NCKU CSIE PhD Qualifying Exam
Probability and Statistics
Fall 2020

1. Probability distribution [20%]

1.1 If X is a discrete random variable following uniform distribution, where $f(x) > 0$ when x = -2, -1, 0, 1, and 2 ($f(x) = 0$, elsewhere). If Y is another discrete random variable with an identical distribution as X. In addition, X and Y are independent. Please find the probability distribution of $(X+Y)/2$ and plot it. [10%]

1.2 Given the joint probability density function of the random variable X, Y:

$$f(x,y) = \begin{cases} \dfrac{6-x-y}{8}, & 0 < x < 2, \quad 2 < y < 4, \\ 0, & elsewhere. \end{cases}$$

Please find $P(1 < Y < 3 \mid X = 1.5)$. [10%]

2. Expectation [20%]

2.1 X is a binomial random variable with parameters of n, p and $q=(1-p)$. Given that $E(X) = np$ and $E[(X - \mu)^2] = npq$, please derive mean of a new random variable $Y = (4X + 3)$. [10%]

2.2 Please derive variance of Y. [10%]

3. Normal distribution [20%]

3.1 X is a random variable following Gaussian distribution $f(x)$ with its parameters μ and σ. Please prove that $E(X) = \mu$ and $E[(X - \mu)^2] = \sigma^2$. [10%]

3.2 If X_1, X_2, X_3, ..., X_n are independent and identically distributed normal random variables with mean of μ and variance of σ^2. A new random variable $Y = (X_1 + X_2 + X_3 + \cdots + X_n)/n$, please derive Y's probability distribution $h(y)$, Y's mean, and Y's variance. [10%]

4. Confidence interval [20%]

4.1 $\bar{x}$ is the mean of a random sample of size n from a normal population with variance of σ^2. Please derive a two-sided 95% confidence interval for population mean μ. [10%]

4.2 s^2 is the variance of a random sample of size n from a normal population. Please derive a two-sided 95% confidence interval for population variance σ^2. [10%]

5. Hypothesis testing [20%]

5.1 In hypothesis testing, please explain Type-I error, Type-II error, and power of a test. [10%]

5.2 Px Mart is selling pineapples from Guanmiao (關廟鳳梨) and needs to examine the average weight of pineapples. It is known that the standard deviation of pineapple weight is 90 grams. Now, a sample of 36 pineapples is randomly selected and it is found that the average weight is 1527 grams. Please test the hypothesis that $\mu = 1500$ grams against the alternative hypothesis of $\mu > 1500$ grams at the 0.05 level of significance. (Please use the attached table to find probability values.) [10%]

Ph.D. Qualify Examination 2020
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 $\Sigma = \{a, b\}$:
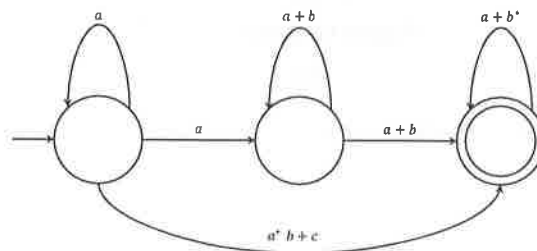 $L = \{w : n_a(w) \bmod 3 < 1\}$.

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

   Find an nfa with no more than five states for the set $\{abab^n : n \geq 0\} \cup \{aba^n : n \geq 0\}$

3. Find a minimal dfa for the following language, and prove that the result is minimal. (10 pts)

   $L = \{a^n b^m : n \geq 2, m \geq 1\}$.

4. What language is accepted by the following generalized transition graph? (10 pts)

5. Find a regular grammar that generates the language on $\Sigma = \{a, b\}$ consisting of all strings with no more than two a's. (10 pts)

6. Prove that the following language is not regular: (10 pts)

   $L = \{a^n b^l a^k : k \leq n + l\}$.

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

$S \to aSb|SS|\lambda$.

8. Construct a nondeterministic pushdown automata for the following language: (10 pts)

$L = \{wcw^R : w \in \{a, b\}^*\}$.

9. 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)

$L_1 = \{a^n b^m : n \geq m\}$,

$L_2 = L(a^* b^*)$,

$L_3 = \{a^n b^n c^n : n \geq 0\}$,

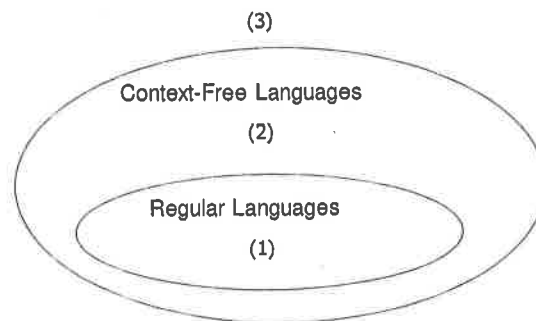$L_4 = \{a^n w w^R a^n : n \geq 0, w \in \{a, b\}^*\}$,

$L_5 = \{ab, ad, a\}$,

$L_6 = \{ww : w \in \{a, b\}^*\}$,

$L_7 = \{a^{nl} : n \geq 0\}$,

$L_8 = \{a^n b^j a^j b^n : n \geq 0, j \geq 0\}$,

$L_9 = \{a^n b^m c^{n+m} : n \geq 0, m \geq 0\}$,

$L_{10} = \{a^3 b^n c^n : n >= 0\}$.

(3)

Context-Free Languages

(2)

Regular Languages

(1)

1. **(20%, Camera Model)**
    (a) If the camera sensor size is 1/3 inch with resolution $w*h=800*600$ pixels, based on 1.0X lens magnification (i.e., image resolution is 800*600 pixels) please find the pixel size = _____ um * _____ um? **(10%)** (Hint: Please check Figure 1.)
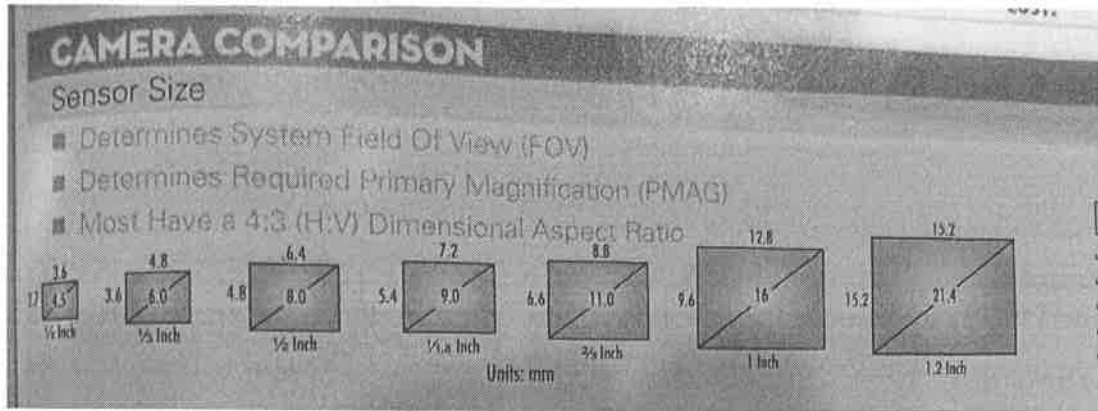

Figure 1

    (b) As shown in Figure 2, please find focal length f =function of (w, θ)? **(5%)** = ? mm **(5%)**

Field of View (FOV) angle $\theta = 60^0$
$\sin 30^0 = 0.5$
$\cos 30^0 = 0.866$

Pine Hole Camera

$\theta/2$ f

Virtual
Image Plane:
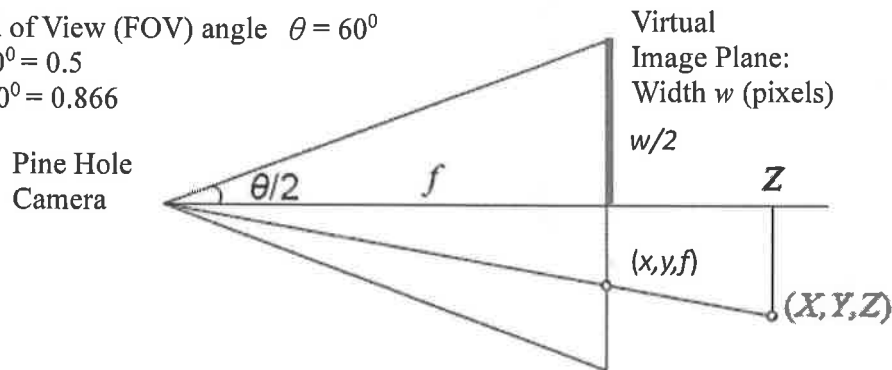Width w (pixels)

$w/2$

Z

(x,y,f)

(X,Y,Z)

Figure 2

2. **(20%, PCA)** For principal component analysis (PCA) computation, first the covariance matrix C is created. Second, the Singular Value Decomposition (SVD) is applied to C (i.e., $C = UDV^T$) to obtain eigenvalue matrix D with corresponding eigenvector matrix U. Here, there are five data samples $x=\{x_1, x_2, x_3, x_4, x_5\}$ as shown in table 1 and corresponding low-dimensional (projected) data is represented by $y=\{y_1, y_2, y_3, y_4, y_5\}$. Suppose the unsorted eigenvalues and corresponding eigenvectors of covariance matrix are shown in the table 2. If we want to reduce the dimension of data vector x from 5 to 2.
    (a) What is the projection matrix w? **(4%)**
    (b) What is the projection data (weight) vector $\{y_2, y_3\}$? (Please show all calculations) **(4%+4%)**
    (c) PCA belongs to _____ model. (Hint: Gaussian, non-Gaussian, or Markov) **(4%)**
    (d) PCA belongs to _____ learning. (Hint: Supervised, semi-supervised, or unsupervised, reinforcement) **(4%)**
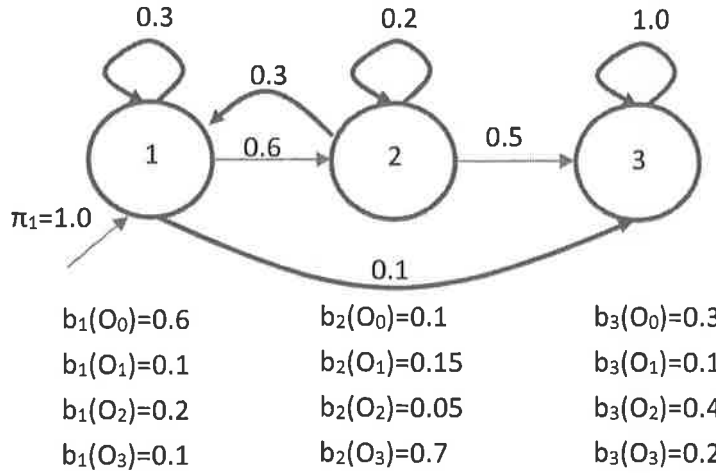
	Table1
x_1	$[1, 2, -7, 5, 3]^T$
x_2	$[4, -2, 6, 0, 3]^T$
x_3	$[-7, 5, -1, -2, 1]^T$
x_4	$[3, -3, 4, -2, -5]^T$
x_5	$[-1, -2, -2, -1, -2]^T$

	Table2
eigenvalues	eigenvectors
1	(4, 3, 6, -2, 0)
9	(-3, 5, 0, 0 7)
4	(1, 8, -4, 5, 6)
7	(2, -1, 0, 4, 1)
3	(5, 5, 9, -1, 2)

3. **(20%, HMM)** A HMM topology and parameters are as following graph.

$$b_1(O_0)=0.6 \quad b_2(O_0)=0.1 \quad b_3(O_0)=0.3$$
$$b_1(O_1)=0.1 \quad b_2(O_1)=0.15 \quad b_3(O_1)=0.1$$
$$b_1(O_2)=0.2 \quad b_2(O_2)=0.05 \quad b_3(O_2)=0.4$$
$$b_1(O_3)=0.1 \quad b_2(O_3)=0.7 \quad b_3(O_3)=0.2$$

Please write its corresponding 1 parameter vector and 2 parameter matrixes, π (1x3 vector) **(6%)**, A (3x3 matrix) **(7%)**, and B (4x3 matrix) **(7%)**, with values?

4. **(20%, VQ)** Please set the sort order for the procedure of Vector Quantization algorithm:

Step : **Codebook Updating** - Update the codeword (symbol) o^i of each cluster C^i by computing new cluster centers $c^i(l+1)$ where $i = 0,1,...,M-1$ at the $l+1$th iteration.

$$c^i(l+1) = \frac{1}{N}\sum_{n=1}^{N} x_n^i \quad \text{where } x^i \in C^i(l+1)$$

N is the number of feature vectors in cluster $C^i(l+1)$ at the $l+1$th iteration. And

$$q(x) = o^i \quad \text{where } 0 \le o^i \le M - 1$$

where $q(.)$ is the quantization operator.

Step : **Termination 1** - If the difference between the current overall distortion $D(l+1)$ and that of the previous iteration $D(l)$ is below a selected threshold,

$\begin{cases} if \ |D(l+1) - D(l)| < threshold, \ then \ Goes \ to \ Step \ \underline{?1} \\ if \ |D(l+1) - D(l)| \ge threshold, \ then \ Goes \ to \ Step \ \underline{?2} \end{cases}$

(where *threshold* is 0.0001 in our study.)

Step : **Termination 2** -

Is the codebook size M equal to the VQ codebook size required ?

$\begin{cases} if \ Yes, \ then \ \underline{?3} \\ if \ No, \ then \ Goes \ to \ Step \ \underline{?4} \end{cases}$

Step : **Classification** - At the lth iteration, according to following equation, classify each k-dimensional sample x of training feature vectors into one of the clusters C^i.

$$x \in C^i(l) \quad if \ \|x - c^i(l)\| < \|x - c^j(l)\| \quad \text{where } i \ne j, \ i, j = 0,1,...,M-1$$

Step : Initialization - Assume all N k-dimensional training vectors to be one cluster C^0, *i.e.*, codebook size $M = 1$ and codeword $o^0 = 0$, and find its k-dimensional cluster centroid $c^0(1)$ where 1 is the initial iteration.
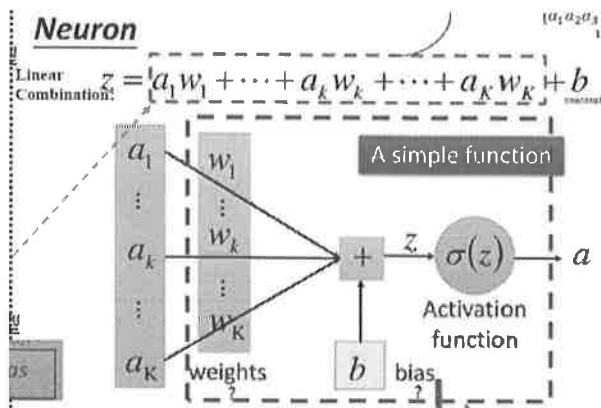
$$c^0(1) = \frac{1}{N} \sum_{n=1}^{N} x_n^0$$

where x is one sample of all N k-dimensional feature vectors at cluster C^0.

Step : Splitting - Double the size M of the codebook by splitting each cluster into two. The current codebook size M is split into $2M$. Set $M = 2M$ by

$$\begin{cases} c_+^i(l) = c^i(l) + \varepsilon \\ c_-^i(l) = c^i(l) - \varepsilon \end{cases} \quad where \ \ 0 \le i \le M-1$$

c^i is the centroid of the ith cluster C^i, M is the size of current codebook, ε is a k-dimensional splitting parameter vector and is value 0.0001 for each dimension in our study. l is the initial iteration.

(a) Set the sort order above 6 steps? **(12%)**

(b) Which step includes the nearest neighbor rule? **(4%)**

(c) Vector quantization belongs to _____ learning. (Hint: Supervised, semi-supervised, or unsupervised, reinforcement) **(4%)**

5. **(20%, DL)** Based on the deep learning lecture:

(a) For each neuron as following, if a_i is the given (known) input image pixel, w_i is the weight parameter of neural network, b is the bias parameter, and z is it output result. Please write its $AX=B$ format? Here A is unknown parameter vector, X is the known input pixel vector and B is the output result. **(7%)** After activation function, the output of $\sigma(z)$ is the _____ result **(3%)** (Hint: Linear Discrimination, Non-Linear Discrimination)

(b) Each of following answers for physical meaning has only one answer selection:

(b.1) Deep learning, which is the same as AdaBoost, has the property of _____? **(2%)**

(b.2) Deep learning, which is the same as Supported Vector Machine, has the property of _____? **(2%)**

3

(b.3) Convolution process has the property of _____? **(2%)**

(b.4) Max Pooling has the property of _____? **(2%)**

(b.5) Softmax function has the property of _____? **(2%)**

(Hint: Non-linear discrimination, subsampling, feature extraction, cascade, output normalization)

計算機組織資格考題（Fall 2020）

1. (30%) Refer the following instruction sequence:

Instruction sequence	
lw	$1,40($2)
add	$2,$3,$3
add	$1,$1,$2
sw	$1,20($2)

   a. Find all data dependences in this instruction sequence.
   b. Find all hazards in this instruction sequence for a 5-stage pipeline with and without forwarding.
   c. To reduce clock cycle time, we are considering a split of the MEM stage into two stages. Repeat (b) for this 6-stage pipeline.

2. (20%) Explain the following synchronization primitives: atomic exchange, test-and-set, and fetch-and-increment. Also, explain the following pair of instructions, load linked (LL) and store conditional (SC) and how this pair of instructions can be used to implement atomic exchange and fetch-and-increment.

3. (20%) With dynamic hardware prediction for reducing branch costs, what is the disadvantage of a simple 1-bit branch-prediction buffer for a 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. (30%) Cache block size (B) can affect both miss rate and miss latency. Assuming a 1-CPI machine with an average of 1.35 references (both instruction and data) per instruction, help find the optimal block size given the following miss rates for various block sizes. (Hint: Average Memory Access Time (AMAT) = (Time for a Hit) + (Miss Rate) x (Miss Latency)).

Block Size	Miss Rate
8	4%
16	3%
32	2%

Block Size	Miss Rate
64	1.5%
128	1%

   a. What is the optimal block size for a miss latency of 20×B cycles?
   b. What is the optimal block size for a miss latency of 24+B cycles?
   c. For constant miss latency, what is the optimal block size?

Algorithms 資格考 2020 Fall

1. (30%) Answer TRUE or FALSE.
   a) $n=O(n^2)$.
   b) $1 = o(n)$.
   c) $n = \Omega(\log n)$.

2. (20%) Present the well-known quick sort algorithm and give its time complexity.

3. (20%) Present a linear time algorithm for the single source shortest path problem on directed acyclic graphs.

4. (10%) Describe a $\Theta(n \lg n)$-time algorithm that, given a set S of n integers and another integer x, determine whether or not there exist two elements in S whose sum is exactly x.

5. (10%) Show the lower bound for comparison-based sorting algorithm.

6. (10%) True or False: an NP-complete problem cannot be solved using an exponential time algorithm.

1.

OS 資格考題 (109 學年度第一學期)

1. [10%] For each of the following scheduling algorithms, please describe why starvation can or cannot occur when the algorithm is used.
   (a) FIFO
   (b) SJF
   (c) RR
   (d) Priority

2. [15%] Please describe the buddy system, slab allocator, and their difference(s).

3. [15%] Please describe the structure of a UNIX inode.

4. [20%] A computer with a 32-bit address. The physical memory size is 1 GB, and each page is 16KB. A program has its code and data together fitted in the lowest 200KB and stack fitted in the highest 8KB of its virtual address space.
   (a) [10%] What is the size of the page table if 1-level traditional page table is used? Assume that each page table entry occupies 4 bytes.
   (b) [10%] What is the size of the inverted page table? Assume that each inverted page table entry occupies 4 bytes.

5. [20%] The Fibonacci sequence is the series of numbers 0, 1, 1, 2, 3, 5, 8, ... Formally, it can be expressed as:
   $$fib_0 = 0$$
   $$fib_1 = 1$$
   $$fib_n = fib_{n-1} + fib_{n-2}$$
   Write a C program that forks a child process to report the Fibonacci sequence. The number of "numbers" in the sequence will be provided in the command line. For example, if 5 is provided, the first 5 numbers in the Fibonacci sequence (i.e., 0, 1, 1, 2, 3) will be output by the **child process**.

6. [10%] Explain why interrupts are not appropriate for implementing synchronization primitives in multiprocessor systems.

7. [10%] The SJF scheduling algorithm needs to estimate the length of the next CPU burst for each process. Please describe a reasonable estimation approach.

1. (25 points) Please briefly describe the following terminologies. (1) ROC curve (2) specificity (3) Apriori property (in Apriori Algorithm), (4) False Positive (5) maximal pattern.

2. (25 points) What is "overfitting" and "underfitting" problem in classification modeling? and what are the relations between these two problems and bias and variance? Please also explain how to reduce their effects when you are training models in DNN and decision tree, respectively.

3. (25 points) Please apply FP-growth algorithm to find large itemsets in the following transaction data, if mini_support=3.

TID	Items bought
100	{a, c, d, f, g, i, m, p}
200	{a, b, c, f, i, m, n, o, p}
300	{b, f, h, j, o}
400	{b, c, k, s, p}
500	{a, c, e, f, l, n, o}

4. (25 points) A simple labeled data with 4 attributes shown in the right table. (a) Please use **naïve Bayes** method to calculate the class probability of a test instance with "Give Birth"=Yes, "Can Fly"=no, "Live in Water"=no, and "Have Legs"=yes. (b) How to deal with the case when the value of some attribute does not appear in the training data?

Name	Give Birth	Can Fly	Live in Water	Have Legs	Class
human	yes	no	no	yes	mammals
python	no	no	no	no	non-mammals
salmon	no	no	yes	no	non-mammals
whale	yes	no	yes	no	mammals
frog	no	no	sometimes	yes	non-mammals
komodo	no	no	no	yes	non-mammals
bat	yes	yes	no	yes	mammals
pigeon	no	yes	no	yes	non-mammals
cat	yes	no	no	yes	mammals
leopard shark	yes	no	yes	no	non-mammals
turtle	no	no	sometimes	yes	non-mammals
penguin	no	no	sometimes	yes	non-mammals
porcupine	yes	no	no	yes	mammals
eel	no	no	yes	no	non-mammals
salamander	no	no	sometimes	yes	non-mammals
gila monster	no	no	no	yes	non-mammals
platypus	no	no	no	yes	mammals
owl	no	yes	no	yes	non-mammals
dolphin	yes	no	yes	no	mammals
eagle	no	yes	no	yes	non-mammals

NCKU CSIE PhD Qualifying Exam
Anatomy & Physiology for Engineers
Fall 2020

1. Please describe the process of translation. [15%]

2. Please explain location and function of skeletal, smooth, and cardiac muscles. [15%]

3. Please draw and explain stages of ossification of long bones. [15%]

4. Please explain structure of myelinated axon, saltatory conduction, and refractory period. [15%]

5. Please draw human cerebrum to explain its structure and its function. [20%]

6. Please draw human heart to explain its structure and its function throughout a cardiac cycle. [20%]

1. (25%) Please explain the details of how to construct an *inverted file* for indexing scheme. Why need the block addressing for search?

2. (25%) Please explain the model of "word to vector" for an information retrieval system.

3. (25%) Please describe the detailed procedure of how to obtain the 11-point *precision* and *recall rates* curve. Given you have a test data set consists of *n* documents for the purpose of information retrieval, and illustrate how to draw the curve from the retrieving results. Also, explain the *sensitivity* and *specificity* in terms of positive/negative results.

4. (25%) How to use rules to determine how many sentences in documents (number of sentences)? Following is a sample of examples.

NOT-END-OF-SENTENCE	119	1 viewpoint , as David	C. Robinson has recently shown , t
NOT-END-OF-SENTENCE	128	evealed , '' by Arthur	C. Clarke , Gentry Lee (Bantam)
NOT-END-OF-SENTENCE	136	E . The group led by	C. Delores Tucker , head of the NA
NOT-END-OF-SENTENCE	147	ence and Electronics ;	C. Scott Kulicke , on behalf of Se
NOT-END-OF-SENTENCE	184	g Committee chaired by	C. Rubbia . The report covers stat
END-OF-SENTENCE	192	occurs at 440 degrees	C. A hydrogenation test was carrie
END-OF-SENTENCE	210	ystem at 25 and 50 deg	C. Isotherms consist of five branc
END-OF-SENTENCE	239	C while not at 40 deg	C. Minima on the S/sub Pu / vs. C/
NOT-END-OF-SENTENCE	247	ellulases . Culture of	C. thermocellum will be optimized
NOT-END-OF-SENTENCE	255	the cellulase genes of	C. cellulolyticum and those from t
END-OF-SENTENCE	258	anging from 200 to 300	C. A system developed by the autho
END-OF-SENTENCE	262	ourse on programming in	C. Finally, those who are interest
END-OF-SENTENCE	300	a house on 2213 Perry	Dr. Then the Thomases were seen in
NOT-END-OF-SENTENCE	330	, <P> Early in 1980	Dr. Thomas B. Reed of SERI and Pro

無線通訊網路　資格考

1. Please explain the below terms in details.　[25 %]
    A. Poisson Distribution
    B. Delay Spread
    C. TDMA/ FDMA/ CDMA
    D. Reuse Distance
    E. Doppler Shift

2. Consider a cruise boat with two passengers. Each passenger will make 4 calls per hour with each call of 3-minute duration. There is only one telephone set on the boat. Please calculate the probability of the phone being occupied by one person while the other person wishes to make a call. [20%]
    A. Please draw the Markov Chain,
    B. Please calculate the blocking probability.

3. Please describe the following protocol in Pseudo code. [20%]
    A. Aloha
    B. *p*-persistent CSMA
    C. CSMA/CD
    D. CSMA/CA

4. Please calculate the maximum transmission rate for a transmission system when the delay spread is 5 ns (nano-seconds). [7 %]

5. Please explain the following terms in details. [16 %]
    A. HLR and VLR (of GSM)
    B. SGSN and GGSN
    C. Backoff mechanism of IEEE 802.11
    D. Hidden terminal problem

6. Define the **first-meter path loss** as the received signal strength (in dB) when the receiver stands one meter away from the transmitter. Now, consider the case when the first-meter path loss is 20dB . Please calculate the free-space path loss for a receiver if the distance between the transmitter and receiver is [12 %]
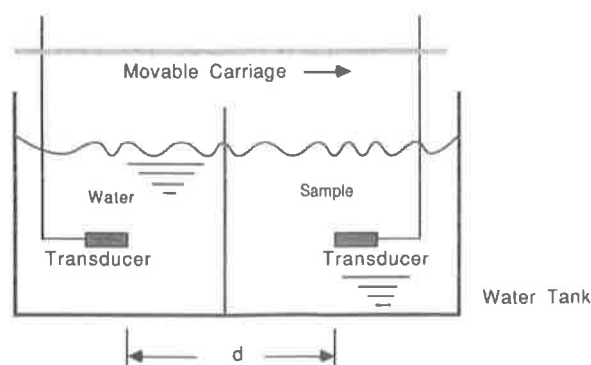   A. 10 meters,
    B. 100 meters,
    C. 1 KM.

1. Ultrasound imaging is a modality frequently applied to clinical diagnosis. The ultrasound frequency has to be increased to achieve an appropriate resolution of ultrasound image to be applicable for examining the structure of the eye in ophthalmology. **(a)** Plot the anatomy of the whole human eye, including the terminologies and size of each essential part. (6%); **(b)** A 50 MHz single element transducer was designed to be with a round shape of PZT piezoelectric disk and diameter of 2 mm for imaging the eye tissue. Calculate the wavelength, transition point between the near-field and far-field as well as the divergent angle of the transducer which was placed in a water tank. (15%); **(c)** Develop and plot a block diagram for a 50 MHz high-frequency ultrasound B-mode imaging system and explain functions or considerations for each component in the system (24%); **(d)** The developed system is to be applied to examine the retinitis in the retina tissue. What kinds of pathological image features, such as image brightness, size, shape, etc., could be different from the normal tissue? (10%); What are the possible variations of acoustical properties for the retinitis tissue? (6%); **(e)** Provide a clinical available imaging modality frequently used in ophthalmology and briefly describe its function and specification. Compare the Pros and Cons of this modality with ultrasound imaging system just mentioned in 1(c). (14%)

2. For the following arrangement, the water and the sample liquid are separated by a thin membrane whole attenuation is negligible. Two transducers are mounted on a movable carriage with a fixed distance d between them. Suppose the attenuation coefficient of water is given by β_0. The attenuation of the sample, β, can be calculated by observing the change in received pressure after a displacement of carriage, say, to the right, by Δd. **(a)** provide the relationship between frequency, wavelength, and sound velocity (5%); **(b)** derive an expression for β in terms of β_0, Δd, d, and the measured pressures before and after carriage displacement. (20%)

DBMS Qualify Exam
2020 Fall

1. (20%) Assume that we have two relations as follows.

$$R = R(A, B, C)$$
$$S = S(D, E, F)$$

Give the SQL expression that is equivalent to each of the following queries.

(a) $\Pi_{A,B}(\sigma_{C=D}(R \times S))$

(b) $R - S$

(c) $\Pi_{A,B}(R) \div \Pi_D(S)$

And give the equivalent relational algebra of the following query.

(d) Select A, D   From R, S.

2. (15%) A relation, R(A, B, C, D, E, F, G), whose attributes satisfy the functional dependencies:

$(BC \rightarrow A, D, E, F, G), (C \rightarrow E), (D \rightarrow F, G), (A \rightarrow B)$

Normalize the above relation to make it satisfy

(a) 2NF

(b) 3NF

(c) BCNF

Note: Don't make unnecessary normalization unless it is required.

3. (45%) Answer the following query in SQL using the given schema:
   S(S#, Sname, Status, City)   /* This is a relation for Supplier */
   P(P#, Pname, Color, Weight, City)   /* This is a Part relation */
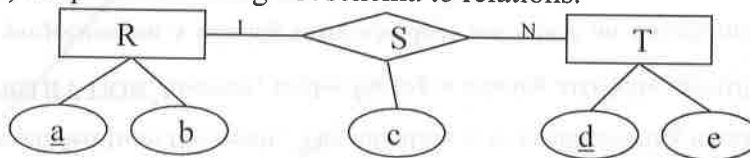   J(J#, Jname, City)   /* This is a Project relation */
   SPJ(S#, P#, J#, Quantity)

   (a) (5%) Get the supplier name and quantity for a part that is supplied by a supplier located at 'Taipei' and its weight is more than 50.
   (b) (10%) Get the name of a supplier who does not supplier any part to a project.
   (c) (10%) Get the total number of projects supplied by supplier S1.
   (d) (10%) Get the supplier names for suppliers supplying all parts that are used in project J1.
   (e) (10%) For each project, get the total quantity and average weight of the parts used in the project.
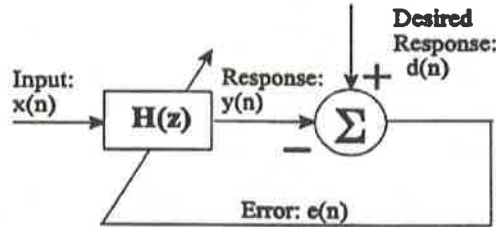
4. (10%) Explain the following terms.
   (a) Two-phase locking protocol.
   (b) Restrictions to update on views.

5. (10%) Map the following ER schema to relations.

Biomedical Signal Processing

1. (25%) For an adaptive filter as shown in Fig. 1, derive the negative gradient of the error function with respect to $b_n(k)$ at time step n. Assume the error function is the sum of squared error between the filter output y(n) and the desired output d(n).

$$y(n) = \sum_{k=0}^{L-1} b_n(k)x(n-k)$$

Fig. 1

2. (25%) Analog-to-digital converter (ADC) converts an analog voltage to an equivalent digital number. (a) What is the resolution of a 5-volt and 10-bit ADC system? (b) Explain the aliasing effect and propose two strategies to deal with aliasing. Give examples.

3. (30%) A group, or ensemble, of time responses averaged together on a point to point basis means ensemble averaging or synchronized averaging. (a) Given two essential requirements to apply ensemble averaging. For the measure y (t) is the signal $x(t)$ with additive random noise η (t) of zero mean. $y(t) = x(t) + \eta(t)$. The signal and noise are statistically independent. (b) Derive $E[y] = u_y =$

$E[x] = u_x$. (c) Derive $E[(y - u_y)^2] = \sigma_y^2 = \sigma_x^2 + \sigma_\eta^2$.

4. (20%) The function of a filter is to retain the components in certain frequency ranges and reject components in other ranges. There are various types of filters such as low-pass, high-pass, band-pass filters, etc. For the noisy ECG signals in Figs. 4-1 and 3-2, which type of filter should be applied to each noisy signal? Explain the frequency characteristics of the signal and noise for each case.
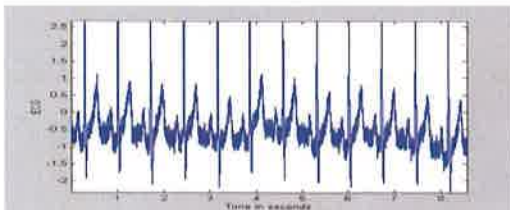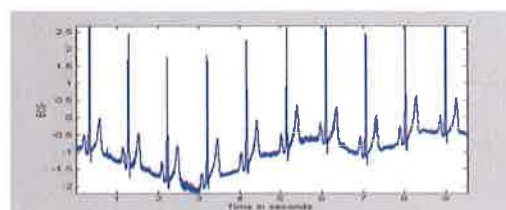

Fig. 4-1   Fig. 4-2

109. 11. 13   VLSI

1. Explain the following terms in detail: (60%)
   - (a) critical path
   - (b) hold time
   - (c) duty cycle
   - (d) hard IP
   - (e) setup 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. (20%)