

$S \Rightarrow id = E \quad \{ s.code = E.code \text{ || gen } (\text{top} \cdot \text{get } (id \cdot \text{lexeme}) '=' E \cdot \text{addr}) \}$

$E \Rightarrow E_1 + E_2 \quad \{ E \cdot \text{addr} = \text{new Temp} ()$
 $\quad E \cdot code = E_1 \cdot code \text{ || } E_2 \cdot code \text{ || gen } (E \cdot \text{addr} '=' E_1 \cdot \text{addr} '+' E_2 \cdot \text{addr}) \}$
 $| - E_1 \quad \{ E \cdot \text{addr} = \text{new Temp} ()$
 $\quad E \cdot code = E_1 \cdot code \text{ || gen } (E \cdot \text{addr} '=' 'minus' E_1 \cdot \text{addr}) \}$
 $| (E_1) \quad \{ E \cdot \text{addr} = E_1 \cdot \text{addr}$
 $\quad E \cdot code = E_1 \cdot code \}$
 $| id \quad \{ E \cdot \text{addr} = \text{top} \cdot \text{get } (id \cdot \text{lexeme})$
 $\quad E \cdot code = '' \}$
 $| num \quad \{ E \cdot \text{addr} = \text{new Temp} ()$
 $\quad E \cdot code = \text{gen } (E \cdot \text{addr} '=' num \cdot \text{lexval})$

$P \Rightarrow S \quad \{ s.next = \text{new label} ()$
 $\quad P \cdot code = S \cdot code \text{ || label } (S \cdot next) \}$

$S \Rightarrow \text{assign} \quad \{ s.code = \text{assign} \cdot code \}$

$S \Rightarrow \text{if } (B) S_1 \quad \{ B \cdot \text{true} = \text{new label} ()$
 $\quad B \cdot \text{false} = S_1 \cdot \text{next} = S \cdot \text{next}$
 $\quad S \cdot code = B \cdot code \text{ || label } (B \cdot \text{true}) \text{ || } S_1 \cdot code \}$

$S \Rightarrow \text{if } (B) S_1 \text{ else } S_2 \quad \{ B \cdot \text{true} = \text{new label} ()$
 $\quad B \cdot \text{false} = \text{new label} ()$
 $\quad S_1 \cdot \text{next} = S_2 \cdot \text{next} = S \cdot \text{next}$
 $\quad S \cdot code = B \cdot code \text{ || label } (B \cdot \text{true}) \text{ || } S_1 \cdot code \text{ || gen } ('goto' S \cdot \text{next}) \text{ || label } (B \cdot \text{false}) \text{ || } S_2 \cdot code \}$

$S \Rightarrow \text{while } (B) S_1 \quad \{ \text{begin} = \text{newlabel} ()$
 $\quad B \cdot \text{true} = \text{newlabel} ()$
 $\quad B \cdot \text{false} = S \cdot \text{next}$
 $\quad S_1 \cdot \text{next} = \text{begin}$
 $\quad S \cdot code = \text{label } (\text{begin}) \text{ || } B \cdot code \text{ || label } (B \cdot \text{true}) \text{ || } S_1 \cdot code \text{ || gen } ('goto' \text{ begin}) \}$

$S \Rightarrow S_1 S_2 \quad \{ S_1 \cdot \text{next} = \text{newlabel} ()$
 $\quad S_2 \cdot \text{next} = S \cdot \text{next}$
 $\quad S \cdot code = S_1 \cdot code \text{ || label } (S_1 \cdot \text{next}) \text{ || } S_2 \cdot code \}$

$B \Rightarrow B_1 \text{ || } B_2 \quad \{ B_1 \cdot \text{true} = B \cdot \text{true}$
 $\quad B_1 \cdot \text{false} = \text{newlabel} ()$
 $\quad B_2 \cdot \text{true} = B \cdot \text{true}$
 $\quad B_2 \cdot \text{false} = B \cdot \text{false}$
 $\quad B \cdot code = B_1 \cdot code \text{ || label } (B_1 \cdot \text{false}) \text{ || } B_2 \cdot code \}$

$B \Rightarrow B_1 \& B_2 \quad \{ B_1 \cdot \text{true} = \text{newlabel} ()$
 $\quad B_1 \cdot \text{false} = B \cdot \text{false}$
 $\quad B_2 \cdot \text{true} = B \cdot \text{true}$
 $\quad B_2 \cdot \text{false} = B \cdot \text{false}$
 $\quad B \cdot code = B_1 \cdot code \text{ || label } (B_1 \cdot \text{true}) \text{ || } B_2 \cdot code \}$

$B \Rightarrow !B_1 \quad \{ B_1 \cdot \text{true} = B \cdot \text{false}$
 $\quad B_1 \cdot \text{false} = B \cdot \text{true}$
 $\quad B \cdot code = B_1 \cdot code \}$

$B \Rightarrow E_1 \text{ rel } E_2 \quad \{ B \cdot code = E_1 \cdot code \text{ || } E_2 \cdot code$
 $\quad \text{|| gen } ('if' E_1 \cdot \text{addr} \text{ relop } E_2 \cdot \text{addr} 'goto' B \cdot \text{true})$
 $\quad \text{|| gen } ('goto' B \cdot \text{false})$

$B \Rightarrow \text{true} \quad \{ B \cdot code = \text{gen } ('goto' B \cdot \text{true}) \}$

$B \Rightarrow \text{false} \quad \{ B \cdot code = \text{gen } ('goto' B \cdot \text{false}) \}$

■ Draw the syntax tree for the following input string:

if ($x + k < 100 \text{ || } x + k > 200 \text{ && } x \neq y$)

$x = 0;$

$y = x + 10;$

