

## QUESTION 1 (2 POINTS)

Consider the following Grammar:

$$A \rightarrow B C D$$

$$B \rightarrow x$$

$$C \rightarrow y$$

$$D \rightarrow z$$

$$| k$$

Show the set of all stack items in  $\text{Closure}(A \rightarrow B \cdot CD)$ 

✓

$$A \rightarrow B \cdot CD$$

$$C \rightarrow \cdot y$$

$$\text{exp} \rightarrow \text{exp} \text{ PLUS exp} \mid \text{int}$$

PLUS : ASSO  
precedence

## QUESTION 2 (2 POINTS)

Draw a grammar that is both ambiguous and has a left-recursive rule for the language of binary addition expressions over integers (i.e. all expressions of the form **int + int**, **int + int + int**, etc). Draw two parse trees that correspond to the same input.

$$\text{exp} \rightarrow \text{exp PLUS term} \mid \text{term PLUS exp} \mid \text{term}$$

$$\text{term} \rightarrow \text{Int}$$

$$\text{factor} \rightarrow \text{INT}$$

$$\text{exp}$$

$$\text{exp} \rightarrow \text{PLUS term} \mid \text{PLUS term Int}$$

$$\begin{array}{c} \text{exp} \\ | \\ \text{term} \quad \text{PLUS exp} \\ | \quad | \\ \text{int} \quad \text{exp} \\ | \\ \text{term} \\ | \\ \text{INT} \end{array}$$

-1 accepts "int" which is not in the language of addition expressions

### QUESTION 3: SETUP

For this question, you'll use the following (augmented) grammar, introduced in class Note:  
*You actually answer the question on the next page:*

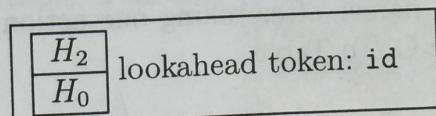
#### Grammar

- Rule ① :  $S' \rightarrow P$
- Rule ② :  $P \rightarrow (D)$
- Rule ③ :  $D \rightarrow D \text{ id}$
- Rule ④ :  $\text{id} \mid \text{id}$

Use the corresponding **LR Parse Table**:

State	Action Table				GoTo Table	
	(	)	id	eof	P	D
$H_0$	shift $H_2$				goto $H_1$	
$H_1$				accept		
$H_2$			shift $H_4$			goto $H_3$
$H_3$		shift $H_5$	shift $H_6$			
$H_4$		reduce by Rule ③	reduce by Rule ③			
$H_5$				reduce by Rule ②		
$H_6$		reduce by Rule ④	reduce by Rule ④			

Let the *LR parser configuration* refer to the current lookahead token value and the configuration of the stack. Thus the configuration:



Refers to the a stack where  $H_0$  has been pushed (which is now at the bottom of the stack) followed by  $H_2$  being pushed (which is now at the top of the stack).

## QUESTION 3: PART A (1 POINT)

Imagine the LR parser on the preceding page is in the following configuration.

$H_3$
$H_2$
$H_0$

lookahead token: id

Draw the configuration of the parser after taking one action from the Action Table and (if necessary) one action from the GoTo Table

$H_b$
$H_3$
$H_2$
$H_0$

$$[H_3, \text{id}] = \text{shift } H_b$$

## QUESTION 3: PART B (1 POINT)

Imagine that the LR parser on the preceding page is in the following configuration:

$H_5$
$H_3$
$H_2$
$H_0$

lookahead token: id

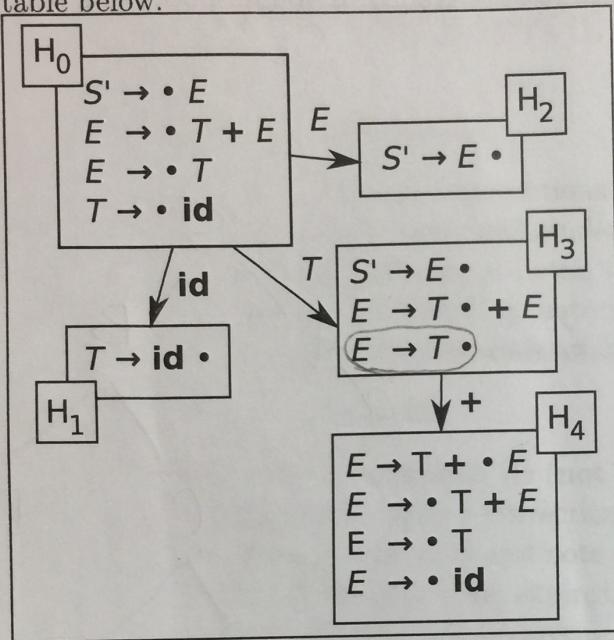
Draw the configuration of the parser after taking one action from the action table and (if necessary) one action from the GoTo Table

$$[H_5, \text{id}] \text{ is nothing rejected.}$$

Student ID: \_\_\_\_\_

**QUESTION 4 (2 POINTS)**

✓ Consider the following Parser Automaton. Complete all shift and goto entries in the parser table below.



$$\text{FOLLOW}(T) = \$ +$$

State	Action Table		GoTo Table	
	id	+	E	T
$H_0$	SH <sub>1</sub>		$H_2$	$H_3$
$H_1$		R <sub>T</sub> $\Rightarrow$ $H_2$		
$H_2$				
$H_3$		SH <sub>4</sub>		
$H_4$				

$$S' = E$$

$$E = T + E \mid E$$

$$T = id$$

$$\text{FOLLOW}(E) =$$

**QUESTION 5: SETUP (2 POINTS)**

On the next page, do ONE of the following:

Create the LL(1) selector table from the following grammar:

**Grammar:**

$$S \rightarrow AaAb$$

$$S \rightarrow BbBa$$

$$A \rightarrow \epsilon$$

$$B \rightarrow \epsilon$$

$$\text{FIRST}(A) = \{ \}$$

$$\text{FIRST}(B) = \{ \}$$

(Note that the FOLLOW sets are not given, you'll have to compute them yourself)

Show the completed CYK parsing table for the following string on the following grammar:

**Input String:** aabb**Grammar:**

$$S \rightarrow A B$$

$$A \rightarrow a$$

$$B \rightarrow C D$$

$$C \rightarrow E F$$

$$D \rightarrow b$$

$$E \rightarrow a$$

$$F \rightarrow b$$

## QUESTION 5: YOUR ANSWER

Choose one of the boxed questions from the previous page and answer it. If necessary, put a checkmark in the box of the problem you'd like to have graded. If you do both, we'll only grade the first one.

	a	a	b	b
1	A, E	A, E	D, F	D, F
2				
3				
4			D, F	D, F

