

COMS W4115 Final

Programming Languages and Translators

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Problem 20

1.

keyword: *time* | *return*

identifier: $[a - z][a - z0 - 9]^*$

time: $[0 - 9]^+$

2.

Terminals:

| | |
|---------------|-----------------------|
| = | Assignment Operator |
| + | Binary Operator |
| = | Binary Operator |
| id | identifier |
| t | time |
| , | colon |
| ; | semicolon |
| { | start of block/scope |
| } | end of block/scope |
| <i>return</i> | keyword <i>return</i> |
| <i>time</i> | keyword <i>time</i> |

Non-Terminals:

S: statement

D: definition

B: block

P: parameter

E: expression

L: literals

R: return statement

Start symbol: *S*

Production Rules:

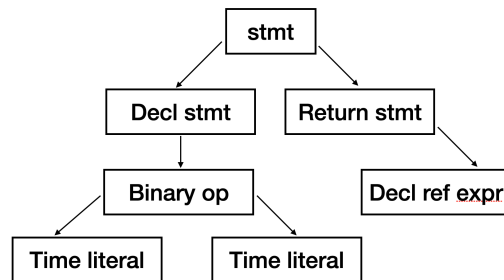
1. $S \rightarrow SS$
2. $S \rightarrow DB$
3. $D \rightarrow \text{id}(P)$
4. $P \rightarrow P, P$
5. $P \rightarrow \text{time id}$
6. $B \rightarrow \{ER\}$

7. $E \rightarrow EE$
8. $E \rightarrow P = L;$
9. $E \rightarrow \text{id} = L;$
10. $L \rightarrow L + L$
11. $L \rightarrow L - L$
12. $L \rightarrow \text{id}$
13. $L \rightarrow t$
14. $R \rightarrow \text{return id}$

3.

```
test(time t1, time t2){
    time t3 = t1 + t2;
    return t3;
}
```

4.



5.

```
addi $sp, $sp, -8
sw   $a, 4($sp)
sw   $r, 0($sp)
add  $a, $a, $r
j    $a
nop
```