that a city in two dimensional space follows Clark's equation such that population density at any point on a circle with radius x from the city center is given by this equation, and that the city extends to the infinite distance.

(1) Describe what kind of characteristics regarding the population density parameter a and b represents, respectively.

(2) Suppose pairs of parameters (a, b) of cities A, B and C are given by (1, 2), (2, 1), (2, 3), respectively. Range these cities in the descending order from the largest population to the smallest population and explain the reason.

Q. 2　Answer the following questions by assuming an independent city, which does not have commuting traffics (for work and school) in and out of the city and that the city size can be measured with its population.

(1) Describe factors contributing to the productivity of the city, as the city size increases.

(2) Describe factors increasing social cost, as the city size increases.

(3) Suppose that optimal city size exists due to the two kinds of factors above. Describe a method to derive the optimal city size.

Ｂ－１３　Urban Transportation Planning

Q.1 Answer the following questions about sustainable mobility.

(1) Nominate three evaluation indicators each for economic aspects, environmental aspects, and social aspects of sustainable mobility.
(2) Describe the problem of “Predict and Provide” approach to achieve sustainable mobility in about three lines.

Q.2 The sentences in the following box describe the validation and application of the travel demand forecasting model. Fill an appropriate term in the blanks [①] - [⑤].

Since the reproduction precision for the data used for parameter estimation depends on the characteristics inherent in the data such as the range of data and mutual [①] among variables, [②] may be drastically reduced if applied to different data in the future forecast. To avoid this problem, it is necessary to validate the model's explanatory power for data different from those used for parameter estimation. For example, there is a method of dividing the data for model estimation into [③], and applying a model constructed on the one side to the other side and validating the model with the explanatory power. In the case of models dealing with the entire urban area, it is highly recommended to check whether there is no [④] in the reproduction precision with respect to the politically important aspects, such as traffic volume by direction and by distance. To predict the future travel demand, it is necessary to substitute the future estimated values of the explanatory variables into the model formulae. Since future prediction of explanatory variables involves errors, it should be noted that an [⑤] in explanatory factors for improving the reproduction precision does not necessarily lead to the improvement of the accuracy of future prediction.

Q.3 Explain each of the following pairs of terms by paying attention to mutual relationships and/or differences.

(1) “Social logistics” and “Business logistics”
(2) “Common variables” and “Specific variables” in utility functions of disaggregate travel demand models
(3) “Revealed preference survey” and “Stated preference survey”

Ｂ－１４　Regional Planning

The Christaller model (hierarchical structure), the Pred model (multi-polar structure) and the Network model (Web structure) are often pointed out as typical urban systems. In relation to three urban system models, answer the following questions.

(1) Explain the characteristics of these three urban system models by using examples.

(2) Though the conventional urban system of Japan has often been regarded that it follows the Christaller model, there is a discussion that a new urban system has been observed in recent years. Explain the characteristics of this new urban system, and discuss the physical, economic and policy factors which have promoted the formation of this new urban system.

(3) Many cities in developing and emerging countries suffer from serious urban environmental problems in recent years. There is a discussion that the formation of global urban systems is one of the background factors of the occurrence of these urban environmental problems. Discuss what and how global urban systems can become one of the background factors of serious urban environmental problems in the cities of developing and emerging countries.

Ｂ－１５ Landscape Planning and Environmental Design

Q.1 （ A ）was launched by the United Nations Secretary-General Kofi Annan in 2001, conducted worldwide, and completed in 2005. In the report of （ A ）, “Ecosystem services” (the benefits people obtain from ecosystems) were categorized into four groups as （ a ） including （ ① ）, （ b ） including （ ② ）, （ c ） including （ ③ ）, and （ d ） including （ ④ ）.

(1) Fill an appropriate word in the blank （ A ）.
(2) Choose appropriate words for the eight blanks as （ a ） to （ d ） and （ ① ） to （ ④ ） from the options below.

For （ a ） to （ d ）:
Provisioning services, Supporting services, Habitat services,
Disaster prevention services, Regulating services, Cultural services

For （ ① ） to （ ④ ）:
Flood regulation, Food provision, Nutrient cycling,
Habitat provision, Aesthetic value, Wildlife nuisance control

Q.2 The persons listed below are understood as those who realized the importance of making use of the benefits that can be obtained from ecosystems when planning/designing landscapes. For each person, give representative project(s) conducted, or book(s) authored, by the person, discuss which service(s) listed in (A) can be linked with their work(s), and how such perspective(s) were taken into their planning/design of landscapes. Answer in about 4 lines respectively.

(1) Frederick Law Olmsted (1822~1903)
(2) Ian L. McHarg (1920~2001)
(3) Richard T.T. Forman (1935~)