

Computer Networks – Qualified Exam

(2017/Spring)

系別 _____ 年級 _____ 學號 _____ 姓名 _____

1. (10%)

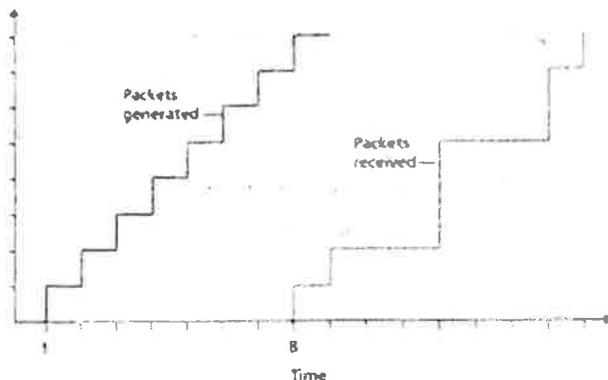
Consider a packet of length L which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i , s_i , and R_i denote the length, propagation speed, and the transmission rate of link i , for $i = 1, 2, 3$. The packet switch delays each packet by d_{proc} . Assuming no queuing delays, in terms of d_i , s_i , R_i , ($i = 1, 2, 3$), and L , what is the total end-to-end delay for the packet? Suppose now the packet is 1,500 bytes, the propagation speed on all three links is $2.5 \cdot 10^8$ m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

2. (10%)

Is it possible for an organization's Web server and mail server to have exactly the same alias for a hostname (for example, foo.com)? What would be the type for the RR that contains the hostname of the mail server?

3. (10%)

Consider the figure below. A sender begins sending packetized audio periodically at $t = 1$. The first packet arrives at the receiver at $t = 8$.



i) What are the delays (from sender to receiver, ignoring any playout delays) of packets 2 through 8? Note that each vertical and horizontal line segment in the

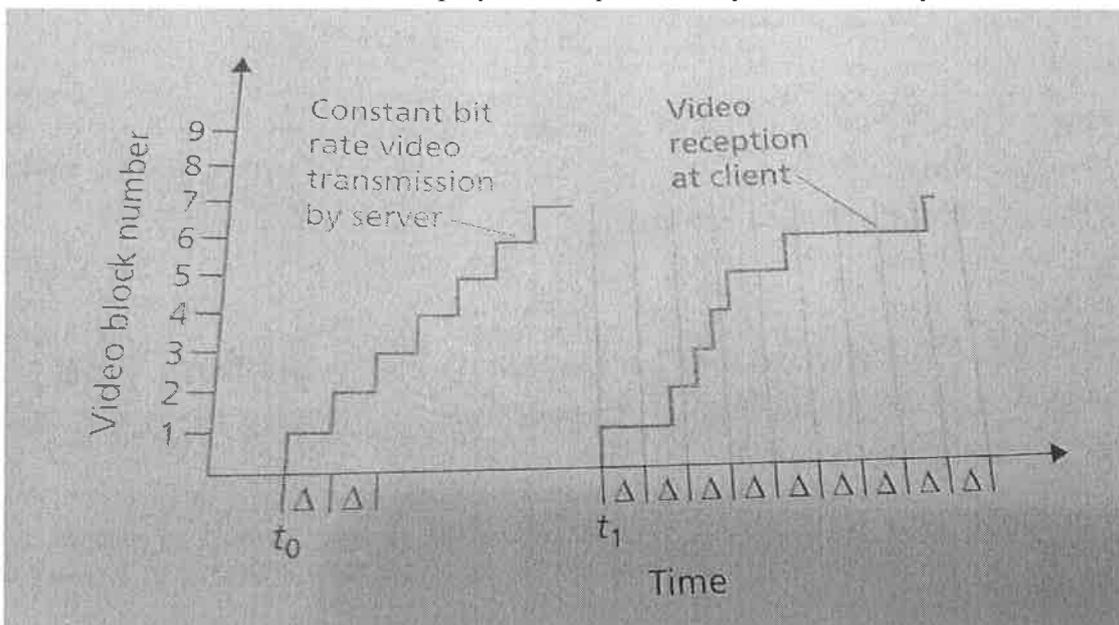
windows for each of the following protocols?

- a. Stop-and-Wait
- b. Go-Back- N
- c. Selective-Repeat

8. (10%)

Consider the figure below. Suppose that video is encoded at a fixed bit rate, and thus each video block contains video frames that are to be played out over the same fixed amount of time, Δ . The server transmits the first video block at t_0 , the second block at $t_0 + \Delta$, the third block at $t_0 + 2\Delta$, and so on. Once the client begins playout, each block should be played out Δ time units after the previous block.

- a. Suppose that the client begins playout as soon as the first block arrives at t_1 . In the figure below, how many blocks of video (including the first block) will have arrived at the client in time for their playout? Explain how you arrived at your answer.
- b. Suppose that the client begins playout now at $t_1 + \Delta$. How many blocks of video (including the first block) will have arrived at the client in time for their playout? Explain how you arrived at your answer.
- c. In the same scenario at (b) above, what is the largest number of blocks that is ever stored in the client buffer, awaiting playout? Explain how you arrived at your answer.
- d. What is the smallest playout delay at the client, such that every video block has arrived in time for its playout? Explain how you arrived at your answer.



Digital Signal Processing 資格考

April 2017

1. (20%) Consider an LTI system with frequency response

$$H(e^{j\omega}) = \frac{1 - e^{-j2\omega}}{1 + \frac{1}{2}e^{-j4\omega}}, \quad -\pi < \omega \leq \pi$$

Determine the output $y[n]$ for all n if the input $x[n]$ for all n is

$$x[n] = \sin\left(\frac{\pi n}{4}\right).$$

2. (20%) A causal and stable LTI system S has its input $x[n]$ and output $y[n]$ related by the linear constant-coefficient difference equation

$$y[n] + \sum_{k=1}^{10} \alpha_k y[n-k] = x[n] + \beta x[n-1],$$

Let the impulse response of S be the sequence $h[n]$

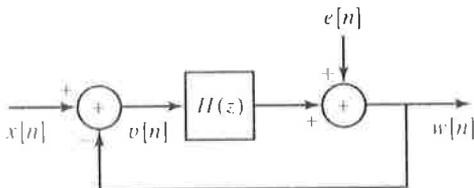
(a) Show that α_1 can be determined from the knowledge of $h[0]$ and $h[1]$.

(b) If $h[n] = (0.9)^n \cos(\pi n/4)$ for $0 \leq n \leq 10$, sketch the pole-zero plot for the system function of S , and indicate the region of convergence.

3. (20%) In the following figure, $H(z)$ is the system function of a causal LTI system. As shown in the figure, $W(z)$ can be expressed in the form

$$W(z) = H_1(z)X(z) + H_2(z)E(z)$$

For the case $H(z) = \frac{z^{-1}}{(1-z^{-1})}$, determine $H_1(z)$ and $H_2(z)$.



4. (20%) A discrete-time causal LTI system has the system function

$$H(z) = \frac{(1 + 0.2z^{-1})(1 - 9z^{-2})}{(1 + 0.81z^{-2})}$$

(a) Is the system stable?

(b) Determine expressions for a minimum-phase system $H_l(z)$ and an all-pass system $H_{ap}(z)$ such that

$$H(z) = H_l(z) H_{ap}(z)$$

5. (20%) Let $X(e^{j\omega})$ denote the Fourier transform of the sequence $x[n] = \left(\frac{1}{2}\right)^n u[n]$. Let $y[n]$ denote a finite-duration sequence of length 10; i.e., $y[n] = 0, n < 0$, and $y[n] = 0, n \geq 10$. The 10-point DFT of $y[n]$, denoted by $Y[k]$, corresponds to 10 equally spaced samples of $X(e^{j\omega})$; i.e., $Y[k] = X(e^{j2\pi k/10})$. Determine $y[n]$.

106. 04.14 VLSI

1. Explain the following terms in detail: (60%)

- (a) critical path
- (b) setup time
- (c) functional simulation
- (d) Design for testability
- (e) hold time
- (f) soft IP

2. Describe the difference between full custom and Cell-based design flow. (20%)

3. Suppose you have completed a circuit design with hardware description language. Please describe the advantages and disadvantages of implementing your circuit with (a) ASIC and (b) CPLD/FPGA, respectively.

**Digital Image Processing,
PH.D. Qualification Examination,
Department of CSIE**

April 14, 2017

1. Please describe the iterative basic global thresholding algorithm. Will the algorithm converge with any given initial threshold? Why? (10%) Please describe the Otsu's thresholding algorithm. Why it is the optimal algorithm that maximizes the between-class variance? (10%)
2. (a) What is the 1-D convolution theorem of a continuous variable? (4%) please prove it. (6%) (b) What is aliasing? (4%) Will the shrinking and zooming operations cause aliasing? (Shrinking? zooming? or both?) Why? (6%)
3. If a color image is given and you are asked to detect (or segment) a target area from the image, you then have to develop an image processing program to solve this problem. Suppose you have to do three main color image processing steps which are smoothing, color and tone correction, and color segmentation, please explain how you want to accomplish these three steps and why you select these approaches. (20%)

4. The Laplacian of Gaussian filter is given as

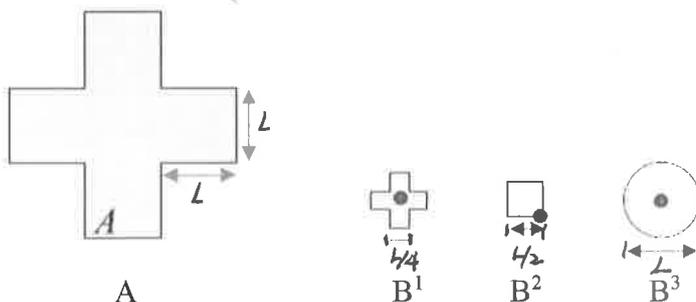
$$\nabla^2 G(x, y) = \left[\frac{x^2 + y^2 - 2\sigma^2}{\sigma^4} \right] e^{-\frac{x^2 + y^2}{2\sigma^2}}$$

Please also prove that the average value of this filter is zero. (Please note

$$\sigma^2 = \frac{1}{\sqrt{2\pi}\sigma} \int_{-\infty}^{\infty} z^2 e^{-\frac{z^2}{2\sigma^2}} dz \quad \text{and} \quad \frac{1}{\sqrt{2\pi}\sigma} \int_{-\infty}^{\infty} e^{-\frac{z^2}{2\sigma^2}} dz = 1, \quad 10\%$$

Please also show that the average value of an image convolved with this filter is also zero. (Hint: Please use the convolution theorem and DC value in Fourier transform in the proof.) (10%)

5. Given the following Image A and structure elements B^1, B^2, B^3 , sketch the results of the following two morphological operations. (a) $(A \ominus B^3) \oplus B^1$, (b) $(A \oplus B^2) \ominus B^1$.



計算機組織資格考題 (Spring 2017)

1. (10%) What do you need to consider if you want to add new instructions in to the MIPS instruction set? (please write at least 5 factors)
2. (20%) The classical approach to improve cache behavior is to reduce miss rates. Please summarize the techniques that can reduce miss rates.
3. (20%) With dynamic hardware prediction for reducing branch costs, what is the disadvantage of a simple 1-bit branch-prediction buffer for branch that is almost always taken? Explain why the 2-bit prediction scheme can remedy this disadvantage. Also, explain what correlated predictors are by illustrating an example.
4. (25%) Answer the followings questions
 - a. Compare the pros and cons of the write invalidate and write update protocols.
 - b. Compare snooping and directory-based cache coherence protocol. Which protocol (snooping or directory-based) is often used for centralized shared-memory multiprocessor, and which protocol (snooping or directory-based) for distributed shared-memory multiprocessor? Explain why.
5. (25%) Explain the following property of static superscalar processors, dynamic superscalar processors, speculative superscalar processors, and VLIW,
 - a. Issue Structure (hint: explain their issue structure, static or dynamic)
 - b. Hazard detection (hint: explain how the hazard detection is done, hardware or software)
 - c. Scheduling (hint: explain how their scheduling is done, static or dynamic)
 - d. Instruction Execution Order (hint: explain the order of instruction execution, in-order or out-of-order)

5/2017 博士班資格考： 機率與統計 Show All Details.

1. (20%)
 - (a) State the differences among independent, uncorrelated, and orthogonal
 - (b) What is Strict Sense Stationary (SSS) and what is Wide Sense Stationary?
2. (20%) In a random sample of $n=500$ families owning TV sets in a city, it was found that 360 subscribed to HBO. Find 95% confidence interval for the actual proportion of families in the city who subscribe to HBO.
3. (20%) Consider the R.V. with the density function as

$$f(x) = \begin{cases} \frac{1}{\beta} e^{-x/\beta} & x \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Suppose that independent observations $x_1, x_2, x_3, \dots, x_n$ are taken from this distribution. Then

- (a) What is the likelihood function?
 - (b) Find the MLE for the parameter, β
4. (20%) Let us assume the prior distribution for the proportion p of the defectives produced by a machine is triangle distributed as follows.

$$f(p) = \begin{cases} 16p & , 0 \leq p < 1/4 \\ 8 - 16p & , 1/4 \leq p < 1/2 \\ 0, & \text{otherwise} \end{cases}$$

Find the Bayes estimate for the proportion of defectives being produced by this machine if a random sample of size 2 yields 1 defective.

5. (20%) A random variable X has a mean equal to 10 and a variance equal to 2.
 - (a) Estimate $P(|X - 10| \geq 1)$.
 - (b) Find the value c such that $P(|X - 10| \geq c) \leq 0.05$.

Biostatistics test for Qualification of PhD candidate

Problems and discussions (申論題) 每題 20 分

Hint for mathematical expression: \bar{X} \rightarrow sample mean, n \rightarrow sample size, s \rightarrow sample standard deviation, population mean $\rightarrow \mu$, population size $\rightarrow N$, and σ \rightarrow population standard deviation

- (a) Please explain the concepts, definitions, and relationship between type I error, type II error, and the power of the test. (b) How are these factors relevant to sample size?
- According to the previous question (1.), a data scientist found his (her) experimental results with statistical test was $P = 0.051$. To our common understanding, this p value shows there is no statistical significance on the data, please answer and discuss the following questions

 - How do you explain this p value properly and encourage him/her?
 - How do you help him/her?
- (a) What's difference between sample standard (標準差) deviation and standard error/standard error of the mean (SEM, 標準誤)? (b) In the statement of scientific report or article, there are two ways to express confidence interval for the mean. How? (c) Based on the same sample, what is the major difference between 95% and 99% confident interval? (d) What is the general sampling distribution to estimate the confidence interval of population mean and variance respectively?
- Normally economy-sized boxes of potato chips average 50 oz with a standard deviation of 5.0 oz. To improve quality control a new process is developed that you hope will significantly decrease variability. Forty boxes packed by the new process are weighted and have a standard deviation of 4.0 oz. Please describe the sequential typical steps in a statistical test of hypothesis (e.g. formulation of null and alternative hypotheses in terms of the variance, express the statistic ...)?
- What are the major concerns and proper statistical testing methods of two samples used for (a) continuous data type (under parametric approach) and (b) categorical data type?

OS 資格考題 (105 學年度第二學期)

1. [20%] Please describe the advantages and disadvantages between spinlocks and blocking-based semaphores.
2. [20%] Please describe the **two** common ways to **recover** a deadlock when a deadlock is detected.
3. [20%] (a) What is TLB reach? (b) Please describe two ways to increase the TLB reach.
4. [15%] Please describe the rate-monotonic scheduling algorithm.
5. [15%] (a) What is **thrashing** in a virtual memory system? (b) Please describe a method to deal with the thrashing condition?
6. [10%] Please describe how a traditional UNIX inode keeps track of the data blocks of a file.

Qualify Exam: Computer Graphics (2017 Spring)

1. (a) Draw the flow of *Graphics Pipeline* and briefly describe the process in each step. (10%)
(b) What is programmable pipeline? (5%)

2. (a) What is the difference between *Phong model* and *modified Phong model*? (10%)
(b) What is the difference between *Flat Shading*, *Gouraud Shading*, and *Phong Shading*? (10%)

3. (a) Briefly describe the concepts of *Texture Mapping*, *Bump Mapping*, and *Environmental Mapping*. (10%)
(b) What is the *aliasing problem* in texture mapping? (5%)
(c) How to deal with the *aliasing problem*? (10%)

4. (a) Write the pseudocode of a simple ray tracer algorithm. (15%)
(b) What issues should be considered when designing a ray tracing algorithm? (10%)
(c) What is the difference between *ray tracing* and *path tracing*? (5%)
(d) Explain the physical meaning of the *Radiosity Equation*. (10%)

Ph.D. Qualify Examination 2017
Theory of Computation

- This examination is closed books.
- Please turn off your cell phones.
- Remember that there are 2 pages of the qualify examination.
- Answer all questions as possible. You may have a partial score if you answer the correct direction.

1. Deterministic Finite Acceptor (DFA) (10 pts)

Find a DFA for the following language on $\Sigma = \{a, b\}$:

$$L = \{w : |w| \bmod 3 \neq 0\}.$$

2. Nondeterministic Finite Acceptor (NFA) (10 pts)

Find an NFA with four states that accepts the language

$$L = \{a^n : n \geq 0\} \cup \{b^m a : m \geq 1\}.$$

3. Convert the nfa defined by

$$\delta(q_0, a) = \{q_0, q_1\}$$

$$\delta(q_1, b) = \{q_1, q_2\}$$

$$\delta(q_2, a) = \{q_2\}$$

$$\delta(q_0, \lambda) = \{q_2\}$$

with initial state q_0 and final state q_2 into an equivalent dfa. (10 pts)

4. Determine whether or not the following language on $\Sigma = \{a\}$ is regular: (15 pts)

$$L = \{a^n : n \geq 2, \text{ is a prime number}\}.$$

5. Show that the following grammar is ambiguous. (10 pts)

$$S \rightarrow AB|aaB,$$

$$A \rightarrow a|Aa,$$

$$B \rightarrow b.$$

6. In the derivation of using pumping lemma to prove a language L is not regular, we will give an assumption "A DFA M with the number of states $|M|$ exists for L ". Can you replace the assumption with "An NFA M' with the number of states $|M'|$ "? Please justify your answer. (15 pts)

7. Construct a nondeterministic pushdown automata that accepts the following language on $\Sigma = \{a, b\}$: (10 pts)
 $L = \{a^n b^m : n \geq m - 1\}$.

8. Fill the following languages into the language hierarchy (If L_i is a regular language and also a context-free language, please fill L_i in the set of regular languages): (20 pts)

- $L_1 = \{a^n b^m : n \geq m\}$,
- $L_2 = L(a^* b^*)$,
- $L_3 = \{a^n b^n c^n : n \geq 0\}$,
- $L_4 = \{a^n w w^R a^n : n \geq 0, w \in \{a, b\}^*\}$,
- $L_5 = \{ab, ad, a\}$,
- $L_6 = \{ww : w \in \{a, b\}^*\}$,
- $L_7 = \{a^{n!} : n \geq 0\}$,
- $L_8 = \{a^n b^j a^j b^n : n \geq 0, j \geq 0\}$,
- $L_9 = \{a^n b^m c^{n+m} : n \geq 0, m \geq 0\}$,
- $L_{10} = \{a^3 b^n c^n : n \geq 0\}$.

