MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 301: COMPILER CONSTRUCTION

DATE: 15/12/2021 **TIME: 2.00-4.00 PM**

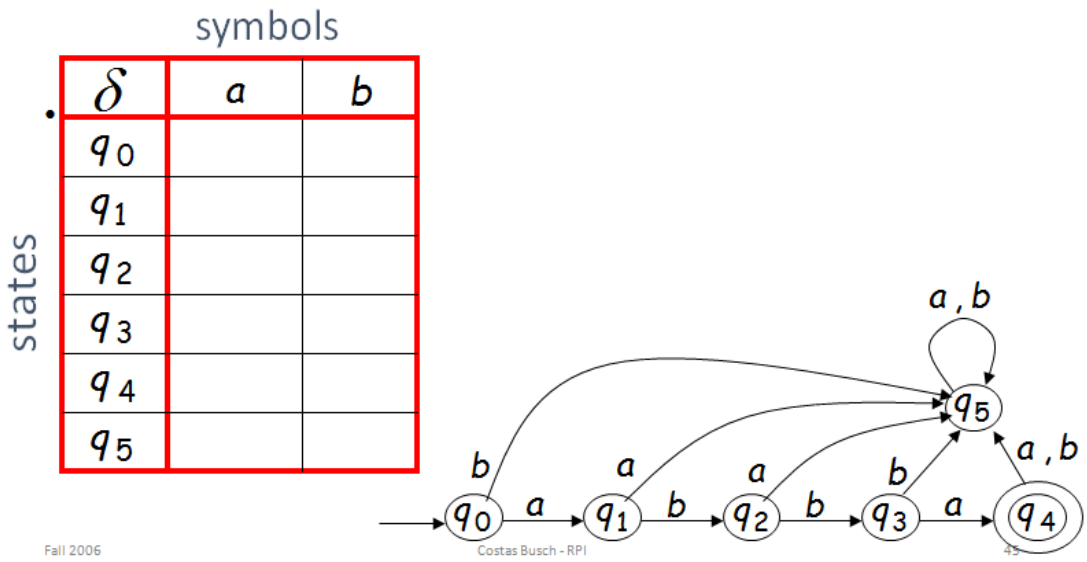
INSTRUCTIONS: Answer Question ONE and other TWO Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Discuss FOUR components of context-free grammar. (4 marks)

b) By use of a diagram describe the various phases of a compiler. (7 marks)

c) Complete the following state transition table. (6 marks)



d) Given the C code below, examine the number of tokens available in the code. (5 marks)

printf ("i = %d, &i = %x", i, &i);

e) Consider the context-free grammar

$$S \rightarrow S\,S+ \mid S\,S* \mid \mathbf{a}$$

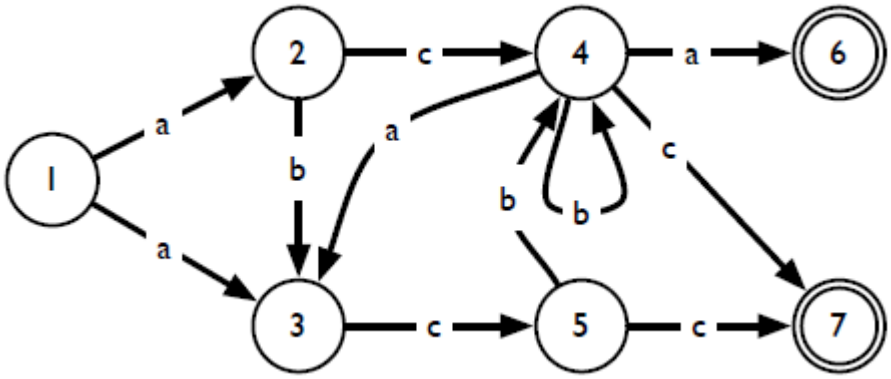
i. Show how the string $aa+a*$ can be generated by this grammar. (4 marks)

ii. Construct a parse tree for this string. (4 marks)

QUESTION TWO (20 MARKS)

a) Distinguish between one-pass compiler and multi-pass compiler. (4 marks)

b) Consider the following NFA.



i. Construct a transition table for the above, showing the corresponding DFA using the subset construction. (6 marks)

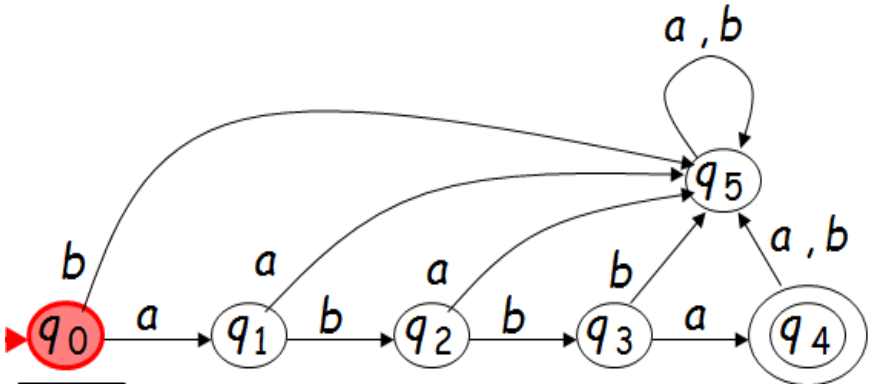
ii. List which states (if any) should be merged when you reduce the DFA you just derived in (i) above. (2 marks)

c) Distinguish between Right Recursion and Left Recursion. (4 marks)

d) Context-free syntax is specified with a context-free grammar. Formally, a CFG G is a 4-tuple (V_t, V_n, S, P). Explain what these represent. (4 marks)

QUESTION THREE (20 MARKS)

a) Create State Transition Table from the following graph. (8 marks)



b) The lexical- (scanner), syntactic- (parser), and semantic-analysis phases of a compiler front-end each process parts of the source program in particular ways and also check certain rules of the language being compiled. For each of the following possible language rules, specify which phase of the compiler should verify that a program conforms to that rule and why that part of the compiler is the best place for that check. If a check could be done equally well in more than one phase of the compiler, briefly discuss the tradeoffs between the alternative implementations. Keep your answers short and to the point.

i. A function is called with the correct number of arguments. (3 marks)

ii. Underscore characters (_) may appear in the middle of identifiers, but not at the beginning or end (i.e., this_identifier is legal, but _this_one is not). (3 marks)

iii. Every variable must be declared before it is used in the program (the classic C or Pascal rule). (3 marks)

iv. Assignment statements must end with a semicolon (;). (3 marks)

QUESTION FOUR (20 MARKS)

a) Let G be the grammar:

$$S \rightarrow A\$$$
$$A \rightarrow (AB)$$
$$A \rightarrow \lambda$$
$$B \rightarrow (A)$$
$$B \rightarrow x$$

Using this grammar, answer the following questions.

i. Mention the terminals and non-terminals of this grammar. (6 marks)

ii. Draw the parse tree for the string "((x)x)$" (6 marks)

b) Give an English description of the sets of strings generated by the following regular expressions. For full marks, give a description that describes the set without just rewriting the regular expressions in English. For example, if the regular expression is (a*b*)*, a good answer would be "all strings with 0 or more a's and b's in any sequence". A not so good answer would be "zero or more repetitions of zero or more a's followed by zero or more b's".

i. (x|y)*x(x|y) (2 marks)

ii. p(p|q)*p (2 marks)

iii. Draw a DFA that accepts the same set of strings generated by the regular expression in part (ii). (4 marks)

QUESTION FIVE (20 MARKS)

a) For the following grammar, show what the first state of the LR(1) machine would be. (6 marks)

$$S \rightarrow AB\$$$
$$A \rightarrow x|y$$
$$A \rightarrow Bz$$
$$B \rightarrow Cz$$
$$B \rightarrow \lambda$$
$$C \rightarrow w$$

b) Give the action table entries for the first state (i.e., for each token that could be coming up, say whether the parser would shift or reduce). For reduce actions, say what rule would be reduced. (6 marks)

c) Distinguish between Top-down parsers ans Bottom-up parsers. (4 marks)

d) The diagram below represents a set of strings containing an even number of zeros and an even number of ones. Represent it as Regular Expression. (4 marks)