



Faculty of Computing and Artificial Intelligence
Cairo University
Mid-term Exam



Program: Computer Science / Software Engineering
Course Name: Theory of Computation
Course Code: CS432 / SCS432
Instructor(s): Dr. Amin Allam

Date: 4/4/2026
Duration: 1 hour
Total Marks: 20 marks

تعليمات هامة:

- حيازة التليفون المحمول مفتوحا داخل لجنة الامتحان يعتبر حالة غش تستوجب العقاب وإذا كان الدخول بالمحمول ضروريا فيوضع مغلقا في الحقيبة .
- لا يسمح بدخول سماعة الأذن أو البلوتوث .
- لا يسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة ويعتبر مخالفة ذلك حالة غش .

- The exam consists of 16 equal-weight multiple-choice questions in 2 pages.
- Record in the bubble sheet exactly ONE answer for each question.
- If a question has multiple correct answers in the available choices, choose the first correct one.
- If a question has no correct answer in the available choices, choose E.

Qa ⇒ Draw a **Mealy** machine (which outputs 0 or 1 with each transition). The machine must consist of **exactly 5 states** (named A, B, C, D, E). The machine must output 1 for each occurrence of “**zzyzz**” inside any input string over the alphabet {y, z} and output 0 otherwise. Suppose the starting state is **A**. Assume $T(A, z) = B$, $T(B, z) = C$, $T(C, y) = D$, $T(D, z) = E$. Answer the following:

1 $T(B, y) =$
☐ A ☐ B ☐ C ☐ D ☐ E

2 $T(C, z) =$
☐ A ☐ B ☐ C ☐ D ☐ E

3 $T(D, y) =$
☐ A ☐ B ☐ C ☐ D ☐ E

4 $T(E, z) =$
☐ A ☐ B ☐ C ☐ D ☐ E

Qb ⇒ Convert the following regular grammar to NFA: $S \rightarrow bI|c$, $I \rightarrow dS|a$. The NFA must consist of **exactly 3 states** (named S, I, F), where the starting state is **S** and the only accepting state is **F**.

5 The following NFA transition is labelled “a”:
☐ A $(S \rightarrow I)$ ☐ B $(I \rightarrow S)$ ☐ C $(I \rightarrow F)$ ☐ D $(S \rightarrow F)$ ☐ E $(F \rightarrow I)$

6 The following NFA transition is labelled “b”:
☐ A $(S \rightarrow I)$ ☐ B $(I \rightarrow S)$ ☐ C $(I \rightarrow F)$ ☐ D $(S \rightarrow F)$ ☐ E $(F \rightarrow I)$

7 The following NFA transition is labelled “c”:
☐ A $(S \rightarrow I)$ ☐ B $(I \rightarrow S)$ ☐ C $(I \rightarrow F)$ ☐ D $(S \rightarrow F)$ ☐ E $(F \rightarrow I)$

8 The following NFA transition is labelled “d”:
☐ A $(S \rightarrow I)$ ☐ B $(I \rightarrow S)$ ☐ C $(I \rightarrow F)$ ☐ D $(S \rightarrow F)$ ☐ E $(F \rightarrow I)$

Qc $\Rightarrow$ Assume the first step to convert the following NFA to a regular expression is deleting state 1. (Thus, do not add new starting state or new accepting state). The start state is 0 and the accepting state is 3. The NFA consists of the following transitions:

$T(0, a) = 1$, $T(0, a) = 2$, $T(0, b) = 3$, $T(1, b) = 1$, $T(1, a) = 2$, $T(1, b) = 3$,
 $T(2, b) = 1$, $T(2, a) = 2$, $T(2, b) = 3$.

After deleting state 1, answer the following:

9 The regular expression on the transition ($0 \rightarrow 2$) is equivalent to:

☐ A ab^* ☐ B b^*a ☐ C b^*b ☐ D $(\Lambda + ab^*)a$ ☐ E $(\Lambda + ab^*)b$

10 The regular expression on the transition ($0 \rightarrow 3$) is equivalent to:

☐ A ab^* ☐ B b^*a ☐ C b^*b ☐ D $(\Lambda + ab^*)a$ ☐ E $(\Lambda + ab^*)b$

11 The regular expression on the transition ($2 \rightarrow 2$) is equivalent to:

☐ A ab^* ☐ B b^*a ☐ C b^*b ☐ D $(\Lambda + ab^*)a$ ☐ E $(\Lambda + ab^*)b$

12 The regular expression on the transition ($2 \rightarrow 3$) is equivalent to:

☐ A ab^* ☐ B b^*a ☐ C b^*b ☐ D $(\Lambda + ab^*)a$ ☐ E $(\Lambda + ab^*)b$

Qd $\Rightarrow$ Consider applying the **first pumping lemma** to prove that the language $a^n b^n$ is not regular. Assume there exists a string xyz which equals to $a^n b^n$ for some n . Let k be the number of repetitions of y . In each of the following cases, state why the pumped string does **not** belong to the language. If the pumped string belongs to the language, choose **E**:

13 $y = b$, $k = 2$

☐ A equal number of a's and b's ☐ B more a's than b's ☐ C more b's than a's ☐ D a comes after b
☐ E the pumped string belongs to the language

14 $y = aa$, $k = 0$

☐ A equal number of a's and b's ☐ B more a's than b's ☐ C more b's than a's ☐ D a comes after b
☐ E the pumped string belongs to the language

15 $y = ab$, $k = 0$

☐ A equal number of a's and b's ☐ B more a's than b's ☐ C more b's than a's ☐ D a comes after b
☐ E the pumped string belongs to the language

16 $y = ab$, $k = 2$

☐ A equal number of a's and b's ☐ B more a's than b's ☐ C more b's than a's ☐ D a comes after b
☐ E the pumped string belongs to the language