

考試科目	計算機概論	所別	資訊科學系甲組	考試時間	4月20日上午第1節 星期日
------	-------	----	---------	------	-------------------

- A. Show all details for non-trivial questions to receive partial credit, in case your answer is wrong.
B. You do not have to write everything in English.

1.	(10%, 1% for each problem) True, False, or select a number.
()	(a) The largest integer can be represented by 8 bits using unsigned integer is 256.
()	(b) Access to the beginning of a RAM takes less time than access to the end of a RAM.
()	(c) The sizes of MAR and the size of MDR are the same, in general.
()	(d) The data store on a disk or on a tape both needs an address mechanism for data retrieval.
()	(e) The task of the linker is to read instructions from the object file and store them into memory for execution..
()	(f) Which of the following tasks the computers will have better performance than human: (1)computation, (2)recognition, (3) reasoning, (4) learning, (5) none of the above tasks?.
()	(g) WAN generally uses Ethernet protocol.
()	(h) Neural networks can be used to simulate the connectionist architecture of the human brain.
()	(i) Binding is the process of associating a symbolic name with a memory address.
()	(j) Which of the following functions is handled by operating system? (1) language translation, (2) memory management, (3) file system management, (4) scheduling, (5) all of the above functions.

2.	(a) (2%) What shall an OS do in order to initiate the execution of a program?
(4%)	(b) (2%) Which program of the OS will do this process, in general?

3.	(a) (4%) What are the purposes of (1) the op-code table and (2) the symbol table generated by the assembler?
(12%)	(b) (8%) Explain the following four terms that are used in compiler or programming language design: (1) BNF, (2) grammar, (3) language, and (4) semantic record.

4.	A computer designer designs a new computer that has 50 instructions in the machine language and the maximal addressable memory space is 1GB. Answer, with explanations, the following questions:
(6%)	(a) (2%) How many bits will be used in the instruction register to hold a two-address instruction?
	(b) (2%) What are the input and output size of the memory address decoder if it is a two-dimensional memory?
	(c) (2%) What will be the decoder's input and output size used for IR_{op} ?

考試科目	計算機概論	所別	資訊科學系甲組	考試時間	4 月 20 日 上午 第 1 節 星期日
------	-------	----	---------	------	--------------------------

5. (10%)	(a) (2%) Describe how a two-input multiplexor works. (b) (3%) Suppose that the two inputs are A and B and the selection line is S. Construct the truth table for the two-input multiplexor. (c) (2%) Use the result in (b) to derive the Boolean expression of the two-input multiplexor. (d) (3%) Draw a simple circuit for this Boolean expression using only AND, OR, and NOT gates.
-------------	--

6.

(8%)

Consider the 32-bit floating point number format shown below.

s	exp	mantissa
1	2	8 9 32

The 24-bit mantissa and 7-bit exponent have a base of 16, and the exponent also has a bias of 64, so that the bit pattern represents

$$(-1)^s \times 16^{\text{exp} - \text{bias}} \times 0.\text{mantissa}_{16} \quad (\text{i.e. } 0.\text{mantissa} < 1)$$

(a) (4%) Using this definition, convert the following representation to decimal number:

C2572000_{16}

(b) (2%) What is the hexadecimal representation for the word that encodes the largest positive number that can be represented in this format? Write this value to the nearest power of 2.

(c) (2%) What is the hexadecimal representation for the word that encodes the smallest positive normalized number that can be represented in this format? Write this value to the nearest power of 2.

考試科目	計算機概論	所別	資訊科學甲組	考試時間	4月20日(上)午第一節 星期 日
------	-------	----	--------	------	----------------------

7. (10%)

- (1) Please give the logarithmic time algorithm to find the minimum node of an AVL tree.
- (2) Please modify the data structure of the AVL tree and give the logarithmic time algorithm to find the k-th node of this tree.

8. (10%)

Consider the infinite set of strings $S = \{WyW^R \mid W \text{ is in } \Sigma^*, \Sigma = \{x, y\}\}$ where R denotes the reverse of W , the symbol '*' represents "any number." That is, $S = \{y, 'xyx', 'yyy', 'xxyxx', 'yyyyy', 'xyyxy', 'yxyyx', \dots\}$. Given a string T , please design the algorithm to check whether T belongs to the set S .

9. (7.5%)是非題，每題 1.5 分，答錯倒扣 1 分

- (1) () While queue is used in topological sorting, stack can also be used and the correct ordering is produced.
- (2) () Both the Dijkstra's algorithm for shortest path algorithm and the Prime's algorithm for minimum cost spanning tree are based on the greedy strategy.
- (3) () The third minimum element of a minimum heap must be one of the two children of the root.
- (4) () If we can prove that the lower bound of an NP-complete problem is exponential, then we have proved that $NP \neq P$.
- (5) () Given a graph with n vertex, the minimum cost spanning tree of this graph contains exactly $n-1$ edges.

10. (7.5%)選擇題，每題 1.5 分，答錯到扣 1 分

- (1) () Which of the following sequence of data will produce a complete binary search tree?
 - (a) 'Mary', 'Lily', 'John', 'James', 'Grace', 'Chris'
 - (b) 'James', 'Grace', 'John', 'Chris', 'Lily', 'Mary'
 - (c) 'Chris', 'Grace', 'James', 'John', 'Lily', 'Mary'
 - (d) 'John', 'Mary', 'Grace', 'Chris', 'Lily', 'James'
- (2) () Which of the following is the prefix form of the expression $A/B^C + D * E - A * C$, where B^C means the C-th power of B .
 - (a) $- * + ^ / A B C D E * A C$
 - (b) $- + ^ / A B C * D E * A C$
 - (c) $+ - ^ / A B C * D E * A C$
 - (d) $- + / A ^ B C * D E * A C$

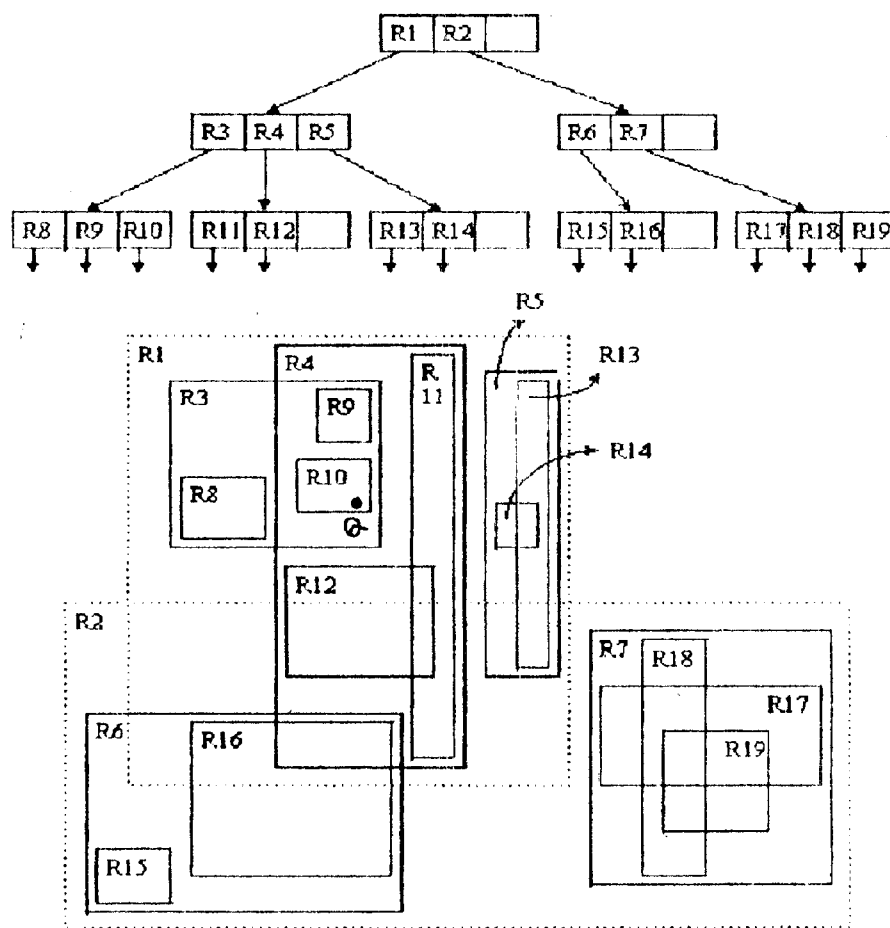
考試科目	計算機概論	所別	資訊科學甲組	考試時間	4月8日(上) 下午第一節 星期日
------	-------	----	--------	------	----------------------

- (3) () Concerning the heap, which of the following is **wrong**?
- The sum of the heights of all the nodes in the N-node heap is $O(N)$
 - In the worst case, the time complexity of insertion into an N-node heap is $O(\log N)$
 - A heap is a complete binary tree.
 - Heap sort is a stable sorting algorithm
- (4) () Given the following six records with two fields name and age, in the sequence of (Chris, 25), (James, 40), (Lily, 22), (Grace, 25), (John, 20), which of the following sorting method on the age field will produce the result in the sequence of (John, 20), (Lily, 22), (Grace, 25), (Chris, 25), (James, 40) ?
- radix sort
 - merge sort
 - selection sort
 - insertion sort
- (5) () Concerning the graph, please choose the correct one.
- The adjacency list representation is suitable for dense graph.
 - There exist no topological ordering for cyclic graph.
 - Heap is useful in the Kruskal's algorithm for minimum cost spanning tree problem.
 - The critical path is the shortest path of the graph in the critical path analysis.
11. (7%) Please prove that any sorting algorithm that uses only comparisons between elements requires $\Omega(N \log N)$ comparisons.
12. (8%) Given a query point Q and a set of rectangles in 2-dimensional space, the 'where am I' query is to search for the set of rectangles which enclose the query point Q. R-Tree is useful for fast processing of 'where am I' query. An R-tree is a balanced tree structure with the indexed rectangles stored in leaf nodes, much like a B⁺-tree. Each non-leaf node stores the minimum bounding boxes of the corresponding children nodes along with the pointers to the children nodes. For example, the following figure shows an example of twelve indexed rectangles and the corresponding 3-way R-tree. The twelve indexed rectangles are rectangle R₈, R₉, ..., R₁₉. In root node, there are two entries. The first entry stores the minimum bounding box R₁ of entries (R₃, R₄, R₅) of its children node. The entry R₃ stores the minimum bounding box R₃ of entries (R₈, R₉, R₁₀) of its children

考試科目	計算機概論	所別	資訊科學甲組	考試時間	4月20日(上)下午第一節 星期日
------	-------	----	--------	------	----------------------

node. Note that some of the bounding rectangles of the entries in the non-leaf nodes overlapped each other.

- (1) Please design the algorithm to process the 'where am I' query using R-tree.
- (2) Given the query point Q shown in the figure, please denote the nodes visited in order to process the 'where am I' query.



考試科目	計算機系統 (計算機組織與結構)	所別	資訊科學(甲組) 931	考試時間	4月20日(日)下午第二節 星期日
------	---------------------	----	-----------------	------	----------------------

一、Computer Organization and Design

1. **[Cache]** Suppose that you have a computer system with the following properties:

- Instruction miss rate (IMR): 1.5%
- Data miss rate (DMR): 4.0%
- Percentage of memory instructions (MI): 30%
- Miss penalty (MP): 60 cycles

Assume that there is no penalty for a cache hit. Also assume that a cache block is one-word (32 bits).

- (a) Express the number of CPU cycles required to execute a program with K instructions (assuming that $CPI=1$) in terms of the miss rates, miss percentage and miss penalty. (4%)

- (b) You are allowed to upgrade the computer with one of the following approaches:

- Get a new processor that is twice as fast as your current computer. The new processor's cache is twice as fast too, so it can keep up with the processor.
- Get a new memory that is twice as fast.

What is a better choice? Explain with a detailed quantitative comparison between the two choices. (6%)

2. **[Floating-point Arithmetic]**

- (a) Why is biased notation used in IEEE 754 representation? (2%)
- (b) Write the binary representation for the smallest negative floating point value greater than -1 using single precision IEEE 754 format. (3%)
- (c) Illustrate the key steps in floating-point multiplication using the example: $0.5_{10} \times -0.4375_{10}$. (5%)

3. **[Parallel Computing]**

- (a) What are the two possible approaches for parallel processors to share data? (3%)
- (b) Outline Flynn's taxonomy of parallel computers. (3%)
- (c) Suppose you want to perform two sums: one is a sum of two scalar variables and one is a matrix sum of a pair of two-dimensional arrays, size 500 by 500. What speedup do you get with 500 processors? (4%)

考試科目	計算機系統 (計算機組織與結構)	所別	資訊科學	考試時間	4月20日(土)下午第二節 星期日
------	---------------------	----	------	------	----------------------

4. **[Disk I/O]** Suppose we have a magnetic disk with the following parameters.
- Controller overhead 1 ms
 - Average seek time 12 ms
 - # sectors per track 32 sectors/track
 - Sector size 512 bytes
- (a) If the disk's rotation rate is 3600 RPS, what is the transfer rate for this disk? (3%)
- (b) What is the average time to read or write an entire track (16 consecutive KB), if the disk's rotation rate is 3600 RPM? Assume sectors can be read or written in any order. (3%)
- (c) If we would like an average access time of 21.33 ms to read or write 8 consecutive sectors (4 KBytes), what disk rotation rate is needed? (4%)
5. **[Pipelining]** (a) Explain the three types of hazards encountered in pipelining. (**Note:** State the causes and possible solutions.) (6%)
- (b) What are the characteristics of the MIPS Instruction Set Architecture (ISA) that facilitate pipelined execution? (**Note:** State at least two properties.) (4%)

考試科目	計算機系統(作業系統)	所別	資訊科學所	考試時間	4月20日(上)午第2節
------	-------------	----	-------	------	--------------

二、 There are 5 problems in this computer systems: operating systems. The weights for each problem (or subproblem) is indicated after the problem (or subproblem) number. Please do all of them.

1. [basic concepts] Please answer the following questions:

- (a) (3%) Show the difference between client-server file sharing systems and peer-to-peer file sharing systems.
- (b) (3%) When no kernel support for multi-threaded processes is provided, a user-level threads implementation might suffer from what kinds of problems?
- (c) (4%) First compare symmetric multiprocessing (SMP) and asymmetric multiprocessing on system architecture, then tell us why all modern operating systems - including Windows NT, Solaris, and Linux - now support for SMP but not for ASMP?

2. [computer & operating systems structures] A file server uses caching, and achieves a hit rate of 80%. File operations in the server cost 5 ms of CPU time when the server finds the requested block in the cache, and take an additional 15 ms of disk I/O time otherwise. Explaining any assumptions you make, estimate the server's throughput capacity (average requests/sec) if it is:

- (a) (3%) single-threaded;
- (b) (3%) two-threaded, running on a single processor;
- (c) (4%) two-threaded, running on a two-processor computer

3. (10%) [process synchronization] Assuming that you are compiler developer and you need to write **monitor** library procedures using semaphores provided by operating systems for application programmer. Your **monitor** library must include the following APIs:

- enter_monitor(void)
- leave_monitor_normally(void)
- leave_monitor_with_signal(c)
- wait_in_monitor(c), where mutex=1 and c (condition variable) are semaphores.

Please write down each library in C programming language with respect to each **monitor** library API.

考試科目	計算機系統(作業系統)	所別	資訊科學所	考試時間	4月20日(上)午第2節 星期日
------	-------------	----	-------	------	---------------------

國立政治大學圖書館

4. (10%) [memory management] A computer has four page frames. The timing of loading, time of last access, and the R (reference) and M (modified) bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last ref.	R	M
0	126	279	0	0
1	230	260	1	0
2	120	272	1	1
3	160	280	1	1

- (a) Which page will Enhanced Second-Chance replace?
 - (b) Which page will FIFO replace?
 - (c) Which page will Least-Recently-Used (LRU) replace?
 - (d) Which page will second chance replace?
5. (10%) [distributed file system]
- Network File System (NFS) views a set of interconnected workstations as a set of independent machines with independent file systems. The goal is to allow some degree of sharing among these file systems (on explicit request) in a transparent manner. So SUN NFS aims to support heterogeneous distributed systems by the provision of an operating system-independent file service.
- (a) What are the key decisions that the implementer of an NSF server for an operating system other than UNIX would have to take?
 - (b) What constraints should an underlying filing system obey to the suitable for the implementation of NFS servers?

考試科目	計算機數學(一)	所別	資科所	考試時間	4月20日 上午第1節 星期日 (F)
------	----------	----	-----	------	------------------------

離散數學部分 (60 %)

I 選擇與填充 (34 %; 不倒扣)

- (4%) How many zeros are there at the end of the decimal representation of $400!$?
(a) 80 (b) 96 (c) 99 (d) 100
- (4%) How many Boolean functions are there with 4 inputs ?
(a) 2^4 (b) 2^8 (c) 2^{16} (d) 2^{32}
- (4%) Which of the following well-formed formulas is not valid under the usual arithmetic interpretation?
(a) $1 \neq 1 \rightarrow 2=3$ (b) $(1=1 \rightarrow 2=2) \leftrightarrow (2 \neq 2 \rightarrow 1 \neq 1)$
(c) $(\exists x \forall y p(x,y)) \rightarrow \forall y \exists x p(x,y)$ (d) $(\forall x \exists y p(x,y)) \rightarrow \exists y \forall x p(x,y)$
- (4%) Which of the following languages is *not* regular? Where A and B are two arbitrary regular languages,
(a) $\{a^n b^n \mid n \geq 0\}$ (b) $A - B$ (c) $\{x \mid \exists y \text{ with } xy \in A \text{ and } |x|=|y|\}$
(d) $\{a^{f(n)} \mid f(n) = n^2 + n + 1 \text{ and } n \geq 0\}$
- (4%) Consider the program $S = \{x = x+y; \quad y = (y > 0 ? x : -x) ;\}$. Suppose after the execution of the program the postcondition " $x > y$ " holds, then which of the following conditions must be true before the execution of S ?
(a) $y < 0$ (b) $x > 0$ (c) $x + y \geq 0$ (d) $x = y$
- (4%) Suppose f is an increasing function satisfying the divide-and-conquer relation $f(n) = 3f(n/2) + 2n$ and the initial condition $f(1) = 0$. What is the asymptotic order of $f(n)$?
(a) $\Theta(n^3)$ (b) $\Theta(n^3 \lg n)$ (c) $\Theta(n^{\lg 3})$ (d) $\Theta(n^2)$
- (10 %) Suppose that a full 4-ary tree has 27 internal vertices.
(a) How many leaves does it have ? [4%]
(b) What is the smallest height it could possibly have ? [4%]
(c) What is the largest height it could possibly have ? [2%]
Note: Single-vertex tree is defined to have height 0.

考試科目	計算機數學(-)	所別	資科所	考試時間	4月20日 上午第1節 星期日 (下)
------	----------	----	-----	------	------------------------

離散數學部分

II 計算與證明 (26 %)

8. (6%) Solve the recurrence relation $a_n = 4a_{n-1} + 3a_{n-2}$ with the initial conditions $a_0 = 3$ and $a_1 = 13$.
9. (10%) We call a positive integer *perfect* if it equals the sum of all its positive divisors other than itself.
 - (a) Find a perfect number in the range (20,30). [3%]
 - (b) Show that if $2^p - 1$ is prime, then $2^{p-1}(2^p - 1)$ is perfect. [7%]
10. (10%) Let A be an infinite set and N the set of all non-negative integers. Show that if there is an onto mapping from N to A , then there must exist a 1-1 and onto mapping (bijection) from A to N .

考試科目	計算機數學(一) 機率部份	所別	資訊科學	考試時間	4月20日 星期日	上午第 節
------	------------------	----	------	------	--------------	-------

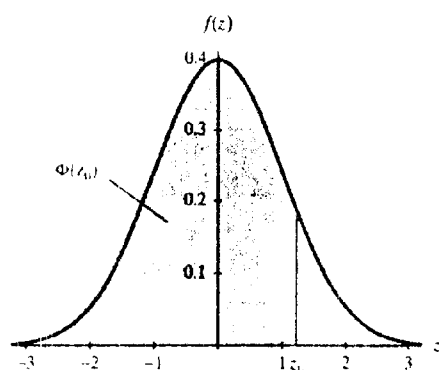
- (9) 1. A die is loaded in such a way that an even number is twice as likely to occur as an odd number. If this die is rolled once, what is the probability that the outcome will be 1 or 2?
- (9) 2. A random variable X has a mean $\mu=10$ and a variance $\sigma^2=16$. Using Chebyshev's theorem, find
- $P(|X-10| \geq 8)$;
 - $P(0 < X < 20)$;
 - the value of the constant c such that $P(|X-10| \geq c) \leq 0.01$.
- (12) 3. A soft-drink machine is regulated so that it discharges an average of 100 milliliters per cup. If the amount of drink is normally distributed with a standard deviation equal to 10 milliliters,
- what fraction of the cups will contain more than 113.5 milliliters?
 - what is the probability that a cup contains between 93.5 and 120.5 milliliters?
 - how many cups will probably overflow if 125 milliliters cups are used for the next 10,000 drinks?
 - below what value do we get the smallest 10% of the drinks?
- (10) 4. A bank has an average of 12 customers between 9:00 am to 12:00 noon. Customers arrive according to a Poisson distribution.
- What is the probability that the time between consecutive arrivals (customers) will fall between six and fifteen minutes?
 - What is the expected time between the arrivals of the next two customers (in minutes)?

考試科目	計算機數學(一)	所別	資訊科學 931	考試時·間	4月20日上午第1節 星期 日 (下)
------	----------	----	----------	-------	------------------------

計算機數學(一)統計表

656 App. C Tables

Table Va The Normal Distribution



$$P(Z \leq z) = \Phi(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-u^2/2} du$$

$$\Phi(-z) = 1 - \Phi(z)$$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7703	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
α	0.400	0.300	0.200	0.100	0.050	0.025	0.020	0.010	0.005	0.001
z _α	0.253	0.524	0.842	1.282	1.645	1.960	2.054	2.326	2.576	3.090
z _{α/2}	0.842	1.036	1.282	1.645	1.960	2.240	2.326	2.576	2.807	3.291

考試科目	計算機數學(二)	所別	資科所(甲組)	考試時間	4月20日上午第1節
					星期日(下)

離散數學部分 (60 %)

I 選擇與填充 (34 %; 不倒扣)

- (4%) How many zeros are there at the end of the decimal representation of $400!$?
(a) 80 (b) 96 (c) 99 (d) 100
- (4%) How many Boolean functions are there with 4 inputs ?
(a) 2^4 (b) 2^8 (c) 2^{16} (d) 2^{32}
- (4%) Which of the following well-formed formulas is not valid under the usual arithmetic interpretation?
(a) $1 \neq 1 \rightarrow 2=3$ (b) $(1=1 \rightarrow 2=2) \leftrightarrow (2 \neq 2 \rightarrow 1 \neq 1)$
(c) $(\exists x \forall y p(x,y)) \rightarrow \forall y \exists x p(x,y)$ (d) $(\forall x \exists y p(x,y)) \rightarrow \exists y \forall x p(x,y)$
- (4%) Which of the following languages is *not* regular? Where A and B are two arbitrary regular languages,
(a) $\{a^n b^n \mid n \geq 0\}$ (b) $A - B$ (c) $\{x \mid \exists y \text{ with } xy \in A \text{ and } |x|=|y|\}$
(d) $\{a^{f(n)} \mid f(n) = n^2 + n + 1 \text{ and } n \geq 0\}$
- (4%) Consider the program $S = \{x = x+y; \quad y = (y > 0 ? x : -x); \}$. Suppose after the execution of the program the postcondition " $x > y$ " holds, then which of the following conditions must be true before the execution of S ?
(a) $y < 0$ (b) $x > 0$ (c) $x + y \geq 0$ (d) $x = y$
- (4%) Suppose f is an increasing function satisfying the divide-and-conquer relation $f(n) = 3f(n/2) + 2n$ and the initial condition $f(1) = 0$. What is the asymptotic order of $f(n)$?
(a) $\Theta(n^3)$ (b) $\Theta(n^3 \lg n)$ (c) $\Theta(n^{\lg 3})$ (d) $\Theta(n^2)$
- (10 %) Suppose that a full 4-ary tree has 27 internal vertices.
(a) How many leaves does it have ? [4%]
(b) What is the smallest height it could possibly have ? [4%]
(c) What is the largest height it could possibly have ? [2%]
Note: Single-vertex tree is defined to have height 0.

考試科目	計算機數學(二)	所別	資科所	考試時間	4月20日上午第1節 星期日
------	----------	----	-----	------	-------------------

離散數學部分

II 計算與證明 (26 %)

8. (6%) Solve the recurrence relation $a_n = 4a_{n-1} + 3a_{n-2}$ with the initial conditions $a_0 = 3$ and $a_1 = 13$.
9. (10%) We call a positive integer *perfect* if it equals the sum of all its positive divisors other than itself.
- (a) Find a perfect number in the range (20,30). [3%]
- (b) Show that if $2^p - 1$ is prime, then $2^{p-1}(2^p - 1)$ is perfect. [7%]
10. (10%) Let A be an infinite set and N the set of all non-negative integers. Show that if there is an onto mapping from N to A , then there must exist a 1-1 and onto mapping (bijection) from A to N .

線性代數部分 (40%)

(6) 1. If $|A| = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = 2$, find the determinants of the following matrices:

$$B = \begin{bmatrix} 2a_2 & a_1 & 3a_3 \\ 2b_2 & b_1 & 3b_3 \\ 2c_2 & c_1 & 3c_3 \end{bmatrix} \quad \text{and} \quad C = \begin{bmatrix} b_1 & b_2 & b_3 \\ a_1+b_1-c_1 & a_2+b_2-c_2 & a_3+b_3-c_3 \\ 2c_1 & 2c_2 & 2c_3 \end{bmatrix}$$

(10) 2. Find all values of a for which the resulting linear system has (A) no solution, (B) a unique solution, and (C) infinitely many solutions:

$$\begin{cases} x + y - z = 2 \\ x + 2y + z = 3 \\ x + y + (a^2-5)z = a \end{cases}$$

(9) 3. Find the cosine of the angle between each pair of vectors $\underline{u}$ and $\underline{v}$.

(a) $\underline{u} = (2, 3, 1)$, $\underline{v} = (3, -2, 0)$. (b) $\underline{u} = (2, 0, 1)$, $\underline{v} = (3, 2, -1)$.

(c) $\underline{u} = (0, 4, 2, 3)$, $\underline{v} = (0, -1, 2, 0)$.

(9) 4. Which of the following are linear transformations? (You must verify or explain your answer)

(a) $L(x, y, z) = (x-y, x^2, 2z)$.

(b) $L\left(\begin{bmatrix} x \\ y \\ z \end{bmatrix}\right) = \begin{bmatrix} 2x-3y \\ 3y-2z \\ 2z \end{bmatrix}$.

(c) $L(x, y) = (x-y, 2x+2)$.

(6) 5. Let $A = \begin{bmatrix} 3 & -5 \\ 1 & -3 \end{bmatrix}$. Compute A^{16} .

考試科目	計算機概論	所別	資訊科學系乙組 ⁹³²	考試時間	4月20日上午第1節 星期日
------	-------	----	------------------------	------	-------------------

- A. Show all details for non-trivial questions to receive partial credit, in case your answer is wrong.
B. You do not have to write everything in English.

1.	(20%, 1% for each problem) True, False, or select a number.
()	(a) The key to measuring the efficiency of an algorithm is to find out how long it takes to run on a specific machine.
()	(b) The largest integer can be represented by 8 bits using unsigned integer is 256.
()	(c) The binary search algorithm is a good algorithm for searching an unordered list.
()	(d) NOT [(x<y) OR NOT (x<z)] (assume that x=1,y=2,z=3)
()	(e) All the logic circuits can be realized using only AND, OR, and NOT gates.
()	(f) RAM is divided into cells of different size, in general.
()	(g) Access to the beginning of a RAM takes less time than access to the end of a RAM.
()	(h) The sizes of MAR and the size of MDR are the same, in general.
()	(i) The data store on a disk or on a tape both needs an address mechanism for data retrieval.
()	(j) Which of the following tasks the computers will have better performance than human: (1) computation, (2) recognition, (3) reasoning, (4) learning, (5) none of the above tasks?
()	(k) Which of the following functions is handled by operating system? (1) language translation, (2) memory management, (3) file system management, (4) scheduling, (5) all of the above functions.
()	(l) One can fetch or store part of a memory cell.
()	(m) Direct access to an I/O device is much faster than random access to a memory location.
()	(n) Memory fetch and store both will destroy the content in the memory.
()	(o) The task of the linker is to read instructions from the object file and store them into memory for execution..
()	(p) FORTRAN does not have iteration mechanism.
()	(q) Binding is the process of associating a symbolic name with a memory address.
()	(r) WAN generally uses Ethernet protocol.
()	(s) Compare to T1, modem is a high speed device used in computer network connections.
()	(t) Neural networks can be used to simulate the connectionist architecture of the human brain.

備 考 試 題 隨 卷 繳 交

命 題 委 員 :

-64-

(簽章) 92年4月7日

考試科目	計算機概論	所別	資訊科學系 乙組	考試時間	4月20日上午第1節 星期日
------	-------	----	----------	------	-------------------

2. (10%)	Write (in the table provided) the worst-case and the average-case time complexity of the following algorithms on n input elements. (For Radix sort, each element has at most d -digits.)		
		Worst-case time complexity	Average-case time complexity
	(a) Sequential search		
	(b) Binary search		
	(c) Merge sort		
	(d) Quicksort		
	(e) Radix sort		

3. (10%)	(a) (6%) The concept of divide and conquer can be used in designing algorithms. Explain the three phases of the divide and conquer process.
	(b) The recurrence equation, as described below, can be used to analyze the complexity of divide and conquer method. $T(n) = aT(n/b) + f(n)$ Explain the following: (1) (2%) the role of the function $f(n)$, and (2) (2%) the restriction on b , and, why we need such a restriction.

4. (10%)	The algorithm for insertion sort is given below
	<pre> 1 for $j \leftarrow 2$ to $\text{length}[A]$ 2 do $\text{key} \leftarrow A[j]$ 3 *Insert $A[j]$ into the sorted sequence $A[1..j-1]$ 4 $i \leftarrow j-1$ 5 while $i > 0$ and $A[i] > \text{key}$ 6 do $A[i+1] \leftarrow A[i]$ 7 $i \leftarrow i-1$ 8 $A[i+1] \leftarrow \text{key}$ </pre> The running time of the above algorithm can be described by the following equation: $T(n) = c_1n + c_2(n-1) + c_4(n-1) + c_5 \sum_{j=2}^n t_j + c_6 \sum_{j=2}^n (t_j - 1) + c_7 \sum_{j=2}^n (t_j - 1) + c_8(n-1)$ where n is the input size, c_i is the steps required for the i^{th} statement, and t_j is the number of times the while loop test in line 5 is executed for that value of j. Using this equation, explain (a) (3%) the best-case, (b) (4%) the worst-case, and (c) (3%) the average-case running time of the insertion sort.

備 考 試 題 隨 卷 繳 交

考試科目	計算機概論	所別	資訊科學系	考試時間	4月20日上午第1節
------	-------	----	-------	------	------------

5. (a) (2%) What shall an OS do in order to initiate the execution of a program?
(4%) (b) (2%) Which program of the OS will do this process, in general?
6. (3% each) Explain the following four terms that are used in compiler or programming language design: (1) BNF, (2) grammar, (3) language, and (4) semantic record.
(12%)
7. If a RAM is using a 24-bit address mechanism, answer the following:
(6%)
(a) (2%) What is the maximal possible memory size of it? (using the unit K, M or G)
(b) (2%) What are the input and output size of the memory address decoder if it is a one-dimensional memory?
(c) (2%) What are the input and output size of the memory address decoder if it is a two-dimensional memory?
8. The XOR (exclusive OR) takes 2 binary inputs (X and Y) and produces 1 binary output (O). The output goes ON only when the two inputs are different.
(10%)
(a) (4%) Construct the truth table of a XOR.
(b) (3%) Write the Boolean expression for its output O.
(c) (3%) Draw a simple circuit for this Boolean expression using only AND, OR, and NOT gates.
9. The single-precision floating point number is represented in the following format:
(8%)
- | | | |
|------|--------|----------|
| 1bit | 8 bits | 23 bits |
| s | exp | mantissa |
- The 8-bit exponent is represented using excess 127 mechanism so that the bit pattern represents:
- $$(-1)^s \times 2^{\text{exp}-127} \times 0.\text{mantissa}_2 \text{ (i.e. } 0.\text{mantissa} < 1)$$
- Using this representation, convert the following binary number to decimal number:
- 11000000111010000000000000000000
- (a) (5%) Using exactly the above definition.
(b) (3%) Using a similar format such that the exponent part has 9 bits (with excess 255 mechanism) and mantissa part has 22 bits.

備 考 試 題 隨 卷 繳 交

考試科目	計算機概論	所別	資訊科學系	考試時間	4 月 20 日 上午第 1 節 星期日
------	-------	----	-------	------	-------------------------

國立政治大學圖書館

10. (10%)	Answer only one of the following three subproblems (only one from (a), (b), or (c))
	(a) (1) (4%) What is "deadlock"?
	(2) (6%) Give a deadlock recovery algorithm (in communication) and a deadlock prevention algorithm (in resource sharing). (3% each)
	or
	(b) (1) (2%) What is the function of the routing table used in computer networks.
	(2) (3%) Explain how does the Ethernet protocol work?
	(3) (3%) What will you do in case of a collision in implementing the Ethernet protocol?
	(4) (2%) Explain the differences between packet-switching and circuit-switching.
	or
	(c) (1) (4%) What is the Turing test?
	(2) (3%) The information retrieved on the internet usually contains irrelevant answers, suggests some mechanism that could improve this situation.
	(3) (3%) Best-first search is widely used in various applications, describes briefly how the idea of best-first search can be applied to game playing.

備 考 試 題 隨 卷 繳 交

命題委員：

-67-

(簽章) 92年 4 月 7 日