

BBM 301 - Programming Languages - Fall 2021 Midterm
November 12, 2021

Name: _____

Student ID number: _____

Please write your name, ID and following honor pledge:

"On my honor, I pledge that I have neither given nor received any unauthorized assistance on this exam. "

"I give permission that my camera recordings will be taken for identification purposes for BBM301 exam and I understand that these recordings will not be used for any other purposes".

and **sign** your answer sheet.

1- Ambiguity [15 pts]

Consider the following grammars

- i) $\langle S \rangle \rightarrow a \langle S \rangle \mid \langle S \rangle a \mid \epsilon$
- ii) $\langle S \rangle \rightarrow (\langle A \rangle) \mid a$
 $\langle A \rangle \rightarrow \langle A \rangle \langle S \rangle \mid \langle S \rangle$
- iii) $\langle S \rangle \rightarrow \langle A \rangle \langle A \rangle$
 $\langle A \rangle \rightarrow \langle A \rangle a$
 $\langle A \rangle \rightarrow b$
- iv) $\langle S \rangle \rightarrow \langle S \rangle \langle S \rangle \mid \langle A \rangle \langle B \rangle$
 $\langle A \rangle \rightarrow a \langle A \rangle \mid a$
 $\langle B \rangle \rightarrow b \langle B \rangle \mid b$
- v) $\langle S \rangle \rightarrow a \mid \# \langle S \rangle \mid \langle S \rangle \langle S \rangle$

- a) **(5 pts)** Indicate which of these grammars are ambiguous by filling the table below (Put a check mark in the correct cell for each grammar. Note that, wrong answers will cancel the correct ones.)

	i	ii	iii	iv	v
Ambiguous	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Unambiguous	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- b) **(10 pts)** Choose one of the ambiguous grammars above, and prove the ambiguity. Clearly specify your reasons, and show the entire representation.

2- BNF [20 pts]

Consider the following grammar in BNF for a language with three infix operators represented by \$, % and #, and a prefix operator !.

```
<exp> →      ! <exp>
           |      <exp> $ <exp>
           |      <exp> % <exp>
           |      <exp> # <exp>
           |      x
           |      y
```

Construct an unambiguous grammar for this language by implementing the following precedence and associativity rules.

- Prefix operator ! has the highest priority.
- Precedence order of the infix operators from highest to lowest: %, \$, #.
- Associativity of the operators: \$ and % are left, # is right associative.

Do not use EBNF notation.

$$\begin{aligned} \text{exp} &\rightarrow \text{exp2} \# \text{exp} \mid \text{exp2} \\ \text{exp2} &\rightarrow \text{exp2} \$ \text{exp3} \mid \text{exp3} \\ \text{exp3} &\rightarrow \text{exp3} \% \text{exp4} \mid \text{exp4} \\ \text{exp4} &\rightarrow ! \text{exp4} \mid x \mid y \end{aligned}$$