软件学院本科生 2020——2021 学年第 2 学期算法导论课程期末考试试卷（B 卷）

专业：　　年级：　　学号：　　姓名：　　成绩:

草　稿　区

得分

一 、选择题（本题共 30 分，每小题 3 分）

1. In terms of asymptotic analysis, which function grows the fastest (　　)

A. $2n-3$　B. 5^n　C. $7n^2+n$　D. $n^2\log n$

2. Which of the following is not $O(n^2)$ (　　)

A. $1500n+12099$　B. $n^{1.98}$　C. $2n^2$　D. $n^3\cdot\sqrt{n}$

3. If m denotes the number of edges in a graph, and n denotes the number of nodes. The time complexity of Kruskal is (　　)

A. $O(mn)$　B. $O(mlogn)$　C. $O(n+m)$　D. $O(mlogm)$

4. Which of the following problem cannot be solved by dynamic programming (　　)

A. Knapsack Problem　B. Stable Matching　C. Segmented Least Squares　D. Weighted Interval Schedule

5. Considering the following pairs of functions $f(n)$, $g(n)$, which pair of the functions satisfies that $f(n)=O(g(n))$ but $g(n)\neq O(f(n))$ (　　)

A. $f(n)=n^3, g(n)=n^2\log(n^2)$　B. $f(n)=\log n, g(n)=7\log n$

C. $f(n)=10\log\sqrt{n}, g(n)=\sqrt{n}+10$　D. $f(n)=\log n+1.001^n, g(n)=1000\log\sqrt{n}$

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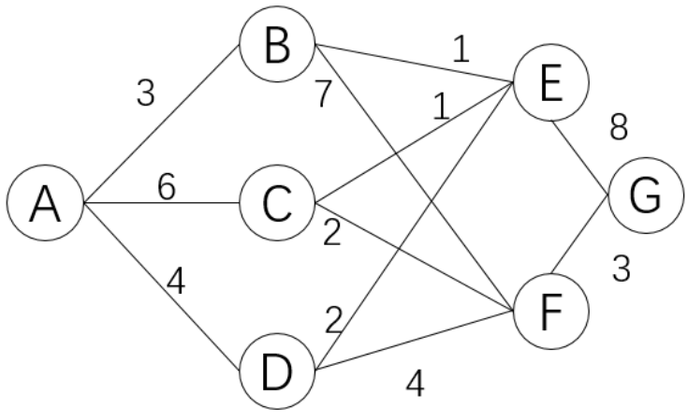
6. Given a graph G, all its edges are positively weighted. Suppose that you change the length of every edge of G as follows. For which is every shortest path in G also the shortest path in G′ (　　)

A. Add 17　　B. Multiply by 17　　C. Takes its cube (立方)　　D. Take its square (平方)

7. What is the length of the shortest path from A to G in the following graph (　　)



A. 10　　B. 11　　C. 12　　D. 13

8. The main difference between greedy algorithms and the dynamic programming is (　　)

A. Optimal substructure

B. Greedy choice

C. Construct optimal solution

D. Define the optimal solution

9. What is the time complexity of the following code (　　)

```
int i = 0;
while(i * i * i <= n)
    i ++;
```

A. $O(\log n)$　　B. $O(n^3)$　　C. $O(n^{1/3})$　　D. O(n)

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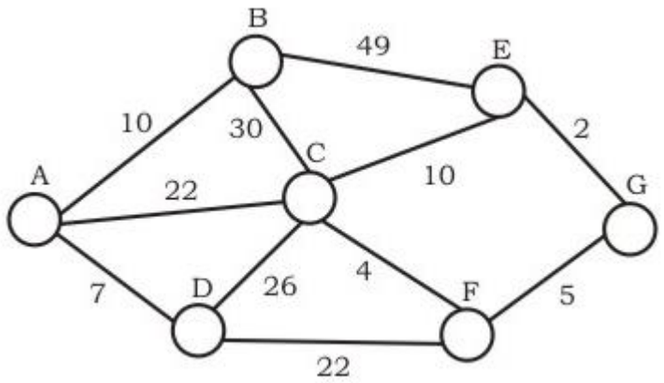
10. Consider the undirected graph below. Using Prim's algorithm to construct a minimum spanning tree starting from node A, which one of the following sequences of edges is a possible solution to construct the minimum spanning tree ( )



A. (E, G), (C, F), (F, G), (A, D), (A, B), (A, C)

B. (A, D), (A, B), (A, C), (C, F), (G, E), (F, G)

C. (A, B), (A, D), (D, F), (F, G), (G, E), (F, C)

D. (A, D), (A, B), (D, F), (F, C), (F, G), (G, E)

得分

二 、填空题（本题共 20 分，每空 2 分）

1. Rank the following functions:$\log n$, $3\,\mathrm{n}\log\sqrt{n}$, $\sqrt{2n}$, 2n!, 3^n, n^3 in ascending order in terms of computational complexity: _____.
2. Using binary search to search for an element in a sorted list with n elements. In the best case, the running time is _____. In the worst case, the time complexity is _____.
3. The asymptotic expression Ω indicates _____. (上界/下界/紧的界)

4. Given sequence X = [B, C, A, D, B, C, D] and sequence Y = [A, C, B, A, B, D, C, D], please give one of the longest common subsequence of X and Y _____.
5. The running time of the following code is _____.

```
int i=0, k=0;
while(k<n) {
    i++;
    k+=i
}
```

6. In the problem of optimal offline cache, the chars stored in the cache of size 5 are {e, a, c, d, b}, and the required string is "abfcegedb". If we use the farthest-in-future algorithm, the char ejected from the cache at the first cache miss is_____.
7. The three basic methods for proving that the problem can be solved with a greedy algorithm are _____、_____ and _____.

得分

三 、简答题（本题共 **20** 分）

1. The subset-sum problem can be described as: given a set of integers, is there a non-empty subset whose sum is zero? One algorithm able to solve it works as follows. Each possible combination of entries from the input set (treated as a list) is denoted as a binary number. For example, for the input set $\{1,2,-3,4,-2\}$ we would utilize 5-digit binary numbers and the number 01001 would indicate a combination involving 2 and −2 (upon finding such a combination the algorithm would stop and return a positive answer). For an input set of size n, please give the asymptotic complexity of this algorithm and justify (证明) your answer. （**本小题 10 分**）

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2. Table 1 shows men's preference ranking for women, and Table 2 shows women's preference ranking for men. After matching men and women, if man A and woman X are not matched, A prefers X than his assigned partner, and X prefers A than her assigned partner, we say (A, X) is an unstable pair and the matching is unstable. Please devise a stable matching method and describe the core idea in terms of pseudocode. **（本小题 10 分）**

Table 1
Men's preference list for women

	1st	2nd	3rd
A	X	Y	Z
B	Y	X	Z
C	X	Y	Z

Table2
Women's preference list for men

	1st	2nd	3rd
X	B	A	C
Y	A	B	C
Z	A	B	C

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四 、综合题（本题共 30 分）（注：凡是要求设计算法的题目，请写出详细的伪代码）

1. In the interval scheduling problem, we are given n jobs, each of which has a starting time s and a finishing time f, and the goal is to find a maximum set of mutually compatible jobs (two jobs are compatible if they don't overlap).
   (本小题 12 分)
   Please answer the following questions:
   (a) Design a greedy algorithm for the interval scheduling problem and give the pseudocode.
   (b) Assume that we are given 8 jobs with starting time and finishing time (s, t) being (0,2), (1,3), (8,9), (3,7), (7,8), (2,4), (6,9), (4,5). Use your algorithm to find a solution to this problem.

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2. There is an array A which contains n integers $x_1, \ldots, x_n$.We need to find a non-empty contiguous subset T of A whose sum is maximized. For example, if A = [1, -2, 4, -2, 3], then T is [4, -2, 3] with a sum of 5. Design a dynamic programming algorithm that solves this problem. **(本小题 18 分)**
   (a) Give your pseudocode and explain it.
   (b) Analyze the time complexity.
   (c) Assume A = [13, -3, -25, 20, -3, -16, -23, 18, 20, -7, 12, -5, -22, 15, -4, 7], calculate its corresponding T and the maximized sum using your algorithm.