COMPS265F

Online Test ①

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Question 1 (10 marks)

(a) [5]

The main operation of the algorithm is additions, so its time complexity equals the number of additions.

line 4 takes 1 addition, so the for-loop in line3 takes $3 \cdot 1 = 3$ additions.

So the for-loop in line 1 takes total: $n \cdot 3 = 3n$ additions. ✓

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The total time complexity is at most $O(n)$.

(b) [5]

when $n=1$: $T(n) = O(1)$

when $n>1$: $T(n) = T(n-1) + c$

$$= T(n-2) + c + c$$

$$= \cdots$$

$$= T(1) + (n-1)c$$

$$= c + (n-1) \cdot c = n \cdot c$$

$$= O(n) \cdot O(1) = O(n)$$ ✓

The time complexity:

$$T(n) = \begin{cases} O(1) & \text{if } n=1, \\ O(n) & \text{if } n>1. \end{cases}$$

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Question 2 (15 marks)

Steps to construct the Huffman code tree:

1. Merge B, F to (B, F)
2. merge D, (B, F) to (D, B, F)
3. Merge C, G to (C, G)
4. Merge E, (D, B, F) to (E, D, B, F)
5. Merge A, (C, G) to (A, C, G).
6. Merge (E, D, B, F), (A, C, G) to (E, D, B, F, A, C, G).

✓

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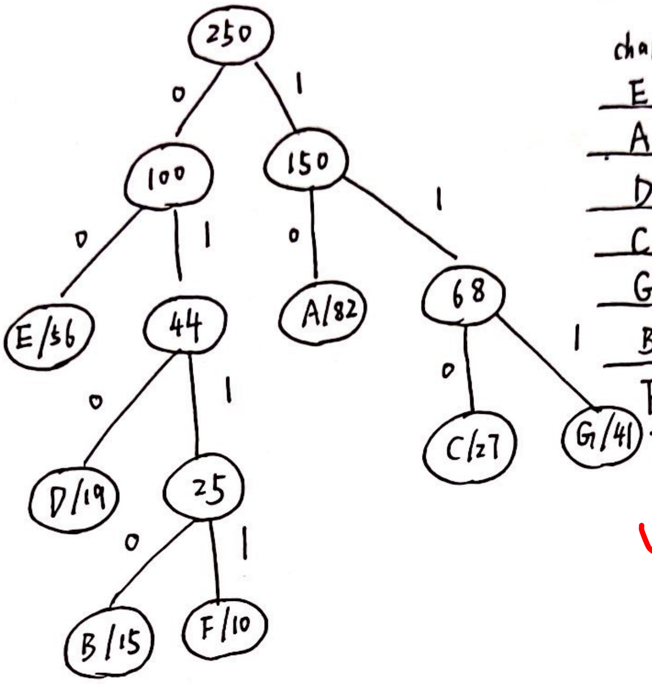
Question 2 (cont'd)

code tree:



Huffman code :

char	Huffman code
E	00
A	10
D	010
C	110
G	111
B	0110
F	0111

✓

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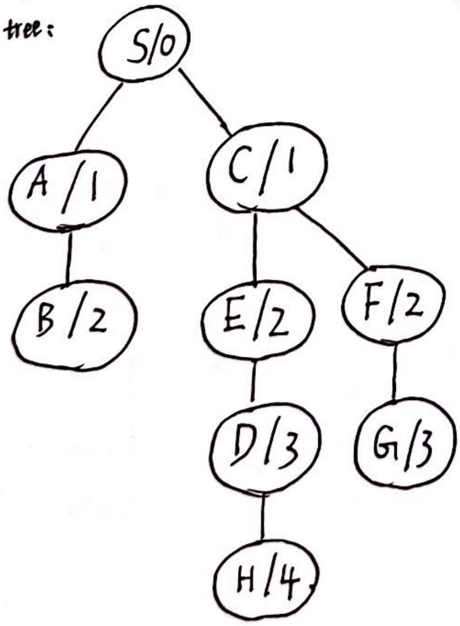
average character length ·

$$L = \frac{56 \times 2 + 82 \times 2 + 19 \times 3 + 27 \times 3 + 41 \times 3 + 15 \times 4 + 10 \times 4}{250}$$

$= 2.508$ X

Question 3 (15 marks)

breadth-first tree:



the output :

(node 0 , dist 0) (node 1 , dist 1) (node 3 , dist 1).

(node 2, dist 2) (node 5 , dist 2) (node 6 , dist 2).

(node 3, dist 3) (node 7, dist 3) (node 8 , dist 4).

visited order	1	2	3	4	5	6	7	8	9
vertex V	S	A	C	B	E	F	D	G	H
dist[V]	0	1	1	2	2	2	3	3	4.
Parent in BF-tree	-	S	S	A	C	C	E	F	D

✓

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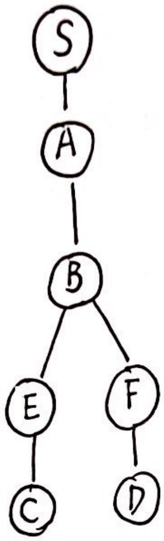
Question 4 (15 marks)

(a) [9]

Depth-First Search tree:



discovered order:	1	2	3	4	5	6	7
vertex v	S	A	B	E	C	F	D
d[v]	1	2	3	4	5	8	9
f[v]	14	13	12	7	6	11	10
π[v]	-	S	A	B	E	B	F.

✓ 9

(b) [6].

edge	(S, A)	(S, B)	(A, D)	(B, D)	(B, F)	(B, C)	(B, E)	(C, S).
type	tree ✓	forward ✓	forward ✓	forward ✓	tree ✓	forward ✓	tree ✓	back ✓

edge	(E, C)	(F, E)
type	tree ✓	cross. ✓

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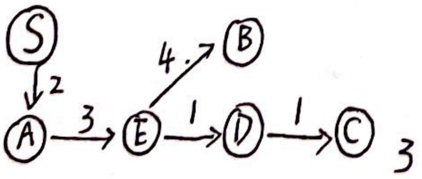
Question 5 (15 marks).

Iteration	Vertex v	S	A	B	C	D	E	P
1st	d[v]	⓪	②	∞	8	∞	∞	{S}.
2nd	d[v]	⓪	②	∞	8	∞	⑤	{S, A}
3rd	d[v]	⓪	②	9	8	⑥	⑤	{S, A, E}
4th	d[v]	⓪	②	9	⑦	⑥	⑤	{S, A, E, D}
5th	d[v]	⓪	②	⑨	⑦	⑥	⑤	{S, A, E, D, C}
								{S, A, E, D, C, B}.

✓

the shortest tree:



✓ 15

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Question 6 (10 marks)

(a) the output: I ✓ 4

(b) the algorithm is recursive :

In the worst case: which start from root with n tree elements:

$$T(n) = 2T(\frac{n}{2}) + O(1)$$

For the master theorem:

$f(n) = O(1)$ $\quad \therefore f(n) = n^{\log_b a} \Rightarrow$ case 2. applied ✓

$n^{\log_b a} = n^0 = 1$

$T(n) = \Theta(\lg n)$. ✗

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Question 7 (10 marks)

(a) [4]

① $i == 0$

② 0

③ $i-1$

④ i

✓ 4