Xi'an Jiaotong-Liverpool University
西交利物浦大学

Module Code	Examiner	Department	Tel
INT201	Yushi Li	Intelligent Science	5351

1st SEMESTER 22-23 FINAL EXAMINATION

Undergraduate

Decision Computation and Language

TIME ALLOWED: *2 hours*

INSTRUCTIONS TO CANDIDATES

1. **This is a blended close-book exam and the duration is 2 hours.**
2. **Total marks available are 100. This accounts for 80% of the final mark.**
3. **Answer all questions. Relevant and clear steps should be included in the answers.**
4. **Only English solutions are accepted. For online students, answers need to be handwritten and fully and clearly scanned or photographed for submission as one single PDF file via LEARNING MALL.**
5. **Online students should use the format "Module Code-Student ID.filetype" to name their files before submitting to Learning Mall. For example, "INT201-18181881.pdf".**

Question 1

Indicate true or false of the following statements, and briefly justify your answers. (**21 Marks**)

(a) If A is regular, then A must be finite. (**3 Marks**)

(b) If A has an NFA, then A is nonregular. (**3 Marks**)

(c) The transition function of an NFA is $\delta : Q \times \Sigma \to Q$. (**3 Marks**)

(d) If A is recognized by an NFA, then A is a context-free language. (**3 Marks**)

(e) Every context-free language is also regular. (**3 Marks**)

(f) If a language A has a regular expression, then A has a CFG in Chomsky normal form. (**3 Marks**)

(g) Every Turing-decidable language is also Turing-recognizable. (**3 Marks**)

Question 2

Let $\Sigma = a, b$. Define the language $A = \{w \in \Sigma^* \mid w = sbab \text{ for some string } s \in \Sigma^*\}$. (**12 Marks**)

(a) List the first 4 strings in A^* in lexicographic order. (**4 Marks**)

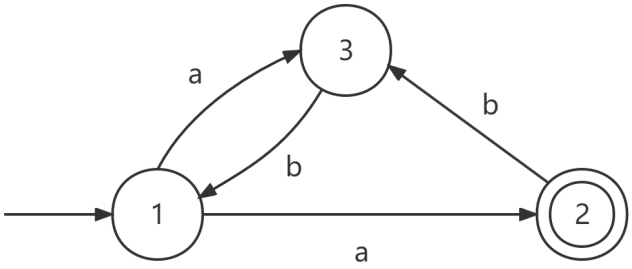
(b) Is A closed under reversal? If so, give a proof. If not, give a counterex-

ample. (**2 Marks**)

(c) Draw a DFA for A. (**6 Marks**)

Question 3

An NFA over alphabet $\Sigma = \{a, b\}$ is given by the diagram below. (**11 Marks**)



(a) Which of the following strings are accepted by it? (**3 Marks**)
i. abaaba
ii. abbabba
iii. abababababa

(b) Convert it to the equivalent DFA by filling the entries of the table.
(**8 Marks**)

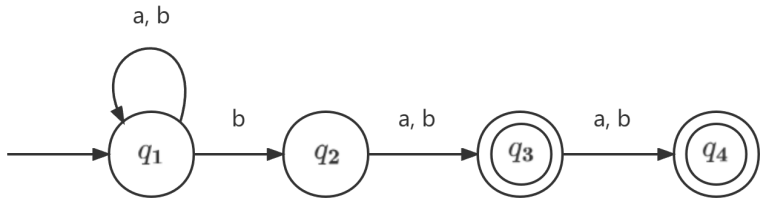
	a	b
{1}		
{2, 3}		
{1, 3}		
Empty set {}		

Question 4

Given the following two finite automata, find out their equivalent regular

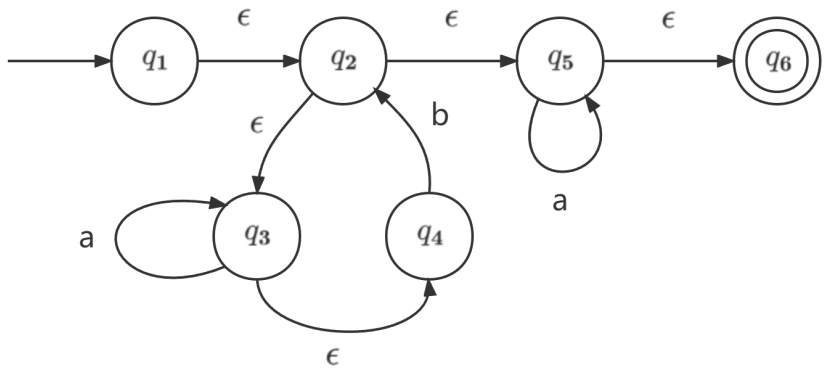
expressions.(**10 Marks**)

(a)



(**5 Marks**)

(b)



(**5 Marks**)

Question 5

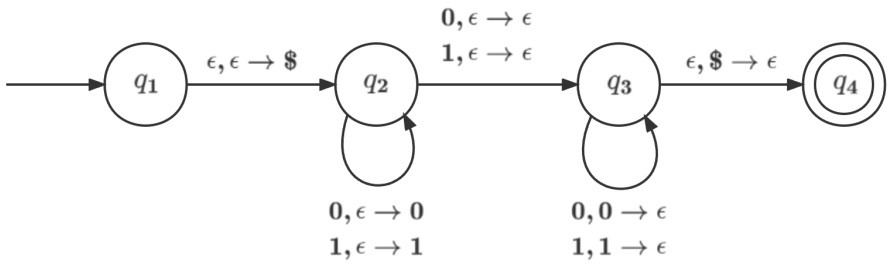
The original CFG is shown as follows, and convert it to Chomsky normal form. (**15 Marks**)

$$S \rightarrow ASA \mid aB$$
$$A \rightarrow B \mid S$$
$$B \rightarrow b \mid$$

Question 6

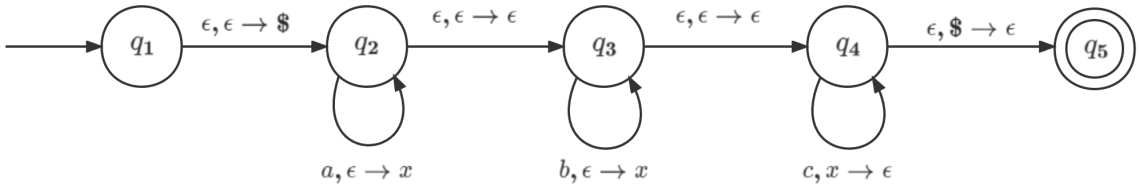
Pushdown automata are given by the diagrams below. (**10 Marks**)

(a)



Which of the following strings are accepted by it?
i. 000111
ii. 1110011
iii. 1100011
(**3 Marks**)

(b)



Which of the following strings are accepted by it?
i. *aabccc*
ii. *aaabcc*
iii. *aaabbbccccc*
(**3 Marks**)

(c) What is the language accepted by the pushdown automata shown in (b)?
(**4 Marks**)

Question 7

Consider the Turing machine M (B denotes the blank symbol):
$Q = \{q_0, q_1, q_2, q_3\}$
$\Sigma = \{0, 1\}$
$\Gamma = \{0, 1, \text{B}\}$
start state: q_0
$q_{accept} = q_3$
$q_{reject} = \text{B}$
δ is defined as follows:
$\delta(q_0, 0) = (q_0, 0, R)$
$\delta(q_0, 1) = (q_1, 1, R)$
$\delta(q_1, 0) = (q_1, 0, R)$
$\delta(q_1, 1) = (q_2, 1, R)$
$\delta(q_2, 0) = (q_2, 0, R)$
$\delta(q_2, 1) = (q_3, 1, R)$
(**10 Marks**)

(a) If initially 1100 is placed on the tape, which state will the machine be halting at? Assume the head of the machine initially points to the left-most 1. (**5 Marks**)

(b) If initially 1101 is placed on the tape, which state will the machine be halting at? (**5 Marks**)

Question 8
Briefly answer the following questions. (**11 Marks**)

(a) What are recursive and recursively enumerable languages? Which one of the two sets stands for decidable problems? (**5 Marks**)

(b) What is a reduction? Briefly explain how this technique can be used to

prove that certain problems are undecidable. (**6 Marks**)