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 RESIT 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 100% 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) The language $\{a^n b^n \mid n \geq 3\}$ is non-regular (**3 Marks**)

True

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

False

(c) If $A \subseteq B$ and A is a regular language, then B is a regular language. (**3 Marks**) True

(d) There is a language recognized by an NFA but has no DFA. (**3 Marks**)

False

(e) If A has a regular expression, then A has a PDA. (**3 Marks**)

True

(f) There are languages recognized by multi-tape Turing machines that cannot be recognized by single-tape Turing machines. (**3 Marks**)

False Stimulate

(g) There are languages recognized by nondeterministic Turing machines that cannot be recognized by deterministic Turing machines. (**3 Marks**)

False

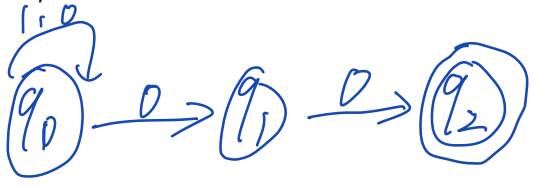
Question 2

Let L be a language over $\{0, 1\}$ consisting of strings which end with 00. (**10 Marks**)

(a) Give a regular expression that defines L. (**4 Marks**)

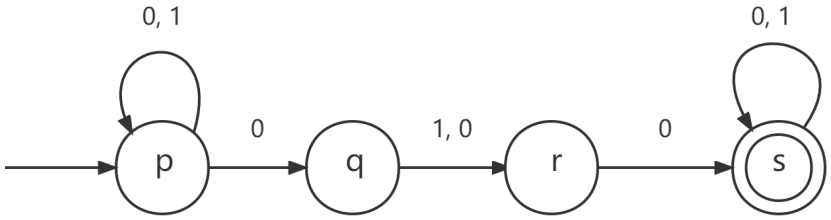
$(0 \cup 1)^* 00$

(b) Give an NFA diagram that accepts L. (**6 Marks**)



Question 3

An NFA over alphabet $\Sigma = \{0, 1\}$ is given by the diagram below. Convert it to the equivalent DFA by filling the entries of the table. (**16 Marks**)

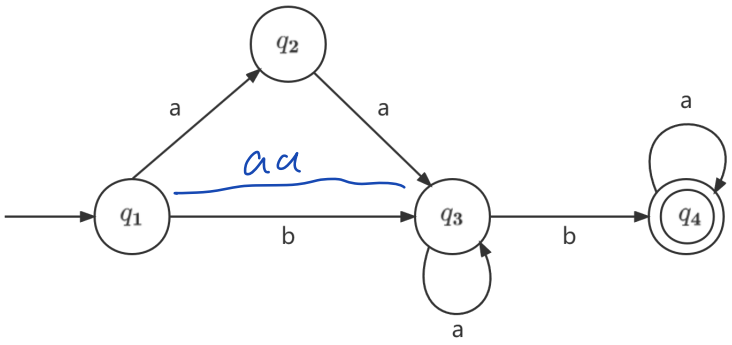


	0	1
{p}	{p, q}	{p}
{p, q}	{p, q, r}	{p, r}
{p, r}	{p, q, s}	{p}
{p, q, r}	{p, q, r, s}	{p, r}
{p, q, s}	{p, q, r, s}	{p, r, s}
{p, q, r, s}	{p, q, r, s}	{p, r, s}
{p, r, s}	{p, q, s}	{p, s}
{p, s}	{p, q, s}	{p, s}

Question 4

Given the following two finite automata, find out their equivalent regular expressions. (**10 Marks**)

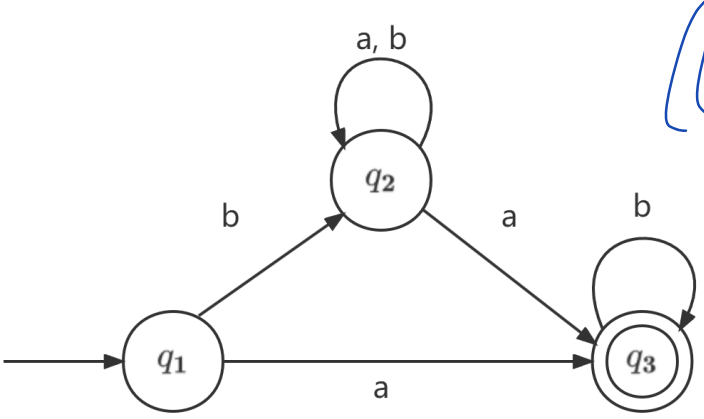
(a)



$(aa \cup b)a^* ba^*$

(5 Marks)

(b)



$((b(a \cup b)^* a) \cup a)b^*$

(5 Marks)

Question 5

The original CFG is shown as follows, and convert it to Chomsky normal form. (**16 Marks**)

$$S \rightarrow TaT$$
$$T \rightarrow aTb|bTa|TT|\epsilon$$

Question 6

Answer the following questions. (**8 Marks**)

Step1: $S \to TaT \mid TalaT \mid a$

$T \to aTb \mid ab \mid bTa \mid ba \mid TT$

Step2: $S \to TaT \mid TalaT \mid a$

$T \to aTb \mid ab \mid bTa \mid ba \mid TT$

Step3: $S \to TX \mid TalaT \mid a$

$T \to aX \mid ab \mid bR \mid ba \mid TT$

$X \to aT$

$Y \to Tb$

$R \to Ta$

Step4: $S \to TX \mid TA \mid AT \mid a$

$T \to AX \mid AB \mid BR \mid BA \mid TT$

$X \to AT$

$Y \to TB$

$R \to TA$

$A \to a$

$B \to b$

(a) Describe the pumping lemma for regular languages. (**4 Marks**)

(b) Describe the pumping lemma for context-free languages. (**4 Marks**)

Question 7

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

(a) What does it mean that a language is accepted by a Turing Machine? (**4 Marks**)

(b) If initially 1010# is placed on the tape, which state will the machine be halting at? (**4 Marks**)

(c) If initially 0100# is placed on the tape, which state will the machine be halting at? (**4 Marks**)

Question 8

Assume L_{FA} is the set of languages accepted by NFA, L_{DPDA} is the set ac-

cepted by deterministic pushdown automata, and L_{PDA} is the set accepted by general pushdown automata. What are the relations between them? Briefly justify your answer. (**7 Marks**)

6. (b)

7. only and only if L has a "1"

(b) q_1 (c) q_3

8. $L_{FA} \subseteq L_{DPDA}$

$L_{DPDA} \subseteq L_{PDA}$