COP4020.02 **Brandon Thompson**
Dr. Muhammed Abid Due: 3/31/21

Assignment 5: Chapter 10, 11, 12

PROBLEM #1 (20 POINTS):

Consider the following CFG:

$S \to AY|BZ|AA|BB$

$Y \to SA$

$Z \to SB$

$A \to a$

$B \to b$

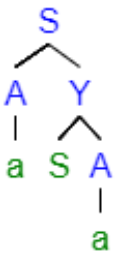
a) Find a derivation tree that does not have a self-embedded nonterminal.

b) Find a derivation tree that contains a self-embedded nonterminal.

SOLUTION:

a)

b)



PROBLEM #2 (20 POINTS):

Decide whether the following grammar generates any words using the algorithm of Theorem 43 (page 403) Chapter 18.

1. $S \to AB$
   $A \to BC|b$
   $C \to DA$
   $B \to CD$
   $D \to a$

2. $S \to AB$
   $A \to BSB$
   $B \to AAS$
   $A \to CC$
   $B \to CC$
   $C \to SS$
   $A \to a|b$
   $C \to b|bb$

SOLUTION:

1. First we replace the D production everywhere with a.
   $S \to AB$
   $A \to BC|b$
   $C \to aA$
   $B \to Ca$
   Next we replace the A production everywhere with b.
   $S \to bB$
   $C \to ab$
   $B \to Ca$
   Now we replace the C production everywhere with ab
   $S \to bB$
   $B \to aba$
   Lastly we replace the B production everywhere with aba.
   $S \to baba$
   There is a production of the form $S \to t$ so the language is not empty.

2. First we replace the C production with b
   $S \to AB$
   $A \to BSB$

$B \to AAS$

$A \to bb$

$B \to bb$

$A \to a|b$

Next we replace all of the B productions with bb. $S \to Abb$

$A \to bbSbb$

$A \to bb$

$A \to a|b$

Lastly we replace all of the A productions with a. $S \to abb$

There is a production of the form $S \to t$ so the language is not empty.

PROBLEM #3 (20 POINTS):

Consider the following grammar for arithmetic expressions.

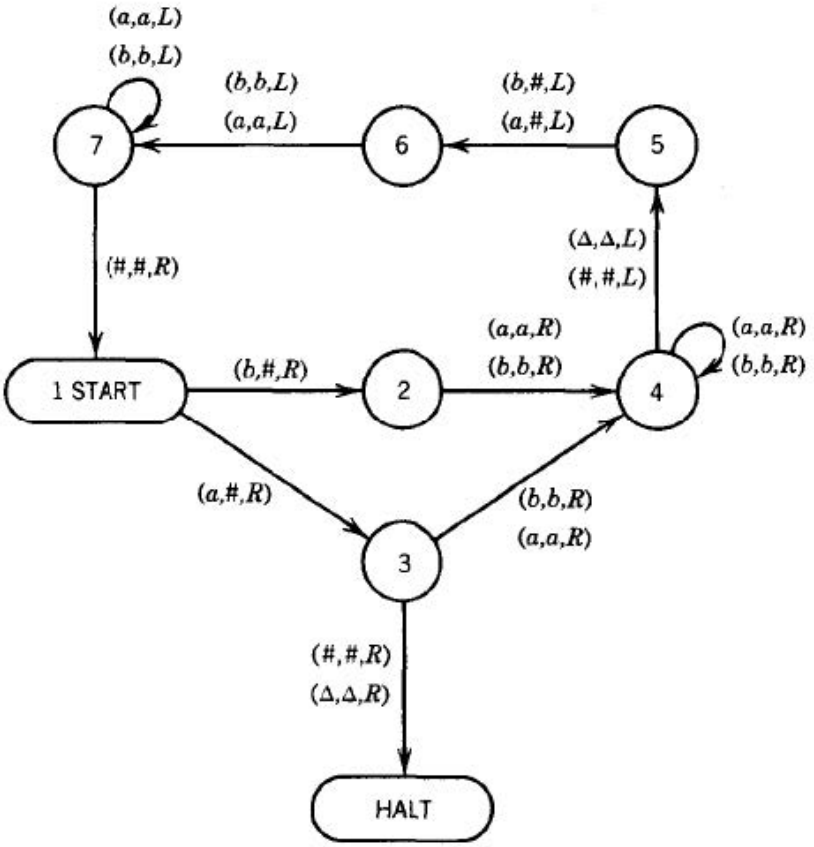
$$S \to E$$
$$E \to T|E + T|E - T| - T$$
$$T \to F|T * F|T/F$$
$$F \to (E)\,|i$$

Using top-down parsing, find a leftmost derivation in this grammar for the expression $i/i + i$. Show your work.

SOLUTION:

PROBLEM #4 (20 POINTS):

a) Consider the following Turing Machine (TM).



Trace the execution chains of the following input strings on this machine.

1) baaba

2) ababb

SOLUTION:

START	**2**	**4**	**4**	**4**
$\underline{b}$aaba	#$\underline{a}$aba	#a$\underline{a}$ba	#aa$\underline{b}$a	#aab$\underline{a}$
4	**5**	**6**	**7**	**7**
#aaba$\underline{\Delta}$	#aab$\underline{a}$	#aa$\underline{b}$#	#a$\underline{a}$b#	#$\underline{a}$ab#
7	**1**	**3**	**4**	**4**
$\underline{\#}$aab#	#$\underline{a}$ab#	##$\underline{a}$b#	##a$\underline{b}$#	##ab$\underline{\#}$
5	**6**	**7**	**1**	**3**
##a$\underline{b}$#	##$\underline{a}$##	##$\underline{\#}$a##	##$\underline{a}$##	########
HALT				
#####				

a)

START	**3**	**4**	**4**	**4**
$\underline{a}$babb	#$\underline{b}$abb	#b$\underline{a}$bb	#ba$\underline{b}$b	#bab$\underline{b}$
4	**5**	**6**	**7**	**7**
#babb$\underline{\Delta}$	#bab$\underline{b}$	#ba$\underline{b}$#	#b$\underline{a}$b#	#$\underline{b}$ab#
7	**1**	**2**	**4**	**4**
$\underline{\#}$bab#	#$\underline{b}$ab#	##$\underline{a}$b#	##a$\underline{b}$#	##ab$\underline{\#}$
5	**6**	**7**	**1**	**3**
##a$\underline{b}$#	##$\underline{a}$##	##$\underline{\#}$a##	##$\underline{a}$##	########
HALT				
#####				

b)