2016 年 8 月 30 日　10 時～13 時
10:00-13:00, August 30, 2016

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

Explain the two terms listed below. Include cause, problem, and solution of the problem in the explanation.

(1) tastes and odors

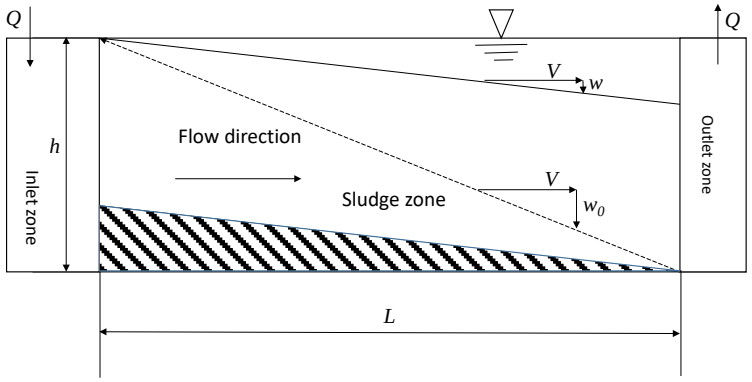
(2) CSO

Q. 2

Draw a process flow diagram of the anaerobic-aerobic process, a typical biological phosphorus removal method, and explain it. Include phosphorus removal mechanisms in the explanation.

Q. 3

Figure 1 is an ideal horizontal-flow rectangular settling basin for water treatment. Determine the surface loading rate of the settling basin, whose width is B [m]. Express the removal rate of the particle using settling velocity of particles w [m/s] and the surface loading rate.



Q : flow rate, m^3/s
V : average flow velocity, m/s
h : depth of the basin, m
L : length of the basin, m
w : settling velocity of particles, m/s
w_0 : minimum settling velocity of the particles removed completely, m/s

Figure 1. Settling basin diagram

B – 2　Hydraulics

Q. 1　Explain the following terms concisely.

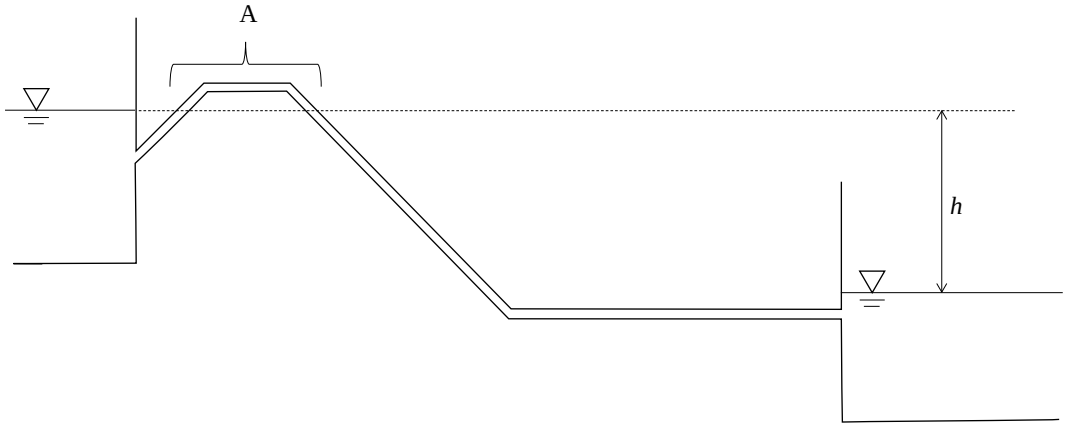
1) Hydraulic radius of open channel flow in circular cross sections
2) Logarithmic distribution law in turbulent flow
3) Control section in transitional flow

Q. 2　Answer the following questions on flow in a rectangular open channel. Here unit flow is given as q.

1) Express the specific force F with water depth h.
2) Derive the expression for the water depth H when the specific force F is a minimum. Give the technical term of the water depth H.
3) Assuming that the water depths are h_1 and h_2 before and after a hydraulic jump, respectively, express h_2 with h_1.

Q. 3　Answer the following questions on pipe flow between the two reservoirs shown in the figure below. Here, part A of the pipe is above the water level of the upstream reservoir.

1) Draw a sketch of the hydraulic grade line of the pipe flow.
2) The pipe with part A works as a siphon. There is an upper limit to its part A height. Explain the reason for this limitation, using terms “hydraulic grade line” and “cavitation.”
3) In the case where a siphon is used as a fish-way, low flow velocity is desirable for fish migration. Assuming that the number of bends is n (the figure shows an example of n = 3), express n with the flow velocity in the pipe (v). The following letter symbols are given: water level difference between two reservoirs (h), pipe diameter (d), total pipe length (L), friction factor (f) and other head loss factors for entrance (f_e), exit (f_o), and bends (f_b).



B – 3　Water Environment

Q. 1

Answer the following questions.

(1) In the Environmental Quality Standards for Water Pollution in Japan, water bodies with particular concerns are classified into the Special aquatic life A class, apart from the Aquatic life A class, for adaptability to aquatic life habitat conditions. What are the particular concerns for the special class? Explain concisely.

(2) Waters in some lakes and ponds seasonally undergo stratification and mixing. Explain concisely from (a) to (c).

(a) Mechanisms of stratification in a certain season

(b) Mechanisms of mixing in a certain season

(c) Adverse impacts of mixing on water use

Q. 2

Explain the following terms concisely.

(1) Electric conductivity

(2) Self-purification

(3) Detritus

(4) Confined aquifer

B – 4 Environmental Microbiology

Q.1 Give two examples each for the following microorganisms and give their representative electron donors and carbon sources for their growth. Either electron donors or carbon sources for the two examples should be different.

(1) microorganisms that utilize metals as electron acceptors or electron donors

(2) microorganisms that are involved in the sulfur cycle

(3) photosynthetic bacteria

Q.2 Answer the following questions about the bioremediation of oil-contaminated soil.

(1) By taking examples of benzene and octane, explain the major reactions when they are degraded to final products under aerobic conditions.

(2) Draw a schematic illustration of the technique of biostimulation. Include materials that should be supplied for the cleanup, if any.

(3) When the soil is also contaminated with tetrachloroethylene in addition to the oil, explain how to clean up the soil biologically.

Q.3 Concisely explain the following technical terms related to bioreactors.

(1) Washout

(2) Rotating biological contactors

(3) Microbial fuel cells

B – 5 Environmental Chemistry and Reaction Kinetics

Q. 1 A treatment process consists of three complete-mix reactors in series. For each reactor, volume is V/3 [m^3] and inflow and outflow rates are Q [m^3/s]. Substance A continuously flows into the 1st reactor at a concentration of C_0 [g/m^3]. It is degraded in each reactor according to a first-order reaction with a rate constant of k [1/s]. Here, kV/Q is equal to 3.

1) Express the differential equation representing the mass balance of substance A in the 1st reactor.
2) Determine the steady-state concentration of substance A in the effluent from the 1st reactor.
3) Determine the steady-state concentrations of substance A in the effluents from the 2nd and 3rd reactors. In addition, calculate the overall degradation ratio of substance A in the treatment process consisting of the three reactors.
4) Calculate the degradation ratios of substance A when it is treated in a single complete-mix reactor (volume: V) or in a single plug-flow reactor (volume: V). Compare these ratios with the answer of the above question 3). Use $e^{-3} = 0.05$ (e : the base of the natural logarithm).

Q. 2 A weak acid HA is dissociated in a dilute aqueous solution as shown below. The concentration equilibrium constant of HA is K_A and the total molar concentration of HA and A^- is C_T. The molar concentration of species X is expressed as [X].

$$HA \leftrightarrows H^+ + A^- \qquad K_A = \frac{[H^+][A^-]}{[HA]} \qquad C_T = [HA] + [A^-]$$

1) Molar fractions of HA and A^- relative to C_T are defined as α_0 and α_1, respectively. Express α_0 and α_1 using K_A and $[H^+]$.
2) When pH = pK_A, explain the relationship between α_0 and α_1.
3) Fig. 1 represents the relationship between the logarithmic molar concentration of each species X ($\log_{10}[X]$) and pH in a dilute aqueous solution of HA.
   ① Determine C_T of this solution.
   ② Determine the species corresponding to (a)–(d).
   ③ Determine the equilibrium pH from Fig. 1. Give the pH value and describe the procedure of obtaining the answer.

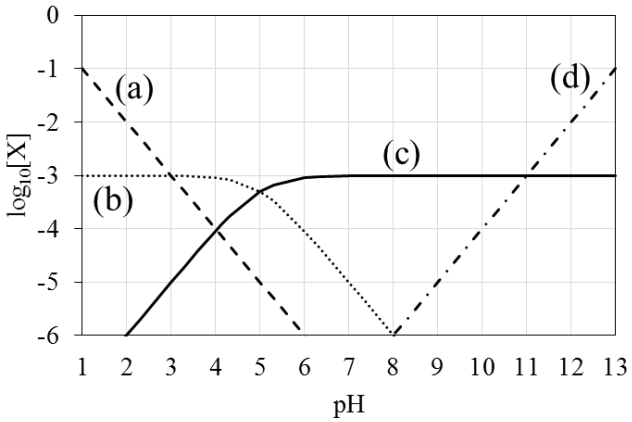


Fig. 1 Relationship between logarithmic molar concentration of each species and pH in a dilute aqueous solution of HA

B – 6 Global Environmental Engineering

Q-1 Answer the following questions about renewable energy and biomass as a renewable energy source.

(1) If a large capacity of photo-voltaic or wind turbine is connected to the transmission and distribution grid, quality and stability of the electricity supply through the grid are considered to be degraded. Explain the cause of such phenomena and technical measures taken against them.

(2) Both photo-voltaic and biomass electricity generation are technologies that transform solar radiation on the earth surface into electric power. Explain what type of data is necessary to compare their performances in terms of expected annual electricity generation per surface area.

(3) Explain advantages of biomass energy use for global environmental conservation and its possible negative environmental impacts.

Q-2 Spell out the following acronyms in English and explain each of them in about five lines.

(1) HFCs
(2) CCS
(3) LCIA

Q-3 Explain the cause of temperature rise in urban areas and measures taken against it by using all of the following terms at least once.
[global warming, heat island, water, adaptation, mitigation]

B – 7　Waste Management and Material Cycles

Q.1　The outline of “Law for Promotion of Recycling and Related Activities for the Treatment of Cyclical Food Resources” states the purpose as follows.

Read the below sentences and answer the questions from (1) to (3).

“ A large amount of food wastes is generated by [　(i)　] and throughout [　(ii)　]. To reduce the final disposal volume of the food wastes by [　(iii)　] and [　(iv)　] and to a) recycle the food wastes as materials for feeds and fertilizers, the recycling of circulative food resources by b) food-related business entities (production, distribution, food service, etc.) should be promoted.”

(1) Provide appropriate words for the boxes from (i) to (iv).

(2) Relating to a), answer the below questions (2-1) and (2-2).

(2-1) Explain the method to produce fertilizers from food wastes.

(2-2) Sewage sludge is a type of urban organic waste as well as food waste. When fertilizers are produced from these urban organic wastes, what are the common problems and what are the problems specific to fertilizer production from sewage sludge? Explain each of them.

(3) In contrast to b), explain the difficult points to promote the recycling of food wastes generated from households.

Q.2　Explain each of the below words (1)–(3), which are used in the field of waste management.

(1) Bag Filter

(2) 4R

(3) NIMBY

B – 8 Urban Planning

Answer the following three questions on “District Plan” based on Japan’s City Planning Act.

Q.1　Fill in the blanks ①～④ in the following sentences with appropriate terms.
Referring to the German system of （　①　）, Japan’s District Planning System was established by amendments in the City Planning Act and the Building Standard Act in the year （　②　）. The district plan largely consists of “the goal of the district plan,” “（　③　）,” which sets the policies to realize the goal, and “（　④　）,” which sets in detail the restrictions for buildings and structures as well as the layout of streets, parks, and plazas. “（　④　）” sometimes does not exist for all or a part of the district plan area.

Q.2　Explain the types and purposes of the items that can generally be provided in a district plan.

Q.3　Pick one example of district plans for an existing urban area where buildings are renewed individually (area where no urban development project is implemented) and explain the situation of the area, the contents of the district plan, and their purposes.

B – 9 Urban Design

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

(1) Superblock
(2) Vest pocket park
(3) Cul-de-sac
(4) Pedestrian deck

Q.2　It is widely recognized that there are two approaches to control the cityscape, namely (a) designating a special district based on planning regulations to regulate buildings' mass, form, and architectural design and (b) setting a design guideline to guide them. Answer the following questions regarding these two cityscape control approaches.

(1) Discuss the differences between the two approaches by pointing out merits and demerits of each.
(2) Take one example that combines the two approaches, either in Japan or abroad, and illustrate its actual situations.

B – 10 Urban Housing

Q.1 It is argued that the location of convenience stores should be permitted with conditions even in Category 1 Low-Rise Exclusive Residential Districts in Japan.

(1) Discuss the background issues related to this argument in about 5 lines.

(2) Discuss the conditions that you think are necessary for permission in about 5 lines.

Q.2 The "Five-Year Plan for Housing Construction" was revised seven times based on the Housing Construction Planning Act in Japan. Fill in the blanks from (a) to (e) in the table with appropriate words listed below.

[Setting targeted housing standard/Setting housing performance standard/Setting minimum housing standard/Securing stable living/Utilization of housing stock/One room for one person/One housing for one household]

Period	Fiscal year	Key objectives
1st	1966～1970	(a)
2nd	1971～1975	(b)
3rd	1976～1980	(c)
4th	1981～1985	Setting the living environment standard
5th	1986～1990	(d)
6th	1991～1995	Responding to aging society
7th	1996～2000	Promotion of safe and comfortable urban living
8th	2001～2005	(e)

Q.3 Explain the following urban housing terms in 3 lines or less.

(1) Housing sugoroku

*Sugoroku is a Japanese board game similar to "snakes and ladders" in which a player throws a dice to move a piece from the "Start" to the "Goal."

(2) (Article 42) Paragraph 2 road

(3) Continuing care retirement community (CCRC)

(4) Government Housing Loan Corporation

(5) Hedonic analysis

B – 11　Urban Disaster Management and Planning

Q.1　Answer the following questions on the four major disasters in Japan listed below.

Typhoon Vera (called Ise Bay Typhoon in Japan)
The Great Kanto Earthquake
The Great East Japan Earthquake
The Great Hanshin-Awaji Earthquake

(1) Arrange these four disasters chronologically and explain the characteristics of the damage in about 1 line each.
(2) Explain, in about 2 lines each, characteristics of the post-disaster recovery by referring to major social trends in the days when each disaster occurred.

Q.2　Answer the following questions.
(1) Explain the meaning of "hazard," "exposure," and "vulnerability" from the perspective of urban disaster management and planning, in about 1 line each.
(2) Explain the structure of natural disaster risks in urban areas using all the three terms, and discuss the role of urban planning for risk reduction in about 3 lines.
(3) Explain possible countermeasures, in theory, against a large-scale flood by referring to your answer to (2) on the role of urban planning for risk reduction in about 5 lines.

Q.3　Answer the following questions.
(1) Choose the appropriate answer.
Event probability of the Tokyo Inland Earthquake is estimated to be
(a) 70% in 10 years. (b) 70% in 30 years. (c) 70% in 50 years. (d) 70% in 100 years.
(2) Choose the appropriate answer.
Event probability of an earthquake in Tachikawa fault zone in Tokyo is estimated to be
(a) 0.5%～2% in 30 years.　(b) 5%～20% in 30 years.　(c) 50%～70% in 30 years.
(3) Express gal and kine using the CGS unit system.
(4) Explain concisely the meaning of PL values.
(5) Provide the major cause of post-earthquake fire in the Great Hanshin-Awaji Earthquake.

B – 12 Urban Analysis

Answer the following questions.

Q.1 Explain the following terms in about 5 lines each.

(1) Coefficient of determination in multiple regression analysis

(2) Rank size rule regarding the city sizes

(3) Clark’s law regarding population density distribution in a city

(4) Hotelling’s model regarding locational competition

Q.2 Describe how to predict the urban area in a city in 2050.

B – 13　Urban Transportation Planning

Q.1　Those who are not able to visit hospital are called “going-to-hospital refugees” in Japan. Explain the reason why the number of “going-to-hospital refugees” is growing in Japanese local cities, in about five lines using all of the following terms.

[Terms to be used]　“time window,” “poor transportation,” “bus service,” “location of hospital,” and “elderly household”

Q.2　The following utility functions are assumed in the disaggregate logit model to explain modal choice between a bus and a car. Answer the following questions.

$V_{bus} = \alpha + \beta_1 \cdot IVTT + \beta_2 \cdot OVTT + \beta_3 \cdot COST + \beta_4 \cdot SEX$

$V_{car} = \beta_1 \cdot IVTT + \beta_3 \cdot COST$

where IVTT: In-vehicle travel time (min)
OVTT: Out-of-vehicle travel time (min)
COST: Cost (yen)
SEX: Sex (male = 0, female = 1)

(1)　When other conditions are all equal and women tend to use bus more than men, what is the sign of β_4, plus or minus?

(2)　Explain the reason why β_2 is often nearly twice as much as β_1.

(3)　How much yen equals one minute of IVTT? Express it using β_1 and β_3.

(4)　What does the constant term α represent?

Q.3　What are the merits of a municipal government to be responsible for making and implementing a public transportation network plan? Explain two major merits in about five lines.

B – 14 Regional Planning

Q.1 An index, which measures the degree of regional disparities in a country divided by n regions, is given by the formula shown below, where y_i is a positive value indicating a socio-economic condition of a region i. Answer the following questions.

$$A = \frac{1}{2n^2\mu}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_i - y_j\right| \qquad \mu = \frac{\sum_{i=1}^{n} y_i}{n}$$

(1) Choose a correct answer for the most commonly used name of A.
(a) coefficient of variation (b) location quotient (c) t-statistic (d) Gini coefficient

(2) Answer in one line, how the situation of regional disparities in the country is if the value of A equals 0 (zero).

(3) When i region is each prefecture in Japan and y_i is per capita prefectural income of the region i, values of A after 1970s are mostly lower than those during high-growth period in 1960s. Explain the reason for this in terms of population movement and industrial locations within about six lines.

(4) Point out and discuss two limitations of evaluating regional disparities with the index A by per capita prefectural income as (3) within about six lines.

Q.2 Measures for the improvement of low income groups' residential conditions in developing countries, besides government-led policies and projects, can be classified into those led by local communities and those promoted through the market dynamism. Discuss the respective characteristics of these two measures within about 10 lines.

B – 15 Landscape Planning and Design

Q.1　Choose three out of the five terms below, and explain them concisely in about 70 words each.

(1) Kleingarten
(2) Garden city
(3) Special green space conservation district
(4) Ecosystem services
(5) Park management

Q.2　Answer the following two questions.

(1) Figure 1 on the next page shows population changes between 1960 and 2010 and population density, in 2010, of four cities in the world. Choose Tokyo (23 Wards) and Detroit from the four options (A to D) in the figure.
(2) Table 1 on the next page shows the current industry and employment status of Tokyo and Detroit. In consideration of the numbers in Figure 1 and Table 1, explain challenges of Tokyo and Detroit in creating and maintaining open space (including farmland) and its social background concisely in about 200 words each.

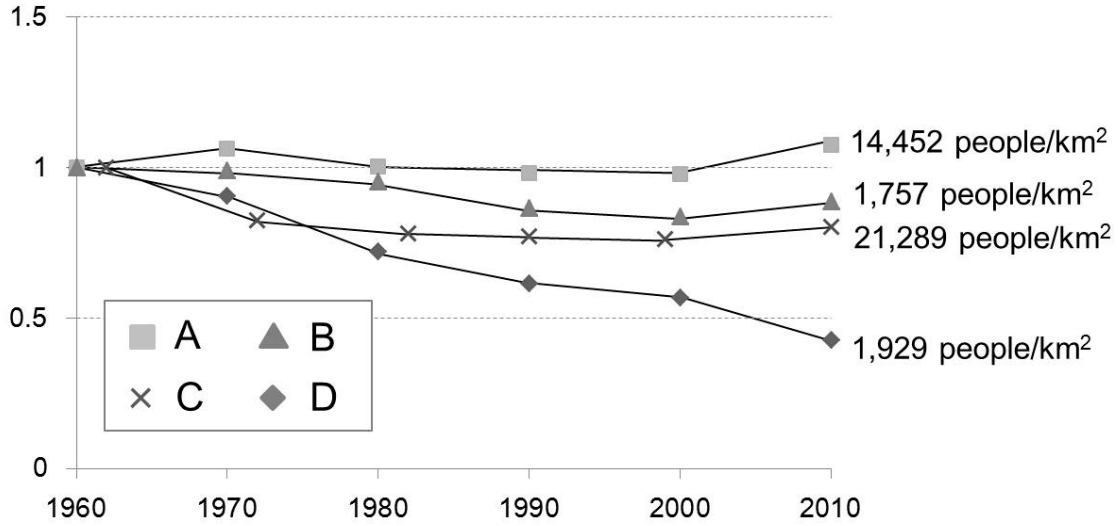


Figure 1　Population changes and population densities of four cities

(Population is shown by ratio from 1960 (A, B, D) and 1962 (C) as the base lines)

Table 1　Industry and employment status of Tokyo and Detroit

		Tokyo (23 wards)		Detroit	
		2000	2015	2000	2014
Population by industry	Primary industry	8,196	5,600*	514	881
	Secondary industry	924,875	518,700*	74,461	35,222
	Tertiary industry	3,309,982	3,273,700*	224,900	173,627
Unemployment rate (%)		5.0**	3.6**	13.8	27.1

**Industry status of Tokyo in 2015 is preliminary figure

**Unemployment rate of Tokyo is based on the administrative area of Tokyo Metropolitan Government