



MID SEM

CS205

26 Feb, 2023

Duration: 120 Min

Max Marks: 60

Name ... Aditya ... Gupta

Roll ... 210101010.

**INSTRUCTIONS**

- This question paper has **9** multiple choice questions (MCQ) and **6** other (subjective) questions. Answers of the **multiple choice questions ONLY** are to be bubbled on the Answer Sheet. **For other questions write the answers in the space provided and do not bubble** on the answer sheet.
- Each MCQ could have multiple correct option. You need to mark all the correct options for getting credit. There is no partial marking. Each MCQ carries 3 marks unless specified. Use supplementary sheets for any rough work. Answers written / continued on the supplementary sheets will **not** be evaluated. Do not attach your rough work/ supplementary sheets.

**MULTIPLE CHOICE QUESTIONS****Question 1** Which of the following statements is/are true?T S1: If  $L$  is regular, then there exists a PDA that accepts  $L$ .

F S2: A DPDA cannot make a move without consuming any input.

- A S2 only     B Both S1 and S2     C Neither S1 nor S2     D S1 only

**Question 2** Which of the following CFG generates the language  $\{a^i b^j c^k \mid i, j, k \geq 1 \text{ and } i + j = k\}$ 

- |  |   |
|--|---|
| <input type="checkbox"/> A $S \rightarrow aSc \mid A, A \rightarrow bAc \mid bc$       | <input type="checkbox"/> D $S \rightarrow AB, A \rightarrow aSb \mid ab, B \rightarrow cB \mid c$ |
| <input type="checkbox"/> B $S \rightarrow abSc \mid A, A \rightarrow bAc \mid bc$      | <input type="checkbox"/> E $S \rightarrow aSc \mid aBc, B \rightarrow bBc \mid bc$                |
| <input type="checkbox"/> C $S \rightarrow aSc \mid B, B \rightarrow bAc \mid \epsilon$ |   |

**Question 3** Which of the following statements is/are true?

F S1: Every subset of a regular language is regular.

F S2: Let  $L_i$  be a regular language for  $i = 1, 2, \dots, \infty$ . Then the language  $\bigcup_{i=1}^{\infty} L_i$  must be regular.

- A S2 only     B S1 only     C Both S1 and S2     D Neither S1 nor S2

**Question 4** Suppose  $G$  is a CFG in GNF and let  $x \in L(G)$  with  $|x| = 20$ . Then the length of any derivation of  $x$  in  $G$  is

- A 21     B 40     C 39     D 19     E 20

**Question 5** Which of the following regular expressions correctly represents the language  $L = \{w \in \{a, b\}^* \mid w \text{ contains exactly one occurrence of two consecutive } a's\}$ 

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> A $b(ab)^*aa(ba)^*b$ | <input checked="" type="checkbox"/> D $(\epsilon + b)(ab)^*aa(ba)^*(\epsilon + b)$ |
| <input checked="" type="checkbox"/> B $b(ab)^*aa(ba)^*$  | <input checked="" type="checkbox"/> E $b^*aab^*$                                   |
| <input checked="" type="checkbox"/> C $(ab)^*aa(ba)^*b$  | <input checked="" type="checkbox"/> F $(\epsilon + b)(ab)^*aa(ba)^*$               |

babaa bab

abaaa a

**Question 6** Which of the following statements is/are true?

T S1: Non-regular languages are closed under complement.

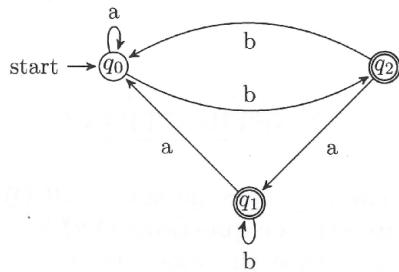
T S2: If  $L \subseteq \Sigma^*$  is a non-regular language and  $h$  is a homomorphism, then  $h(L)$  must also be non-regular.

- A S2 only     B Both S1 and S2     C S1 only     D Neither S1 nor S2



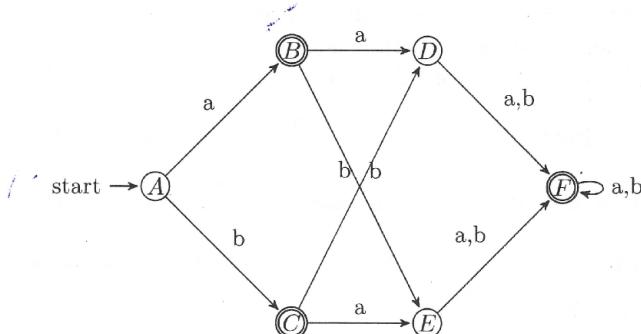
**Question 7** Consider the DFA  $A$  given below. Which of the following regular expressions correctly represent(s)  $L(A)$ ? [4 Marks]

$a^*b$



- A  $a^*b((b + ab^*a))^*(ab^* + \varepsilon)$        D  $a^*b(\varepsilon + ba^*b + ab^*a)^*$   
 B  $(a + bb)^*b(ab^*a(a + bb)^*b)^*(\varepsilon + ab)$        E  $a^*b((b + ab^*a)a^*b)^*(\varepsilon + ab^*)$   
 C  $(a + bb + bab^*a)^*(b + ba)$

**Question 8** Consider the DFA given below. Which of the options correctly represents the merging of equivalent states when the DFA minimization algorithm is applied? (States which are merged are shown in parentheses.) [4 Marks]



- A (AD), (BC), (E), (F)       D (A), (BCF), (DE)  
 B (ADE), (BCF)       E (A), (BC), (DE), (F)  
 C (AE), (BC), (D), (F)

**Question 9** Which of the following grammars generates the language  $\{a^m b^n \mid m > 0 \text{ and } n > 0\}$ ?

- A  $S \rightarrow AB, A \rightarrow a|aA, B \rightarrow \varepsilon|bB$        D  $S \rightarrow AB, A \rightarrow \varepsilon|aA, B \rightarrow \varepsilon|bB$   
 B  $S \rightarrow aAb, A \rightarrow \varepsilon|aAb$        E  $S \rightarrow aAB|ABb, A \rightarrow \varepsilon|aA, B \rightarrow \varepsilon|bB$   
 C  $S \rightarrow AB, A \rightarrow a|aA, B \rightarrow b|bB$

#### OTHER QUESTIONS

For the following questions write your answers in the space provided immediately after the question and DO NOT bubble answers on the answer sheet.



**Question 10** Is the language  $\{wxx^Ry \mid w, x, y \in (0+1)(0+1)^*\}$  regular? If so, give a DFA or regular expression for it. Otherwise, prove it by using the pumping lemma. [5 Marks]

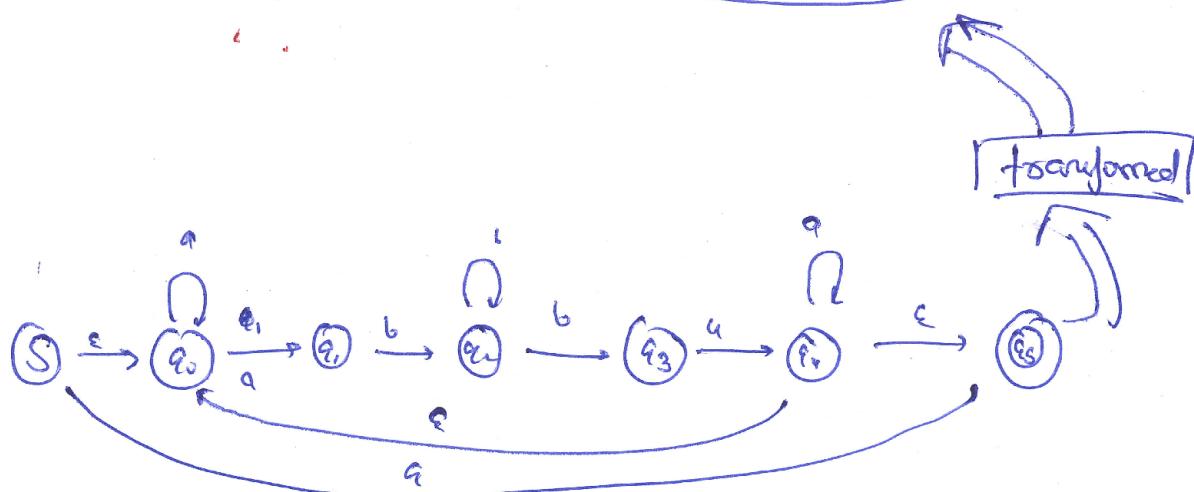
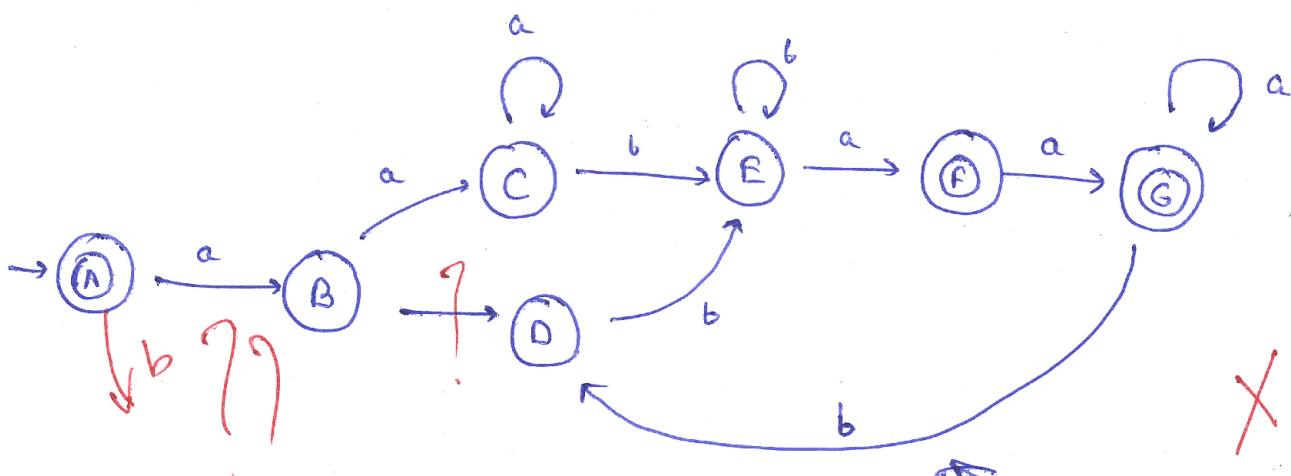
- [A] W    [B] P    [C] C

~~It is not regular~~ (It is regular)

$$\begin{aligned}
 & \text{(regular)} \quad \text{(regular to)} \\
 & \overline{\left( (0+1)^* (00+11) (0+1)^* \right)} \\
 & \left( ((0+1)^* \bullet (0+1)) (00+11) ((0+1)^* \bullet (0+1)) \right)
 \end{aligned}$$

**Question 11** Construct a DFA for the language  $\{w \in \{a, b\}^* \mid w \text{ contains an equal number of occurrences of } ab \text{ and } ba\}$ . [5 Marks]

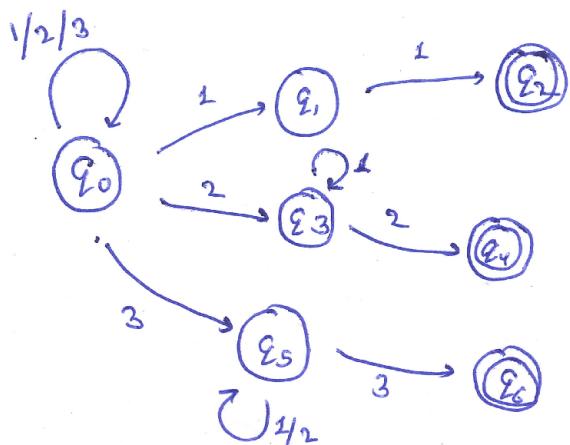
- [A] P    [B] W    [C] C





**Question 12** Construct an NFA for the language  $\{w \in \{1, 2, 3\}^* \mid \text{the last symbol(digit) in } w \text{ appears at least twice but without any intervening larger digit between the last two occurrences of that symbol.}\}$  (For ex, 2311, 2132112, 23123 are in  $L$  but 12312, 121 are not in  $L$ .) [5 Marks]

[A] P      [B] C      [C] W

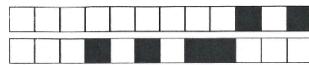


**Question 13** Construct a PDA for the language  $\{a^m b^n \mid 1 \leq n \leq m \leq 3n\}$

[6 Marks]

[A] P      [B] W      [C] C





**Question 14** Is the language  $\{w \in \{a, b\}^* \mid |w|_a \neq |w|_b\}$  regular? If so, give a DFA or regular expression for it. Otherwise, prove it by using the pumping lemma. [5 Marks]

- [A] W    [B] P    [C] C

No language is not regular.

Let given constant be  $n$ , then I choose the string as  $x = a^n b^{n!+n}$

Now, asking adversary to choose  $v$  in  $uvw$  such that  $uv^i w \in L$  According to pumping lemma condition,  $|uv| \leq n$   $v \neq \epsilon$

Let  $x$  breaks as  $a^{n-k} a^k b^{n!+n}$

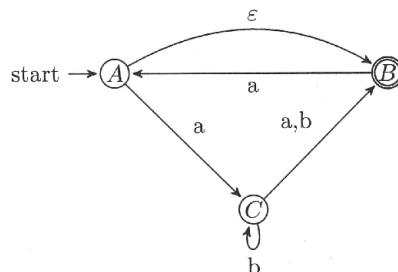
( $1 \leq k \leq n$ ) now,  $x = uv^i w$  must also satisfy  $L$

Assume but  $n - k + i k \neq n! + n$  for any  $i$   
 $(i-1)k \neq n!$  but if  $i = \frac{n!}{k} + 1$  then contradiction,  $k \leq n$ , so  $i$  is a natural number.

for every  $k$  I can find a  $i$  such that  $x \notin L$

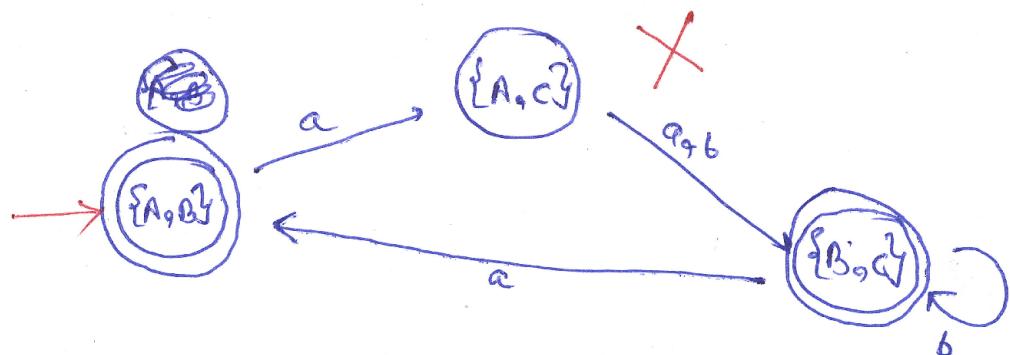
**Question 15** Construct an equivalent DFA for the  $\epsilon$ -NFA given below. (Just give the final transition diagram.) [5 Marks]

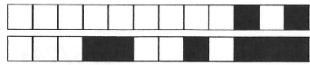
Hence Not a regular language



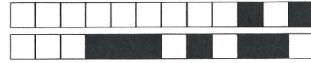
- [A] C    [B] P    [C] W

	a	b
$\{A, B\}$	$\{C, A\}$	—
$\{A, C\}$	$\{C, B\}$	$\{C, B\}$
$\{B, C\}$	$\{A, B\}$	$\{B, C\}$





+5/6/23+



+5/7/22+

## ANSWER SHEET

The last 3 digits of your Roll No. is your UID.

For dual degree students the UID is 2xx, where xx is the last two digits of your Roll No.

Invigilator's Sign : *N. Mohi*

## STUDENT INFORMATION

Please bubble your UID.

Name.....*Aditya Gupta*.....

1  2  3  4  5  6  7  8  9

UID.....*010*.....Roll .....*Q10101010*.....

1  2  3  4  5  6  7  8  9

Email.....*aditya21.cse@iitg.ac.in*.....

1  2  3  4  5  6  7  8  9

## RESPONSES

3/3

Q 1:  A  B  C  D

Q 9:  A  B  C  D  E

0/3

0/3

Q 2:  A  B  C  D  E

Q 10:  A  B  C

5/5

3/3

Q 3:  A  B  C  D

Q 11:  A  B  C

0/5

0/3

Q 4:  A  B  C  D

Q 12:  A  B  C

5/5

3/3

Q 5:  A  B  C  D  E  F

Q 13:  A  B  C

0/6

0/3

Q 6:  A  B  C  D

Q 14:  A  B  C

5/5

4/4

Q 7:  A  B  C  D  E

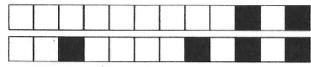
Q 15:  A  B  C

0/5

4/4

Q 8:  A  B  C  D  E

PLEASE DO NOT WRITE ANYTHING ON THE OTHER  
SIDE OF THE ANSWER SHEET.



+5/8/21+