Answer Section A and (either section B OR Section C (15 marks)).

Section A: 25 marks **Section B: 15 Marks** **Section C: 15 Marks**

Section A

A1: a) Answer each part as True or False (5 marks)

1. Every algorithm that decides any CFG is a member of P
2. Every multitape Turing machine (TM) has an equivalent single-tape Turing machine.
3. The complement of a recursively enumerable language is always not TM decidable.
4. The collection of decidable languages is closed under the union operation.
5. The language A= {0n1n|n>=0} is a member of SPACE(log n).

3/

Q	1	2	3	4	5
(T/F) T=True, F=False	T ✓	F ✓	T ✗	T ✓	F ✗

b) Give an implementation-level description of a Turing machine that decides the language $\{0^n1^n0^n \mid n \geq 0\}$ over the alphabet {0,1} **(5 marks)**

$L = \{0^n 1^n 0^n \mid n \geq 0\}$

let p ~~■~~ is xy^iz, $i \geq 0$

Turing machine is a 7-tuple
$\{Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject}\}$
Q → set of state
Σ → input ~~alpha~~ alphabet
δ → transition function
q_0 → start state
q_{accept} → if the end accept
q_{reject} → if the end reject

2

A2 a. Let $A_{REX} = \{\langle R, w\rangle \mid R$ is a regular expression that generates string $w\}$.

Prove that A_{REX} is decidable (5 marks)

NFA

1- convert RE R to DFA A
2. Run M on the theorem A_{DFA} on input <A,w>
3. If M accepts, accept otherwise reject.

5

theorem A_{DFA} Prove:
M = on input <A,W> A is a DFA and w is a string
1- simulate A
2- If the simulation ends accepts, accept.
If it ends nonaccepts, reject.

b. Analyze the space complexity of the SAT problem. (5 marks)

for space complexity, SATIVTCH THEOREM shows that any nondeterministic TM that uses f(n) and can convert to deterministic that uses only $f^2(n)$

[illegible] Give a high level description of a Turing machine that adds two binary numbers. (5 marks)

~~[illegible]~~

~~[illegible]~~

high level description of a Turing machine

and the turing machine have 7-tuple

$\{Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject}\}$

$Q \rightarrow$ set of state

$\Sigma \rightarrow$ input alphabet

$\delta \rightarrow$ transition function

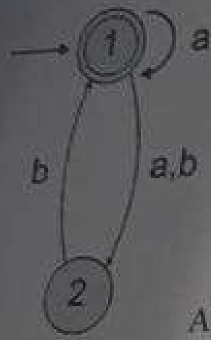
$q_0 \rightarrow$ start of state

$q_{accept} \rightarrow$ if the end accept

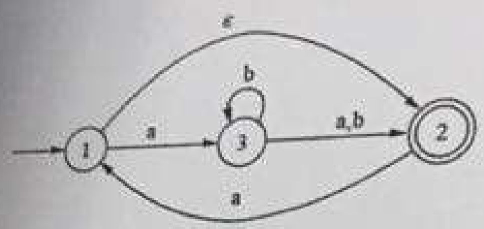
$q_{reject} \rightarrow$ if the end reject

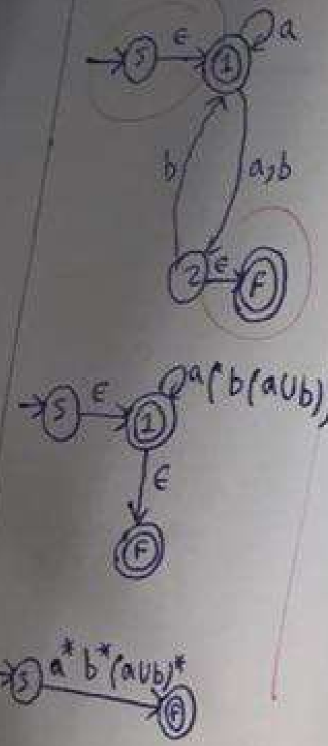
Section B

1. Find the language recognized by the union of the following two finite automata (6 Marks)



AND





11. Assuming that $\Sigma = \{0,1\}$, construct a language for $\overline{\Sigma^* - \ldots}$ (6 Marks) ✗

12. Convert the following NFA into its equivalent DFA ([illegible] Marks) ✗

	a	b	ε
→1	∅	2	{1,3}
2	[illegible]	3	2
3	1	∅	3

2

	a	b
→{1,3}	1	2
1	∅	2
2	[illegible]	3
[illegible]	[illegible]	3
3	1	∅
[illegible]		

...the pumping lemma to show that the language $C = \{w \mid w$ has an equal number of 0s and 1s$\}$ ...
...not regular (6 Marks)

$S \to 0S1 \mid \epsilon$

0011

and Prove of pumping lemma:

let $n = F(G)^{|v|+1}$

$w = L(G) \ast w \geq n$

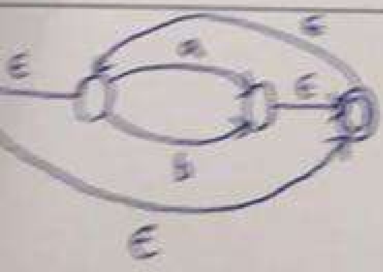
Let T is be pars of tree, the smallest hight

Let P is be path of length h, h is the hight of T

Since $w \geq F(G)^{|v|+1}$ and the length of $p \geq |v|+1$

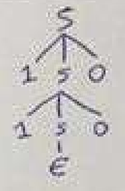
and number of nodes in P is at least $|v|+2$

...vert the regular expression $(a \cup b)^*$ to an NFA (6 Marks)



3. find a DFA that can accepts the language $\{(10)^n \mid n \geq 0\}$ (3 Marks)

language $\{1^n 0^n \mid n \geq 0\}$



$S \to 1S0 \mid \epsilon$

1100

10 ✓

1100 ✓

111000 ✓