

考試科目	計算機數學與網路	所別	資訊科學	考試時間	3月17日 星期六	第3節
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國立政治大學圖書館

1. [Shannon's Theorem]

Suppose that the spectrum of a voice channel is 64 kHz and the SNR (Signal to Noise Ratio) is 10 dB. Then:

- (a) (4%) Compute the theoretical limit of this channel's data rate based on the Shannon's Theorem?
- (b) (4%) How many signaling levels are required to achieve this data rate?

2. [Bandwidth and Latency]

Calculate the total time required to transfer a 2.0 MB file in the following cases, assume an Round-Trip Time (RTT) of 100 ms, a packet size of 1 KB and an initial  $2 \times RTT$  of "handshaking" before data is sent.

- (a) (4%) The bandwidth is 100 Mbps, and data packets can be sent continuously.
- (b) (4%) The bandwidth is 100 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next.

3. [Delay  $\times$  Bandwidth]

Please answer the following questions:

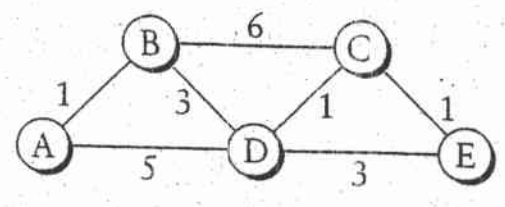
- (a) (4%) Why it is important to know the product of *delay*  $\times$  *bandwidth* when constructing a high performance network?
- (b) (4%) Assume an RTT is 100 ms, please compute *delay*  $\times$  *bandwidth* for T3 and FDDI?

4. [TCP Three-Way Handshake]

- (a) (4%) Please demonstrate how is the TCP three-way handshaking connection protocol established between a client process and a server process?
- (b) (4%) How the TCP three-way handshaking protocol works in case an old delayed duplicate SYN message from a client process was received by the server process?

5. [Routing Protocols]

- (a) (4%) What is the difference between RIP and OSPF routing protocols?
- (b) (4%) Use OSPF routing protocol to build the routing table for node A in the network shown in the following figure:



備	考試題隨卷繳交
命題委員：	070 (簽章) 年 月 日

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考試科目	計算機數學與 網路	所別	8141 資訊科學	考試時間	3月17日 星期六	第 3 節
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(離散數學部分; 共 9 題 60%)

6. [10%] True (mark 0) or false (mark x) questions:

- (a) If  $2 + 2 = 5$  then  $1 + 1 = 3$ .
- (b) Let  $A, B, C, D$  be sets. Then  $(A - B) - (C - D) = (A - C) - (B - D)$ .
- (c)  $\forall x \exists y P(x,y)$  implies  $\exists x \forall y P(x,y)$ .
- (d) There are languages that cannot be recognized by any machine.
- (e) If a relation is irreflexive and transitive, then it is asymmetric.
- (f) The formula  $(P \vee \sim Q) \wedge (\sim P \vee Q)$  is not satisfiable.
- (g) If  $A$  is not a tautology, then  $\sim A$  must be satisfiable.
- (h) If  $A, B$  and  $C$  are languages, then  $A(B \cap C) = AB \cap AC$ .
- (i) If  $A$  is a language, then  $(A^*)^+ = A^+$ .
- (j) There are context free languages that can be recognized by finite automata.

7. [3%] Which of the following formula is in conjunctive normal form and is logically equivalent to the formula:  $(P \wedge S) \rightarrow (Q \wedge R)$

- (a)  $\sim P \vee \sim S \vee (Q \wedge R)$
- (b)  $(\sim P \vee \sim S \vee Q) \wedge (\sim P \vee \sim S \vee R)$
- (c)  $\sim(P \wedge S) \vee (Q \wedge R)$
- (d)  $(P \vee S) \wedge (\sim Q \vee \sim R)$

8. [3%] Suppose we have 4 algorithms designed to solve the same problem. If the running time of the 4 algorithms are expressed by divide-and-conquer recurrence relations as given below, then which algorithm would be asymptotically the best?

- (a)  $f(n) = 10 f(n/3) + 10 n$
- (b)  $f(n) = 5 f(n/2) + 6 n$
- (c)  $f(n) = 9 f(n/3) + 2n^2$
- (d)  $f(n) = 20 f(n/5) + 5 n^2$

9. [3%] Which of the following sets of boolean operators is not functionally complete?

- (a) { or, not }
- (b)  $\{ \rightarrow, 0 \}$
- (c) { xor, 1 }
- (d) { nand }

10. [5%] There are \_\_\_\_\_ ways in which 6 jobs can be assigned to 3 employees so that each employee is assigned at least one job and the hardest job is assigned to the best employee.

備	考試題隨卷繳交
命題委員：	071 (簽章) 96年2月27日

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國立政治大學圖書館

11. [9%] Answer the following questions about trees:

- (a) If  $T$  is a tree with 20 edges, then it has \_\_\_\_\_ vertices.
- (b) If  $T$  is a balanced full 3-ary tree of height 5, then it has at least \_\_\_\_\_ vertices.
- (c) If  $T$  is a full 4-ary tree with 82 leaves, then it has \_\_\_\_\_ internal vertices.

12. [5%] Solve the recurrence relation  $a_n = 4a_{n-1} - 4a_{n-2}$  with the initial condition that  $a_0 = 1$  and  $a_1 = 6$ . The solution is  $a_n = \underline{\hspace{2cm}}$  for all  $n \geq 0$ .

13. [12%] Let  $Q_n = (V_n, E_n)$  be a family of simple graphs where  $n \geq 1$  and the set of vertices  $V_n = \{a, b, c, d\}^n$  consists of all strings over the alphabet  $\{a, b, c, d\}$  of length  $n$  (,for instance, if  $n = 2$ , then  $V_2 = \{aa, ab, ac, ad, ba, bb, \dots, dd\}$ ,) and the set of edges  $E_n$  consists of all unordered pairs of members of  $V_n$  which differ in 1 position (, e.g., if  $n = 4$ , then  $aaab$  and  $acab$  are adjacent since they differs only in position 2. ). The distance of two vertices in a graph is defined to be the number of edges of the shortest path between them and the diameter of a graph is defined to be the longest of all distances of all pairs of vertices of the graph.

- (a) There are \_\_\_\_\_ vertices in  $Q_n$ . [3%]
- (b) The degree of every vertex  $v$  in  $Q_n = \underline{\hspace{2cm}}$  [3%]
- (c) There are \_\_\_\_\_ edges in  $Q_n$ . [3%]
- (d) Find all values of  $n$  under which  $Q_n$  has an Euler circuit [3%]

14. [10%] Show that a simple graph  $G$  with  $n$  vertices is connected if it has more than  $(n-1)(n-2)/2$  edges.

備 考 試 題 隨 卷 繳 交

命 題 委 員 : 072 (簽章) 96 年 2 月 27 日

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