広島大学大学院工学研究科（博士課程前期）外国人留学生特別選抜
社会基盤環境工学専攻　試験科目：社会基盤環境工学
模　擬　問　題

専門科目Ⅰ

小論文Ａ：社会基盤環境工学に関する知識と思考力などを問う

小論文Ｂ：希望研究課題に関する先行研究のレビュー

Graduate School of Engineering (Master's Programs)
Special Selection for International Students
Civil and Environmental Engineering
Entrance Examination Sample Questions

Specialized Subject I

Essay A: Examination on the applicant's knowledge and thinking capacity on Civil and Environmental Engineering

Essay B: Review of previous studies regarding desired research topic

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	小論文 Essay

問題 1
次の 3 問のうち，2 問を選び，解答せよ．

(1) 地球温暖化や酸性化などの地球環境問題の解決に向け，社会基盤環境工学が果たすべき役割について，800 字程度であなたの考えを述べよ．

(2) 1980 年代，「アメリカの荒廃」は，社会基盤施設の深刻な老朽化に警鐘を鳴らしたものであった．日本でも，近年，社会基盤施設の老朽化が社会問題となっている．この問題の原因と解決方法に関して，800 字程度であなたの考えを述べよ．

(3) 近年，世界の様々な地域において，地震，洪水，土砂災害，高潮などの大規模な自然災害が以前よりもより高い頻度で発生しているように思われる．自然災害の被害軽減における社会基盤環境工学の役割について，800 字程度であなたの考えを述べよ．

Question 1
Answer two questions out of the following three questions, (1) to (3).

(1) Express your views in some 400 words regarding roles of civil and environmental engineering to solve global environmental issues such as global warming, acidification and so forth.

(2) In 1980s, "America in ruin" sounded the alarm about the severe deterioration of civil infrastructures. Recently, the deterioration of infrastructures in Japan also becomes a social problem. Write your idea on the reason and the solution of this problem in some 400 words.

(3) It seems that, in various areas of the world, large scale natural disasters, such as earthquake, flood, landslide or storm surge, have been taking place more frequently than before. Explain your idea on the role of civil and environmental engineering for mitigation of these natural disasters in some 400 words.

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	小論文 Essay

問題 2
大学院博士課程前期入学後の希望研究課題を記したうえで，希望研究課題に関して，研究の背景，先行研究の目的，方法，成果，残された課題等を整理して，1,600 字程度で記述せよ.

Question 2
After writing your desired study topic in the master's program, explain the background of the study and summarize the objectives, methodologies, results and problems of previous studies, in some 800 words.

広島大学大学院工学研究科（博士課程前期）外国人留学生特別選抜

社会基盤環境工学専攻　試験科目：社会基盤環境工学

模　擬　問　題

専門科目 II

以下の７科目から１科目を選択（選択する科目は出願時に登録）

- 構造工学（材料力学，構造力学，エネルギー原理）
- コンクリート工学（コンクリート用材料，フレッシュおよび硬化コンクリートの性質，コンクリート構造）
- 地盤工学（土の力学，土構造物の設計，地盤防災）
- 環境衛生工学（水質化学，上下水道，微生物生態，反応速度論）
- 水理学（運動量とエネルギーの保存則，層流と乱流，開水路と管路の流れ）
- 土木計画学（都市計画，交通需要予測）
- 応用数学（線形代数，微積分，常微分方程式，確率・統計）

Graduate School of Engineering (Master's Programs)

Special Selection for International Students

Civil and Environmental Engineering

Entrance Examination Sample Questions

Specialized Subject II

Select one of the following seven subjects, which must be registered in the application:

- Structural Engineering (strength of material, structural mechanics, and energy principles)
- Concrete Engineering (materials for concrete, properties of fresh and hardened concrete, and concrete structure)
- Geotechnical Engineering (soil mechanics, design of earth structures, and geotechnical disaster mitigation)
- Sanitary and Environmental Engineering (water chemistry, water supply and sewerage systems, microbial ecology, and kinetics)
- Hydraulics (conservation laws of momentum and energy, laminar and turbulent flows, and flows in open channels and conduits)
- Infrastructure and Transportation Planning (city planning and transportation demand forecasting)
- Applied Mathematics (linear algebras, differential and integral calculus, ordinary differential equation, and probability and statistics)

模　擬　問　題

専門科目 II

構造工学（材料力学，構造力学，エネルギー原理）

Entrance Examination Sample Questions

Specialized Subject II

Structural Engineering (strength of material, structural mechanics, and energy principles)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	構造工学 Structural Engineering

問題 1
以下の語句について説明せよ.

(1) モールの応力円
(2) 平面応力と平面ひずみ
(3) 補仮想仕事の原理(単位荷重法)

Question 1
Explain following terms.

(1) Mohr's stress circle
(2) Plane stress and plane strain
(3) Principle of complementary virtual work (Unit load method)

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	構造工学 Structural Engineering

問題２

Fig.2-1 に示すトラスの下弦材に格点を介して間接荷重が作用する場合，以下の問に答えよ.

(1) 支点 A と B の反力の影響線を描け.
(2) 上弦材と斜材の部材力 U と D の影響線を描け.
(3) スパン全域に等分布荷重 q が作用する場合の上弦材の部材力 U を求めよ.

Question 2

A truss structure shown in Fig. 2-1 is subjected to an indirect load at the panel point of the bottom chord member. Answer the following questions.

(1) Draw the influence lines of reaction forces at the points A and B.
(2) Draw the influence lines of internal forces, U and D, in the upper chord member and diagonal member.
(3) When the truss is subjected to a uniformly-distributed load, q, at the whole span, give the internal force, U, in the upper chord member.

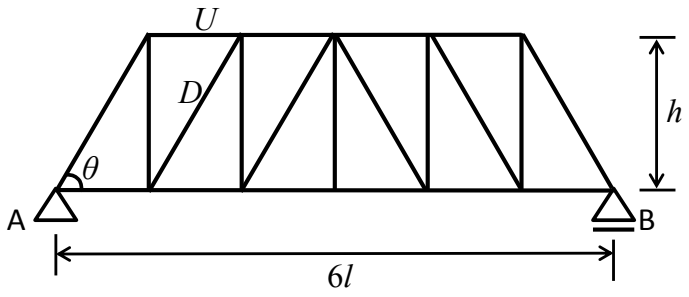

Fig. 2-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	構造工学 Structural Engineering

問題３

Fig.3-1 に示す，等分布荷重 q が作用するゲルバー梁について，以下の問に答えよ.

(1) 支点 A と B の反力を求めよ.

(2) せん断力図および曲げモーメント図を描け.

Question 3

Regarding a Gerber beam subjected to a uniformly-distributed load, q, as shown in Fig. 3-1, answer the following questions.

(1) Give the reaction forces at the points A and B.

(2) Draw the shear force diagram and the bending moment diagram.

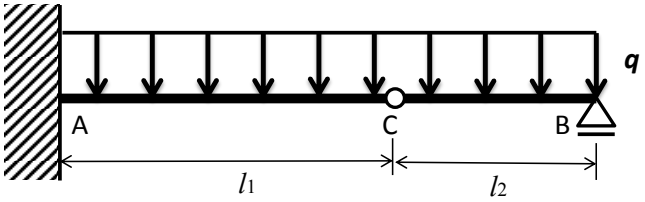

Fig. 3-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	構造工学 Structural Engineering

問題４

Fig. 4-1 に示すように，両端が固定されたはり AB の中央に集中荷重 P が作用している．はりの弾性係数を E，断面２次モーメントを I として，以下の問に答えよ．なお，変形にともなって発生する軸力は無視できるものとする．

(1) このはりの不静定次数を示し，一般的な不静定構造物の断面力を求めるための基本的な考え方を示せ.
(2) 各支点反力を求めよ.
(3) せん断力図と曲げモーメント図を図示せよ.

Question 4

A beam AB fixed at both ends is subjected to a concentrated load P at the center, as shown in Fig. 4-1. Elastic modulus and inertial moment of the beam are E and I, respectively. Answer the following questions, assuming that the axial force caused by the deformation of the beam can be neglected.

(1) Give the degree of redundancy of the beam, and show a policy on obtaining cross-sectional forces of statically indeterminate beam.
(2) Give the reaction forces at the ends.
(3) Draw the shear force diagram and the bending moment diagram.

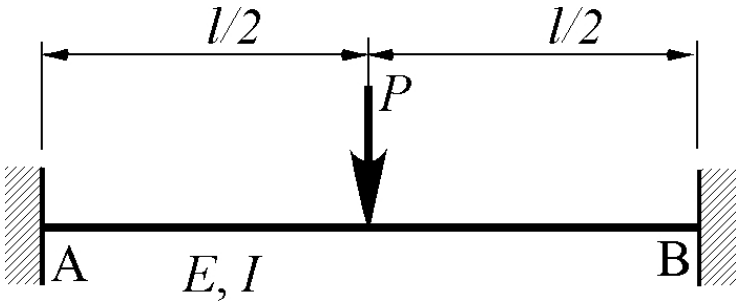

Fig. 4-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	構造工学 Structural Engineering

問題５

Fig. 5-1 に示すようなピン結合された構造物がある．点 A に外力（*x* 方向力：*X*，*y* 方向力：*Y*）が作用し，各部材には N_1，N_2，N_3 の軸力を生じて釣り合っているとき，すべての部材の断面積を *A* として，以下の問に答えよ．

(1) 点 A に仮想変位（*x* 方向変位：δu および *y* 方向変位：δv）を与えたとき，各部材の軸ひずみの増分を変位 δu および δv を用いて表せ．

(2) 仮想仕事の原理を用いて構造物の釣り合い式を導出せよ．

Question 5

A pinned structure constructed by three rods is subjected to a force (*x*-direction: *X*, *y*-direction: *Y*) at the point A, as shown in Fig. 5-1. The axial forces of the rods are N_1, N_2 and N_3 at the equilibrium state. Answer the following questions. Let *A* be cross-sectional area of all rods.

(1) When virtual displacements (*x*-direction: δu, *y*-direction: δv) are given at the point A under the equilibrium state, give the strain of each rod by using the virtual displacements of δu and δv.

(2) Derive the equilibrium equations based on the virtual work principle.

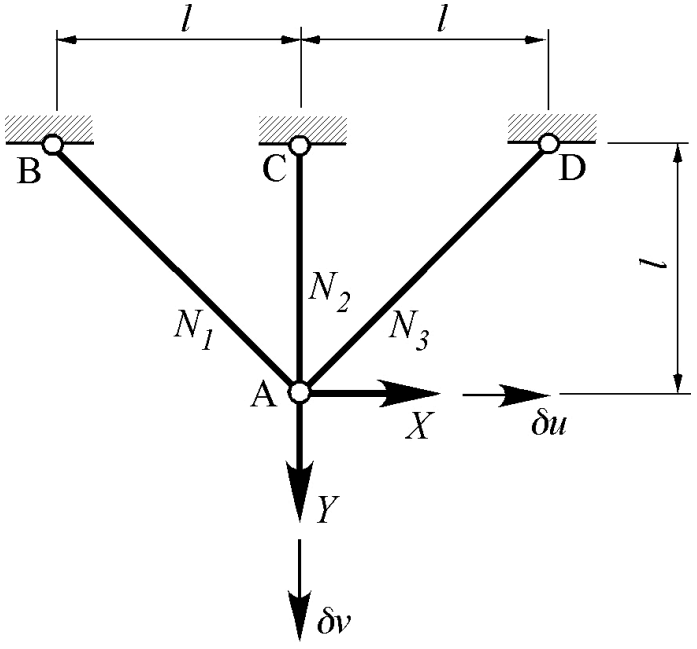

Fig. 5-1

模　擬　問　題

専門科目 II

コンクリート工学（コンクリート用材料，フレッシュおよび硬化コンクリートの性質，
コンクリート構造）

Entrance Examination Sample Questions

Specialized Subject II

Concrete Engineering (materials for concrete, properties of fresh and hardened concrete, and concrete structure)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	コンクリート工学 Concrete Engineering

問題 1
以下の問に答えよ.
(1) C_3S の水和反応式を示し，水和反応の特徴を説明せよ.
(2) 骨材の４つの含水状態について説明せよ.
(3) 減水剤によるセメント分散機構について説明せよ.
(4) 混和材としての高炉スラグ微粉末の特徴を説明せよ.
(5) コンクリートのワーカビリティについて説明せよ.
(6) エントレインドエアについて説明せよ.
(7) コンクリートのクリープに影響を及ぼす要因を挙げよ.
(8) コンクリートの強度におけるセメント水比説について説明せよ.
(9) コンクリートの静弾性係数（初期接線弾性係数，割線弾性係数，接線弾性係数）について説明せよ.

Question 1
Answer the following questions.
(1) Give the hydration reaction equation of C_3S and explain the characteristics of its hydration reaction.
(2) Explain four moisture states of aggregate.
(3) Explain the dispersion mechanism of cement due to water-reducing agent.
(4) Explain the characteristics of ground granulated blast furnace slag as a mineral admixture.
(5) Explain workability of concrete.
(6) Explain entrained air.
(7) Give the factors that influence creep of concrete.
(8) Explain the cement water ratio theory for strength of concrete.
(9) Explain static modulus of elasticity (initial tangent modulus, secant modulus and tangent modulus of elasticity) of concrete.

問題 2
鉄筋コンクリートに埋設された鉄筋を腐食させる代表的な要因を２つ挙げ，それぞれについて腐食に至るメカニズムを説明せよ．また，各要因について，防止対策を２つずつ挙げ，それぞれについてその概要とそれを対策として取り上げた理由を説明せよ.

Question 2
Give two typical factors that cause corrosion of steel embedded in reinforced concrete and explain the mechanism of steel corrosion due to each factor. For each factor, provide two countermeasures and explain their outlines together with the reasons why you provide those countermeasures.

問題 3

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	コンクリート工学 Concrete Engineering

アルカリシリカ反応によるコンクリートの劣化メカニズムならびに劣化の特徴を，ひび割れの特徴とあわせて説明せよ．また，代表的な防止対策を３つ挙げ，それぞれについてその概要とそれを対策として取り上げた理由を説明せよ．

Question 3
Explain the mechanism and characteristics of concrete deterioration caused by alkali silica reaction, together with resultant crack patterns. Also provide three typical countermeasures against alkali silica reaction and explain their outlines in addition to the reasons why you provide those countermeasures.

問題 4
以下の問に答えよ．
(1) コンクリートの収縮のメカニズムを，セメントペーストの収縮の観点から説明せよ．
(2) コンクリートの収縮に及ぼす骨材の影響に関して説明せよ．
(3) コンクリートの収縮が構造物の力学性能に及ぼす影響を説明せよ．

Question 4
Answer the following questions.
(1) Explain the mechanism of the shrinkage of concrete from the view point of the shrinkage of cement paste.
(2) Explain the effect of the aggregates on the shrinkage of concrete.
(3) Explain the effect of the shrinkage of concrete on the mechanical performance of concrete structures.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	コンクリート工学 Concrete Engineering

問題 5
以下の問に答えよ．
(1) 矩形断面を有する鉄筋コンクリートはり（高さ h，有効高さ d，幅 b，中立軸深さ x）の曲げ破壊時のコンクリートの圧縮合力は，等価応力ブロック（$0.85f'_c \times 0.8x$）を用いて計算できることを，以下の Fig.5-1 に示す応力－ひずみ関係を用いて説明せよ．ただし，k_1=0.85，ε_{co}=0.002，ε_{cu}=0.0035 とする．
(2) T 形断面を有する鉄筋コンクリートはり（高さ h，有効高さ d，フランジ厚 t，幅 b，ウェブ幅 b_w，中立軸深さ x）の曲げ破壊時のコンクリートの圧縮合力を，等価応力ブロックを用いて求めよ．

Question 5
Answer the following questions.
(1) Explain that total compressive force in concrete at the bending failure of a rectangular reinforced concrete beam (h: height, d: effective depth, b: breadth, x: neutral axis depth) can be calculated by using equivalent stress block ($0.85f'_c \times 0.8x$) based on the following stress-strain relation in Fig.5-1, where k_1=0.85, ε_{co}=0.002, and ε_{cu}=0.0035.
(2) Give the total compressive force in concrete at the bending failure of a T-shaped reinforced concrete beam (h: height, d: effective depth, t: thickness of flange, b: breadth, b_w: breadth of web, x: neutral axis depth) by using the equivalent stress block.

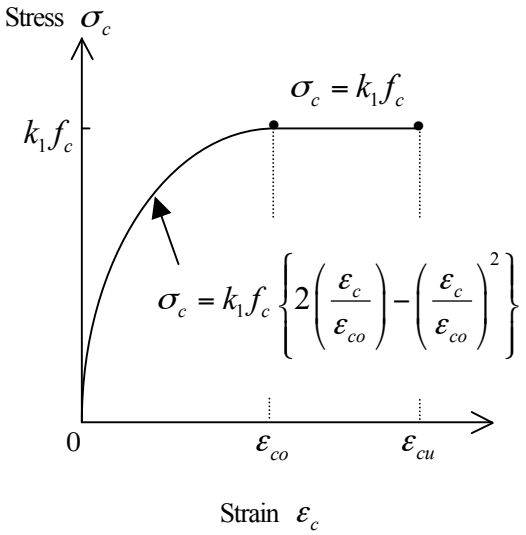

Fig.5-1

模　擬　問　題

専門科目 II

地盤工学（土の力学，土構造物の設計，地盤防災）

Entrance Examination Sample Questions

Specialized Subject II

Geotechnical Engineering (soil mechanics, design of earth structures, and geotechnical disaster mitigation)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

問題 1

以下の問に答えよ.

(1) 以下の 5 つの用語のそれぞれについて，定義式を示し，説明せよ.
均等係数，鋭敏比，塑性指数，相対密度，飽和度

(2) 以下の 3 つの用語を用いて土の動的変形特性について述べよ.
せん断弾性係数，減衰定数，ひずみレベル

Question 1

Answer the following questions.

(1) Explain each of the following 5 technical terms showing the definitions.
coefficient of uniformity, remolding sensitivity, plasticity index, relative density, degree of saturation

(2) Explain dynamic characteristics of soil with the following 3 technical terms.
shear modulus, damping ratio, strain level

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

問題2

以下の問に答えよ.

(1) 定水位透水試験の概要を，試験機の図を描いて示せ.

(2) 粘土地盤が正規圧密地盤であるかあるいは過圧密地盤であるかについて，圧密試験結果を用いてどのようにして判断するかを説明せよ.

Question 2

Answer the following questions.

(1) Show the outline of the constant head permeability test of soil with a figure of the apparatus.

(2) Explain how to judge whether the clayey ground is normally consolidated ground or overconsolidated ground from the result of consolidation test.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

問題 3

Fig.3-1 のように，三軸試験機によって飽和粘土供試体を圧力 σ_c で等方的に圧密した．圧密終了後に非排水条件で圧縮を行った結果，最大の軸差応力とそのときの間隙水圧はそれぞれ，$(\sigma_1-\sigma_3)_f$，u_f であった．この粘土の有効応力に関する内部摩擦角を ϕ'，粘着力を c' とする．以下の問に答えよ．

(1) 破壊時の供試体の全応力状態と有効応力状態をそれぞれモールの応力円を用いて示せ．

(2) 粘土の非排水せん断強度 s_u ，間隙水圧係数 A_f を，それぞれ次式で定義する．

$$s_u = \frac{(\sigma_1 - \sigma_3)_f}{2} \quad , \quad A_f = \frac{u_f}{(\sigma_1 - \sigma_3)_f}$$

非排水せん断強度 s_u を，ϕ'，c'，A_f，σ_c で示せ．

Question 3

As shown in Fig.3-1, a saturated clay specimen was consolidated isotropically in a triaxial cell with the cell pressure of σ_c. After the completion of consolidation, the undrained compression test was carried out and the maximum deviator stress $(\sigma_1-\sigma_3)_f$ and the pore pressure u_f were obtained. The internal friction angle and cohesion on effective stress of this clay are ϕ' and c', respectively. Answer the following questions.

(1) Show the total stress condition and the effective stress condition of the clay specimen at failure, using Mohr's stress circles.

(2) Undrained shear strength of clay s_u , and the coefficient of pore pressure A_f are defined as follows.

$$s_u = \frac{(\sigma_1 - \sigma_3)_f}{2} \quad , \quad A_f = \frac{u_f}{(\sigma_1 - \sigma_3)_f}$$

Show the undrained shear strength s_u using ϕ', c', A_f and σ_c.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

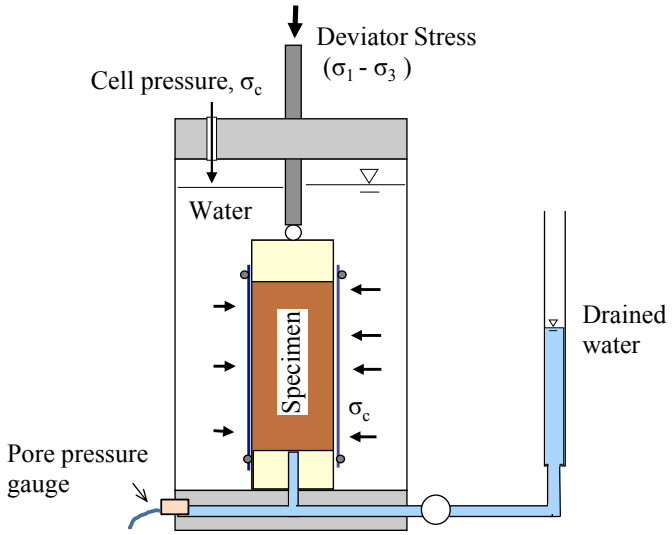

Fig.3-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

問題 4

Fig.4-1 のように一次元的に粘土地盤を圧密する場合を考える．このとき以下に示す圧密の偏微分方程式（Terzaghi の圧密方程式）を，必要な仮定を示しながら導出せよ．

$$\frac{\partial u}{\partial t} = c_v \frac{\partial^2 u}{\partial z^2} \quad ; \quad C_v = \frac{k}{m_v \gamma_w}$$

ただし，u は間隙水圧，k は透水係数，z は粘土要素の位置（粘土層下端からの高さ），m_v は体積圧縮係数，γ_w は水の単位体積重量である．

Question 4

Let us consider the one-dimensional consolidation of clayey ground as shown in Fig.4-1. Derive the following partial differential equation of consolidation (Terzaghi's equation of consolidation), showing the necessary assumptions.

$$\frac{\partial u}{\partial t} = c_v \frac{\partial^2 u}{\partial z^2} \quad ; \quad C_v = \frac{k}{m_v \gamma_w}$$

where, u is pore water pressure, k is coefficient of permeability, z is the distance of the element of clay from the bottom of clay layer, m_v is a coefficient of volumetric compressibility and γ_w is unit weight of water.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

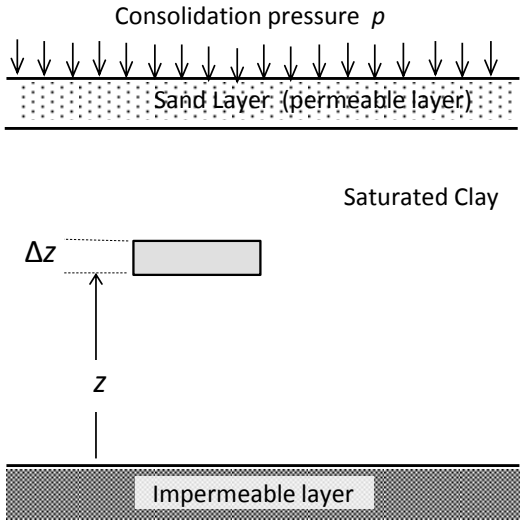

Fig.4-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

問題 5

Fig.5-1 に示すように，円弧すべり面に沿った斜面の安定をスライスに分割した土塊で考える．
円弧の半径をr，その中心点をOとし，右から数えてi番目のスライスについて，このスライスの幅をb_i，高さをH_i，重量をW_iとし，スライス底面の勾配をα_i，スライス底面の長さをl_iとする．すべり面に作用する垂直力をP_i，せん断力をS_iとする．スライスの両側面に働く力は無視し，地下水面は考えないものとする．スライスの底面部分に存在する土の強度定数が円弧全体で等しくcとϕであると仮定する．以下の問に答えよ．

(1) すべり面に垂直な方向の，土塊の力の釣り合い式を示せ．

(2) 下記に示す Fellenius 法の安全率の式を導出せよ．

$$F = \frac{\sum_{i=1}^{n}\left[W_i \cos\alpha_i \tan\phi + cl_i\right]}{\sum_{i=1}^{n} W_i \sin\alpha_i}$$

Question 5

Let us consider the slope stability with sliced mass of soils along the circular arc shown in Fig.5-1. The radius of the arc is r, and the center of the arc is O. The width of the *i*-th slice from the right is b_i, the height is H_i, and the weight is W_i. The inclination at the bottom of the slice is α_i, and the length of the bottom of the slice is l_i. The forces acting on the bottom of the slice in the perpendicular and parallel to the bottom of the slice are P_i and S_i, respectively. The forces acting on the both sides of the slice and the ground water level can be neglected. Assuming the strength parameter for the soil at the bottom of the slice are c and ϕ for all the slices, answer the following questions.

(1) Show the equation for the sum of forces acting on the slice in direction perpendicular to the bottom of the slice.

(2) Derive the following equation of the safety factor (Fellenius method).

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	地盤工学 Geotechnical Engineering

$$F = \frac{\sum_{i=1}^{n}\left[W_i \cos\alpha_i \tan\phi + cl_i\right]}{\sum_{i=1}^{n} W_i \sin\alpha_i}$$

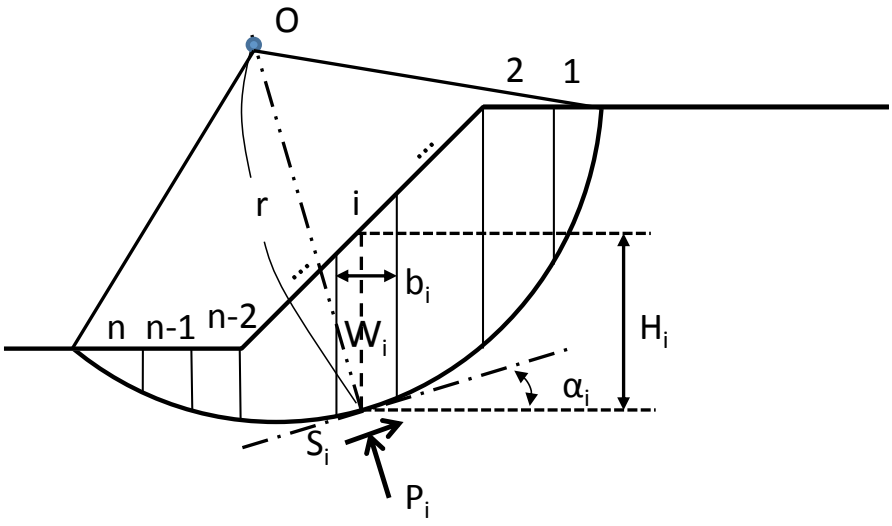

Fig.5-1

模　擬　問　題

専門科目 II

環境衛生工学（水質化学，上下水道，微生物生態，反応速度論）

Entrance Examination Sample Questions

Specialized Subject II

Sanitary and Environmental Engineering　(water chemistry, water supply and sewerage systems, microbial ecology, and kinetics)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	環境衛生工学 Sanitary and Environmental Engineering

問題１

(1)湖沼の pH に影響を与える因子を２つあげ，その因子が pH を変化させる機構を説明せよ.

(2) 水中の有機物濃度を評価する際，湖沼においては BOD よりも COD のほうが一般的に用いられる．その理由を説明せよ.

(3) 濁度と吸光度の違いを説明せよ．ただし以下の用語を用いること：
吸収　反射　散乱　光

Question 1

(1) Indicate two factors that influence the pH in lakes and explain their mechanisms.

(2) For the estimation of the lake water quality, COD is more frequently used for organic matter concentration than BOD. Explain the reason for it.

(3) Explain the difference between turbidity and light absorbance using the following terms:
absorption; reflection; scattering; light

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	環境衛生工学 Sanitary and Environmental Engineering

問題 2

(1) 浄水の消毒について，オゾン，紫外線処理と比較して塩素処理を用いる長所と短所を 100 字程度で述べよ.
(2) 浄水プロセスにおける急速ろ過の浄化原理について，図を用いて 100 字程度で説明せよ.
(3) 理想沈殿池の主要な条件を一つ示せ.

Question 2

(1) Show the advantages and disadvantages of disinfection by chlorination in drinking water treatment processes compared to ozonation and/or ultraviolet treatment in some 50 words.
(2) Explain the purification mechanism of rapid filtration in drinking water treatment processes in some 50 words with figures.
(3) Show a primary condition of the ideal sedimentation tank.

問題 3

(1) 活性汚泥のバルキングとは何かを 100 字程度で説明せよ.
(2) 余剰活性汚泥の有効利用方法を一つ示し，その意義を簡単に説明せよ.
(3) 循環式硝化・脱窒プロセスによる下水の生物学的窒素除去に関して，除去率を高めるためのコントロール可能な因子を一つ示し，プロセスフロー図を用いて除去率が高くなることの説明をせよ.

Question 3

(1) Explain what the bulking of activated sludge is in some 50 words.
(2) Show a way for effective utilization of excess activated sludge, and explain its significance briefly.
(3) With regard to the nitrification/denitrification process with recirculation for biological nitrogen removal from sewage, show a controllable factor to increase its removal efficiency and explain the reason why the efficiency is increased with the process flow diagram.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学（専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	環境衛生工学 Sanitary and Environmental Engineering

問題 4

完全混合の生物反応槽(容積 V(m^3))に水量 Q (m^3 s^{-1})の汚水が流入し末端から水量 Q (m^3 s^{-1})の処理水が流出している(Fig. 4-1). 流入水中の汚濁物質濃度は C_{in} (g m^{-3}), 流出水濃度は C_{out} (g m^{-3})とする．以下の問に答えよ．ただし汚濁物質の分解は濃度の一次反応に従う(反応速度定数：k(s^{-1}))とする．

(1) 定常状態における C_{out} を V, Q, C_{in}, k で表せ.

(2) 定常状態における除去率($1-C_{out}/C_{in}$)は 0.9 であった．除去率の向上を目的として反応槽を追加または容積を増大させるとき，以下の問に答えよ．ただし k は一定とする．

(a) 反応槽の容積を 2 倍(2V)にしたときの定常状態の除去率を求めよ(Fig. 4-2a).

(b) 同じ容積 V の完全混合層の反応槽を後段に直列に設置した場合の定常状態の除去率を求めよ (Fig. 4-2b).

Question 4

There is a completely mixed bioreactor with a volume of V (m^3) and influent and effluent at a flow rate of Q (m^3 s^{-1}) (Fig. 4-1). The influent pollutant concentration is C_{in} (g m^{-3}) and that of effluent is C_{out} (g m^{-3}). The pollutant is decomposed in the tank and its decomposition follows the first-order reaction of the pollutant concentration (reaction rate constant: k (s^{-1})). Answer the following questions.

(1) Formulate C_{out} as a function of V, Q, C_{in}, and k.

(2) The removal ratio ($1-C_{out}/C_{in}$) was 0.9 at the steady state. In the case that one more reactor is added or the volume is increased in order to raise the removal ratio, answer the following questions. The k value is unchanged.

(a) Derive the removal ratio at the steady state in the case that the volume is simply doubled (2V) (Fig. 4-2a).

(b) Derive the removal ratio at the steady state in the case that the completely mixed bioreactor with a same volume V is set in series at the subsequent stage (Fig. 4-2b).

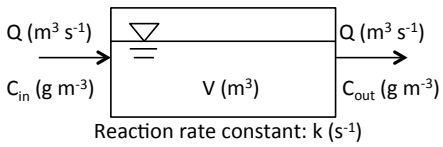

Fig. 4-1

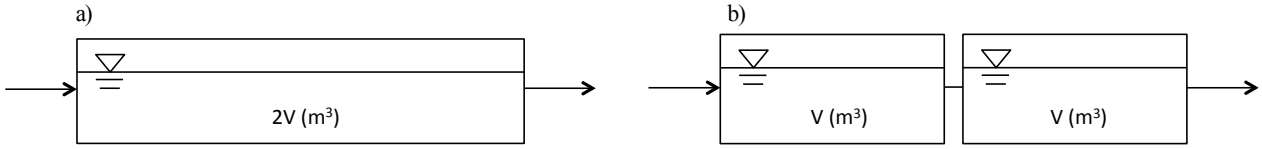

Fig. 4-2

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学（専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	環境衛生工学 Sanitary and Environmental Engineering

問題 5

25℃における 0.5 mol L^{-1} のアンモニア溶液について以下の問に答えよ．アンモニアの解離式および解離定数は以下のように表される．

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

$$\frac{[NH_4^+][OH^-]}{[NH_3]} = K_b$$

25℃におけるアンモニアの塩基解離定数 K_b は 1.8×10^{-5}，水のイオン積 K_w は 1.0×10^{-14} である．必要に応じて次の値を用いよ．$\log_{10}2=0.3$, $\log_{10}3=0.5$, $\sqrt{1.8}=1.34$, $\sqrt{2}=1.4$, $\sqrt{3}=1.7$, $\sqrt{5}=2.2$, $\sqrt{10}=3.2$.

(1) アンモニアの解離度を α とするとき，アンモニア，アンモニウムイオン，水酸化物イオンの濃度を示せ．
(2) 解離度 α を計算せよ．
(3) pH を計算せよ．

Question 5

Answer the following questions related to a solution of 0.5 mol L^{-1} ammonia at 25°C. The equilibrium of ammonia dissociation and the base dissociation constant for ammonia are expressed as follows:

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

$$\frac{[NH_4^+][OH^-]}{[NH_3]} = K_b$$

The base dissociation constant for ammonia K_b is 1.8×10^{-5} and the dissociation constant for water K_w is 1.0×10^{-14} at 25°C. Use the following values if necessary: $\log_{10}2=0.3$, $\log_{10}3=0.5$, $\sqrt{1.8}=1.34$, $\sqrt{2}=1.4$, $\sqrt{3}=1.7$, $\sqrt{5}=2.2$, $\sqrt{10}=3.2$.

(1) When the degree of dissociation for ammonia is expressed as α, show the concentrations of ammonia, ammonium ion, and hydroxide ion.
(2) Determine the degree of dissociation for ammonia, α.
(3) Determine the pH.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	環境衛生工学 Sanitary and Environmental Engineering

問題 6

Fig. 6-1 は 16S rRNA 遺伝子に基づくある細菌グループの系統樹である．以下の問に答えよ．

(1) 図中の括弧内は何を表しているかを示せ．

(2) 図中の下線（スケールバー）は何を表しているかを示せ．

(3) "*Candidatus*"の意味を説明せよ．

(4) 細菌・古細菌の系統分類に 16S rRNA 遺伝子が用いられる理由を 2 つ以上あげ説明せよ．

Question 6

Fig. 6-1 shows the phylogenetic tree of a bacterial group based on 16S rRNA genes. Answer the following questions.

(1) Explain what the notation in parentheses in Fig. 6-1 is.

(2) Explain what the underline (scale bar) in Fig. 6-1 is.

(3) Explain the meaning of the "*Candidatus*" in the clones.

(4) Explain at least two reasons why 16S rRNA gene is used for the phylogenetic classification of the domain Bacteria and Archaea.

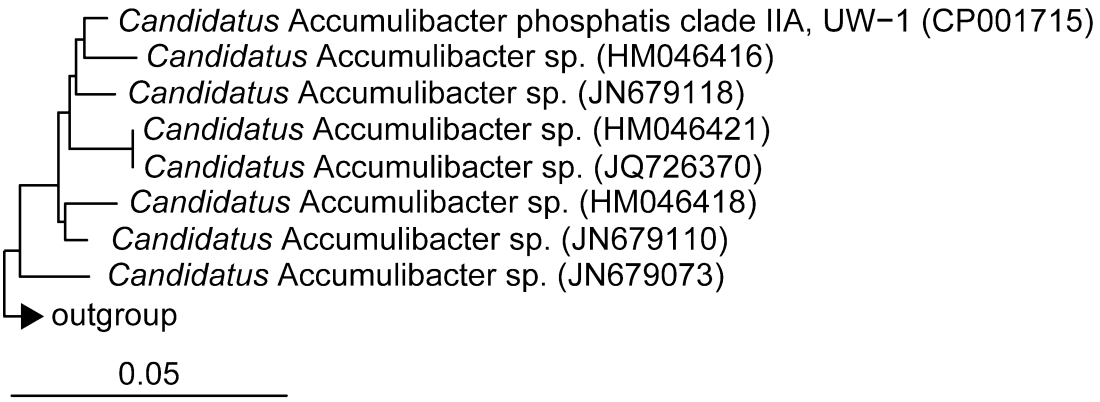

Fig. 6-1

模　擬　問　題

専門科目 II

水理学（運動量とエネルギーの保存則，層流と乱流，開水路と管路の流れ）

Entrance Examination Sample Questions

Specialized Subject II

Hydraulics (conservation laws of momentum and energy, laminar and turbulent flows, and flows in open channels and conduits)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

問題１

広幅の長方形断面を有する開水路における等流に対するレイノルズ方程式は次式で表される．

$$\left.\begin{aligned} 0 &= g\sin\theta + \nu\frac{d^2\overline{u}}{dz^2} + \frac{d(-\overline{u'w'})}{dz} \\ 0 &= -g\cos\theta - \frac{1}{\rho}\frac{d\overline{p}}{dz} \end{aligned}\right\}$$

ここで，θ は水路の傾斜角，g は重力加速度，ρ は水の密度，ν は水の動粘性係数を表し，z は水路床を 0 とし，水路床に垂直上向きを正とした座標である．

水深を h として，以下の問に答えよ．

(1) 圧力分布 $\overline{p}(z)$ を求めよ．

(2) せん断応力分布 $\overline{\tau}(z)$ と摩擦速度 u_* を求めよ．

(3) 層流であるとき，その流速分布が次式で表されることを示せ．

$$u(z) = \frac{g\sin\theta}{2\nu}\left(2hz - z^2\right)$$

(4) 乱流であるとき，その流速分布が次式で表されることを示せ．ただし，混合距離 l_m は $l_m = \kappa z\sqrt{1 - z/h}$ と表されるものとする．

$$\overline{u}(z) = \frac{u_*}{\kappa}\ln z + C$$

ここで，κ はカルマン定数，C は積分定数である．

Question 1

For a uniform flow in a wide rectangular open-channel, the Reynolds equations are as follows:

$$\left.\begin{aligned} 0 &= g\sin\theta + \nu\frac{d^2\overline{u}}{dz^2} + \frac{d(-\overline{u'w'})}{dz} \\ 0 &= -g\cos\theta - \frac{1}{\rho}\frac{d\overline{p}}{dz} \end{aligned}\right\}$$

where θ is the tilt angle of the channel, g the acceleration of gravity, ρ and ν are the density and the kinematic viscosity of water, respectively. The coordinate z is perpendicular to the channel bed and the origin is on the bed; the positive direction is upward.

Let h be the water depth, answer the following questions.

(1) Find the pressure distribution $\overline{p}(z)$.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学（専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

(2) Find the distribution of the shear stress $\overline{\tau}(z)$ and the shear velocity u_*.

(3) In the case of laminar flow, derive the velocity distribution: $u(z) = \dfrac{g\sin\theta}{2\nu}\left(2hz - z^2\right)$.

(4) In the case of turbulent flow, given Prandtl's mixing length $l_m = \kappa z\sqrt{1 - z/h}$, derive the velocity distribution: $\overline{u}(z) = \dfrac{u_*}{\kappa}\ln z + C$, where κ is the Karman constant and C is the constant of integration.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

問題2

Fig. 2-1 に示すように，隆起部のある水平な広幅の長方形水路に単位幅流量qの水が流れている．上流域の流れは常流である．水の密度をρ，重力加速度をg，エネルギー係数をα，運動量係数をβと表し，エネルギー損失は無視できるものとする．以下の問に答えよ．

(1) 隆起の頂部における比エネルギーを求めよ．

(2) 隆起の頂部で限界流となっているとき，頂部における水深と比エネルギーおよび，隆起部の高さΔz_cを求めよ．

(3) 隆起部に働く単位幅あたりの抗力を求めよ．

Question 2

As shown in Fig. 2-1, the water is flowing at a flow rate per unit width q in a horizontal, wide rectangular open-channel with a raised ridge. The flow at the upstream site is subcritical flow. Let ρ be the water density, g be the acceleration of gravity, α be the Coriolis coefficient and β be the Boussinesq coefficient. Assuming that the energy loss of the flow is negligible, answer the following questions.

(1) Find the specific energy at the top of the raised ridge.

(2) When the flow is critical at the top of the raised ridge, find the water depth and the specific energy at the top of the raised ridge, and the height of the raised ridge Δz_c.

(3) Find the drag per width on the raised ridge.

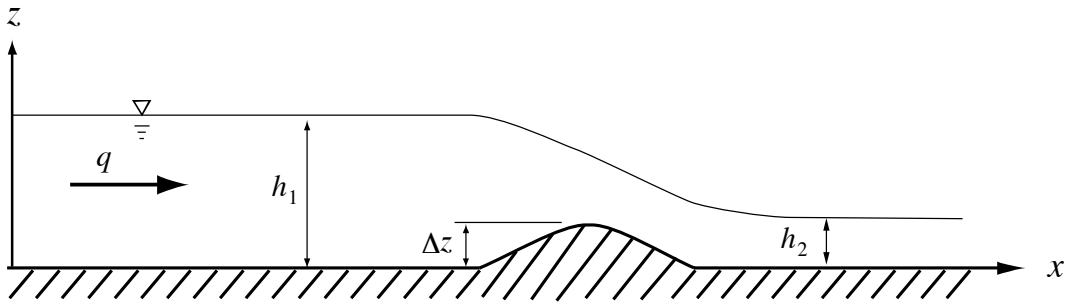

Fig. 2-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

問題 3

Fig. 3-1 に示すように，広い水槽に長さ l，直径 d の管路が接続していて，管路を流れてきた水が大気中に放出されている．管路の先端には放出口の直径が d' のノズルが取り付けてある．水槽は十分広いため，放水による水槽内の水位の低下は無視できる．摩擦損失係数を f，重力加速度を g と表し，管路入り口とノズル部のエネルギー損失は無視できると仮定して，以下の問に答えよ．

(1) 放出口での流速 v' と管路内の流速 v を求め，それらの流速が管径の比 d'/d とともにどのように変化するのか説明せよ．

(2) ノズルがあるときの流量 Q' とノズルがないときの流量 Q の比 Q'/Q を求め，それが管径の比 d'/d とともにどのように変化するかを述べよ．

Question 3

As shown in Fig. 3-1, the water in the tank is flowing through the nozzle with the diameter of d' into the atmosphere. The length and diameter of the horizontal straight pipe are l and d, respectively. The change of the water level in the tank is negligible because the area of the water surface is large. Let f be the friction coefficient of the pipe and g be the acceleration of gravity.

Assuming that the energy losses of the flow at the entrance and the nozzle are negligible, answer the following questions.

(1) Find the flow velocity v' at the nozzle and the velocity v in the pipe. In addition, explain how the velocities change with the ratio of diameter d'/d.

(2) Find the ratio Q'/Q, where Q' is the flow rate of the pipe with the nozzle and Q is the flow rate without the nozzle. In addition, explain how the ratio Q'/Q changes with the ratio of diameter d'/d.

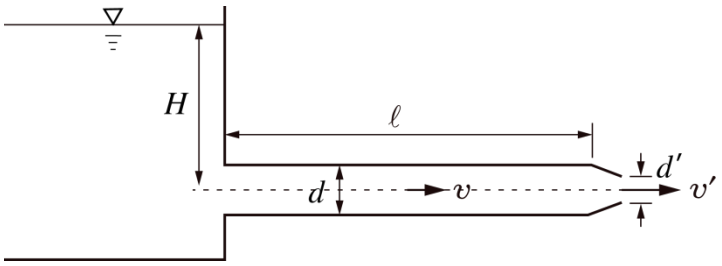

Fig. 3-1

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

問題 4

摩擦損失をシェージーの公式$\left(v = C\sqrt{hI_f}\right)$により与えると，広幅長方形断面水路の水面形方程式は

$$\frac{dh}{dx} = i_0 \frac{1-\left(h_0/h\right)^3}{1-\left(h_c/h\right)^3} \qquad (4\text{-}1)$$

と表される．ここで，hは水深，xは水路床に沿った座標（流下方向を正），i_0は水路勾配，h_0は等流水深，h_cは限界水深である．以下の問に答えよ．

(1) 式(4-1)を導出せよ．与えられていない水理量はその定義を述べて使用せよ．

(2) Fig. 4-1 に示すように，２つの貯水池を結ぶ広幅水路で水路勾配が急勾配から緩勾配に変化している．上流貯水池の水位は，水路上流端での限界流の水位より高く，下流貯水池の水位は下流端での限界流の水位より低い．可能な水面形を等流水深線と限界水深線とともに描き，水面形の名称および追跡方向の矢印を記入せよ．ただし，各水路長は十分長いものとし，射流から常流への遷移が急勾配水路で起こる場合と緩勾配水路で起こる場合の両方について水面形を示せ．

Question 4

In the case of the Chézy's formula $\left(v = C\sqrt{hI_f}\right)$, the water surface profile in a wide rectangular open-channel is given by the following equation:

$$\frac{dh}{dx} = i_0 \frac{1-\left(h_0/h\right)^3}{1-\left(h_c/h\right)^3} \qquad (4\text{-}1)$$

where h is the water depth, x the coordinate along the channel (downstream is positive), i_0 the channel slope, h_0 the normal depth and h_c the critical depth.

Answer the following questions.

(1) Derive Eq. (4-1). Several hydraulic quantities required for the derivation should be defined.

(2) As shown in Fig. 4-1, there is a wide rectangular open-channel that joins two reservoirs. The upper part of the channel has a steep slope and the lower part of the channel has a mild slope. The channel parts are sufficiently long. The water level of the upstream reservoir is higher than that of the critical flow at the upstream end. The water level of the downstream reservoir is lower than that of the critical flow at the downstream end.

Draw possible water surface profiles with the lines of the normal depth and the critical depth. In addition, write in the names of the water surface profiles and indicate the tracking directions of the profiles by arrows. Since the transition from the supercritical flow to the subcritical flow occurs at the steep or the mild slope, show the surface profiles in the two conditions.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II	専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	水理学 Hydraulics

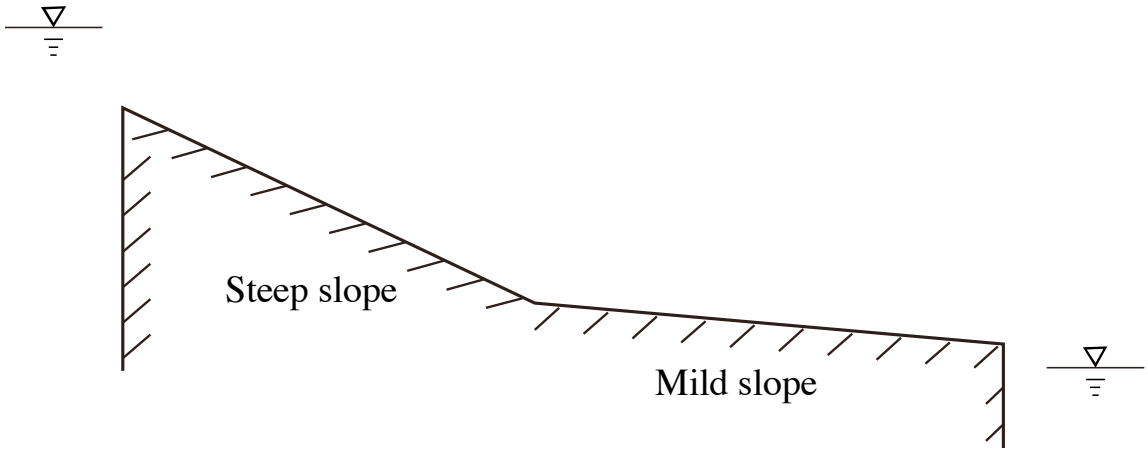

Fig. 4-1

模　擬　問　題

専門科目 II

土木計画学（都市計画，交通需要予測）

Entrance Examination Sample Questions

Specialized Subject II

Infrastructure and Transportation Planning (city planning and transportation demand forecasting)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	土木計画学 Infrastructure and Transportation Planning

問題 1

以下の条件下で表 1 の標本データ x の母平均 μ を信頼率 95%で区間推定せよ.

(1) 母分散 σ^2 は既知とする．σ^2 は 5，信頼率 95%の z 値は 1.96 である.
(2) 母分散 σ^2 は未知とする．信頼率 95%の自由度 4 の t 値は 2.8 である.

表 1　標本データ

ID	x	$x-\bar{x}$	$(x-\bar{x})^2$
1	7	4.2	17.64
2	1	-1.8	3.24
3	1	-1.8	3.24
4	4	1.2	1.44
5	1	-1.8	3.24
標本平均 $\bar{x}$	2.8	合計	28.8

Question 1

Calculate a 95% confidence interval for the population mean μ of data x in Table 1 under the following conditions.

(1) The population variance σ^2 is known. The σ^2 is 5 and the z value of 95% confidence level is 1.96.
(2) The population variance σ^2 is unknown. The t value of 95% confidence level with 4 degrees of freedom is 2.8.

Table 1　Data

ID	x	$x-\bar{x}$	$(x-\bar{x})^2$
1	7	4.2	17.64
2	1	-1.8	3.24
3	1	-1.8	3.24
4	4	1.2	1.44
5	1	-1.8	3.24
Sample mean $\bar{x}$	2.8	Total	28.8

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	土木計画学 Infrastructure and Transportation Planning

問題 2

回帰モデル $y_i = \sum_k b_k x_{ik} + \varepsilon_i$ に関して，以下の問に答えよ．ただし，y_i はサンプル i の目的変数，x_{ik} はサンプル i の k 番目の説明変数，b_k はパラメータ，ε_i はサンプル i の誤差項である．

(1) 以下の式で表される回帰モデルの決定係数について説明せよ．

$$R^2 = \frac{\left(\sum_k \left(\hat{b}_k x_{ik}\right) - \bar{y}\right)^2}{\left(y_i - \bar{y}\right)^2}$$

ここで，$\hat{b}_k$ は k 番目の説明変数に関するパラメータ推定値，$\bar{y}$ は y の平均値である．

(2) パラメータ b_k に関する t 検定の帰無仮説と対立仮説，および有意水準について説明せよ．

Question 2

Answer the following questions about a regression model $y_i = \sum_k b_k x_{ik} + \varepsilon_i$, where y_i is an objective variable of sample i, x_{ik} is the k th explanatory variable of sample i, b_k is a parameter of sample i, and ε_i is an error term of sample i.

(1) Explain R-squared of the regression model, as shown in the following equation.

$$R^2 = \frac{\left(\sum_k \left(\hat{b}_k x_{ik}\right) - \bar{y}\right)^2}{\left(y_i - \bar{y}\right)^2}$$

where $\hat{b}_k$ is an estimated parameter in the k th explanatory variable and $\bar{y}$ is an average of y.

(2) Explain the null hypothesis, alternative hypothesis and significant level of a t-test in parameter b_k.

問題 3

以下の問に答えよ．

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	土木計画学 Infrastructure and Transportation Planning

(1) 非集計行動モデルに使われる表明選好データの長所と短所を説明せよ.
(2) 高齢化社会における地方公共交通の問題とその対策を 400 字程度で論ぜよ.

Question 3
Answer the following questions.
(1) Explain advantages and disadvantages in stated preference data employed in a disaggregate demand model.
(2) Discuss problems with local public transport in aging society and discuss the countermeasures in some 200 words.

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	土木計画学 Infrastructure and Transportation Planning

問題 4
複数の都市圏が被災するような大規模津波災害について，以下の問に答えよ．
(1) 事前対策，事後対策，復興の観点から都市計画，交通計画のそれぞれの分野で必要な対策を，3 つずつ挙げよ．
(2) 上記のうち，都市計画と交通計画の綿密な連携が必要な対策を選び，400 字程度で述べよ．

Question 4
Regarding a large tsunami damage in multiple metropolitan areas, answer the following questions.
(1) Give three countermeasures in both city planning and transportation planning, in terms of pre disaster management, post disaster management and reconstruction.
(2) Pick out some countermeasures requiring a close coordination between city and transportation planning exampled in (1), and discuss them in some 200 words.

模　擬　問　題

専門科目 II

応用数学（線形代数，微積分，常微分方程式，確率・統計）

Entrance Examination Sample Questions

Specialized Subject II

Applied Mathematics (linear algebras, differential and integral calculus, ordinary differential equation, and probability and statistics)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	応用数学 Applied Mathematics

問題 1 （Question 1）

(1) 次の行列式を因数分解せよ．
Factorize the following determinant.

$$\begin{vmatrix} \alpha & \beta & \gamma & 0 \\ \beta & \alpha & 0 & \gamma \\ \gamma & 0 & \alpha & \beta \\ 0 & \gamma & \beta & \alpha \end{vmatrix}$$

(2) 次の行列 $\mathbf{A}$ を対角化し，$\mathbf{A}^n$ を求めよ．

Give $\mathbf{A}^n$ for the following matrix $\mathbf{A}$, by using matrix diagonalization.

$$\mathbf{A} = \begin{bmatrix} 3 & 2 & 12 \\ -1 & 0 & -6 \\ 0 & 0 & -1 \end{bmatrix}$$

問題 2 （Question 2）

部分積分を用いて次の公式を証明せよ．なお，n は自然数である．
Prove the following formula, where n is a natural number, through using integration by parts.

$$B_n = \int_0^1 \left(1-x^2\right)^n dx = \frac{2\cdot 4\cdots(2n)}{1\cdot 3\cdots(2n+1)} = \frac{(2n)!!}{(2n+1)!!}$$

問題 3 （Question 3）

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学 （専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	応用数学 Applied Mathematics

変数変換$x = e^t$を用いて，次の常微分方程式の解を求めよ.

Find the solution to the following ordinary differential equation by changing the variable $x = e^t$.

$$x^2 y'' - 2xy' + 2y = x^2 \quad (x > 0)$$

次ページへ続く (Continued on the following page.)

広島大学大学院工学研究科博士課程前期　入学試験模擬問題
Graduate School of Engineering (Master's Programs), Hiroshima University
Entrance Examination Sample Questions

試験科目 Subject	社会基盤環境工学（専門科目Ⅱ） Civil and Environmental Engineering II

専　攻 Department	社会基盤環境工学 Civil and Environmental Engineering

科目 Specialized subject	応用数学 Applied Mathematics

問題4（Question 4）

1から6までの数字を持つ立方体のサイコロを独立に3回投げ，それぞれの目の数をX_1，X_2，X_3とする．

A cubic dice having a number from 1 through 6 is thrown three times independently. Let X_1, X_2 and X_3 be the first, second and third number on the dice, respectively.

(1) X_1の期待値$E(X_1)$を求めよ．

Give the expected value $E(X_1)$ for X_1.

(2) X_1の分散$V(X_1)$を求めよ．

Give the variance $V(X_1)$ for X_1.

(3) $X_1 + X_2$の期待値$E(X_1 + X_2)$を求めよ．

Give the expected value $E(X_1 + X_2)$ for $X_1 + X_2$.

(4) $X_1 + X_2$の分散 $V(X_1 + X_2)$を求めよ．

Give the variance $V(X_1 + X_2)$ for $X_1 + X_2$.

(5) $X_1 + X_2 < X_3$となる確率を求めよ．

Give the probability for $X_1 + X_2 < X_3$.

次に，サイコロの目は独立ではなく，２回目以降では，前回と同じ目が出る確率は他の目に比べて半減するものとする．
Consider the case when the numbers on the dice are not independent. From the second throw, the probability to have the same number on the dice as that in the last throw shall be a half of the probability for the other number.

(6) $X_1 + X_2 < X_3$となる確率を求めよ．

Give the probability for $X_1 + X_2 < X_3$.

(7) $X_2 = 3$であったとき，$X_1 = 3$である条件付き確率$P(X_1 = 3|X_2 = 3)$をベイズの定理により求めよ．

Give the conditional probability of $X_1 = 3$ under the condition $X_2 = 3$, or $P(X_1 = 3|X_2 = 3)$, by Bayes' theorem.