Nirma University

Institute of Technology
Supplementary Examination (SPE), August - 2022
B. Tech. in Computer Science and Engineering, Semester-VI
2CS601 Theory of Computation

Roll /
Exam No. [   ]

Supervisor's Initial [   ]
with Date

Time: 3 Hours

Max Marks: 100

Instructions:
1. Attempt all questions
2. Figures to right indicate full marks
3. Assume necessary data.
4. Use section-wise separate answer book.
5. Draw neat sketches wherever necessary.

SECTION-I

Q:1 **Answer the following questions** **[18]**
[CLO3]

A (i) Give recursive definition for the language of set A for all strings in **[06]**
BL-3 $\{a,b\}^*$ containing the substring aba

(ii) Find the language from the recursive definition
   a. $a \in L$;
   b. For any $x \in L$, xb and xba are in L.

B Prove that for every $n \geq 0$, using PMI
BL-4 **[06]**
$$\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$$

**OR**

B For any integer a and b with 0<=a<b and every n>=1, show that (b^n-a^n) is **[06]**
BL-4 divisible by (b-a).

C Find the regular expression for following language : **[06]**
BL-5 (i) The language of strings having at most one pair of 0's or at most one
   pair of 1's.

(ii) The language of strings not containing the substring 00.

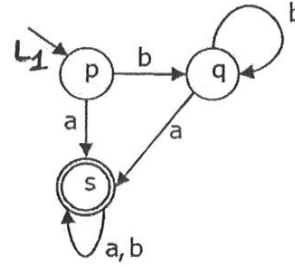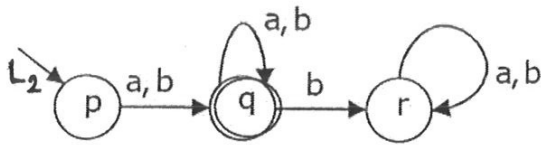**Q:2** **Answer the following questions** **[18]**
[CLO1]

A (i) Draw the DFA for following Regular Expression. **[06]**
BL-5 $(111+100)^*0$

(ii) Find the generated language from given DFA.
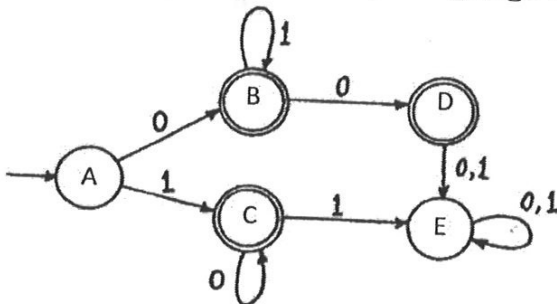
B
BL-5   Let L_1 and L_2 be language represented by the following automata.   [06]
Construct DFA representing L1-L2

C
BL-6   Define δ* recursively for NFA. Also Find δ*(1,ab) for the following NFA.
Consider Σ={a,b}   [06]

State q	δ (q,a)	δ (q,b)
1	{1,2}	{1}
2	{3}	{3}
3	{4}	{4}
4	{5}	φ
5	φ	{5}

Q:3   **Answer the following questions**   **[14]**
[CLO2]

A
BL-4   Minimize the following DFA.   [07]
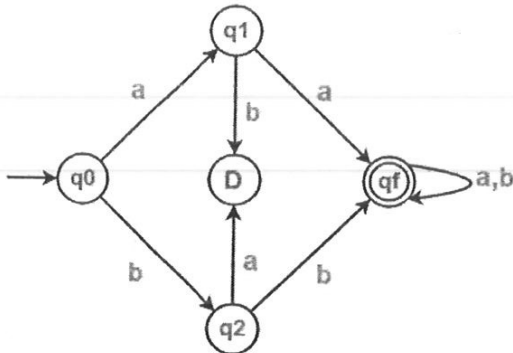
B
BL-5   Convert following NFA - ∧ to DFA   [07]
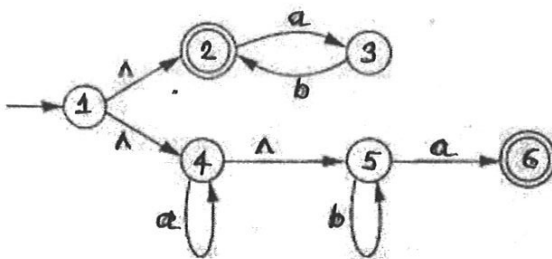
OR

B
BL-4   Assume L1 and L2 languages are recognized by the NFA - ∧ M1 and M2   [07]
respectively. Define and Construct NFA - ∧ for Mu, Mc and Mk to recognize
the language L1 U L2, L1L2 and L1*. Explain the construction with a neat
diagram.

SECTION-II

Q:4 [CLO4]	**Answer the following questions**	**[18]**

A
BL-4

Find the equivalent CFG for following languages. [06]
(i) $\{a^i b^j c^k \mid i > j \text{ or } i > k\}$
(ii) Set of all (positive or negative) odd integer. e.g. +123, -243
(Assume terminals = {+,-,0,1,2,3,4,5,6,7,8,9})

B
BL-5

Convert following CFG to CNF (Chomsky Normal Form). [06]
$S \rightarrow AACD$
$A \rightarrow aAb \mid \wedge$
$C \rightarrow aC \mid a$
$D \rightarrow aDa \mid bDb \mid \wedge$

C
BL-5

Do as Directed [06]
(i) Describe the language generated by following grammar
$S \rightarrow b|S \mid aA \mid \wedge$
$A \rightarrow aA \mid bB \mid b$
$B \rightarrow bS$
(ii) Define an unambiguous grammar. Is following grammar unambiguous? Justify your answer.
$S \rightarrow ABA$
$A \rightarrow aA \mid \wedge$
$B \rightarrow bB \mid \wedge$

Q:5 [CLO1, CLO3]	**Answer the following questions**	**[18]**

A
BL-5

Following table shows the DPDA. Find out the language accepted by DPDA [06] where starting state={q0} and accepting state = {q0}

Move No	State	Input	Stack Symbol	Move(s)
1	q0	a	Z0	(qa,Z0)
2	q0	b	Z0	(qb,Z0)
3	qa	a	Z0	(qa,aZ0)
4	qa	a	a	(qa,aa)
5	qa	b	a	(qa, ∧)
6	qa	b	Z0	(q0,Z0)
7	qb	b	Z0	(qb,bZ0)
8	qb	b	b	(qb,bb)
9	qb	a	b	(qb, ∧)
10	qb	a	Z0	(q0,Z0)

B
BL-6

Design the NPDA for the language of nonpalindromes over $\Sigma=\{a,b\}$ [06]

OR

B
BL-6

Design the DPDA for the language $L = \{x \in \{a,b\}^* \mid n_a(x) < 2 * n_b(x)\}$ [06]

C BL-6	Design a top down PDA for the following CFG also trace the string abaabaa [06] S → aAA A → aS | bS | a

Q:6
[CLO2,
CLO4]

Answer the following questions [14]

A BL-6	Design the Turing Machine(TM) for calculating following function f for the string x where $x \in \{a,b\}^*$ $f(x) = 0$ if x having $n_a(x)=n_b(x)$ $f(x) = 1$ else	[07]
B BL-6	Design the TM for copying the whole string. (eg: i/p string = ΔaabaΔ o/p string=ΔaabaΔaabaΔ)	[07]

OR

B BL-3	Define Regular Language, Context Free Language and Context Sensitive Language. State the difference between all the languages in the context of theory of computation and design of automata. Exemplify each language.	[07]