Exercise 1

Given the following table of operators, with increasing precedence from top to bottom,

Operators	Associativity
and, **or**	right
<, >	nonassoc
+, *	left

specify the BNF of a corresponding language for expressions based on the following requirements:

- Atomic elements of the expression are either constants or identifiers;
- Precedence/associativity relevant to + and * can be altered by parentheses;
- Precedence/associativity relevant to **and** and **or** cannot be altered.

Example of phrase: `(a*(b+24)) > x+y and c < z+12 or (d+3)*4 > 10`

Exercise 1

Given the following table of operators, with increasing precedence from top to bottom,

Operators	Associativity	Nonterminal
and, **or**	right	E
<, >	nonassoc	T
+, $*$	left	S
		F

specify the BNF of a corresponding language for expressions based on the following requirements:

- Atomic elements of the expression are either constants or identifiers;
- Precedence/associativity relevant to + and $*$ can be altered by parentheses;
- Precedence/associativity relevant to **and** and **or** cannot be altered.

Example of phrase: `(a*(b+24)) > x+y and c < z+12 or (d+3)*4 > 10`

$$E \rightarrow T \textbf{ and } E \mid T \textbf{ or } E \mid T$$
$$T \rightarrow S \textbf{ > } S \mid S \textbf{ < } S \mid S$$
$$S \rightarrow S \textbf{ + } F \mid S \textbf{ * } F \mid F$$
$$F \rightarrow \textbf{id} \mid \textbf{num} \mid \textbf{(} S \textbf{)}$$

Exercise 2

Specify the BNF equivalent to the following grammar

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow A$ **d** | **e**
$B \rightarrow B$ **f** | S **g** | **h**

such that the corresponding language can be treated by a recursive-descent parser.

Exercise 2

Specify the BNF equivalent to the following grammar

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow A$ **d** | **e**
$B \rightarrow B$ **f** | S **g** | **h**

such that the corresponding language can be treated by a recursive-descent parser.

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow A$ **d** | **e**
$B \rightarrow B$ **f** | S **g** | **h**

⇨

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow$ **e** A'
$A' \rightarrow$ **d** A' | ε
$B \rightarrow B$ **f** | S **g** | **h**

⇨

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow$ **e** A'
$A' \rightarrow$ **d** A' | ε
$B \rightarrow B$ **f** | A **a g** | B **b g** | **c g** | **h**

⇨

$S \rightarrow A$ **a** | B **b** | **c**
$A \rightarrow$ **e** A'
$A' \rightarrow$ **d** A' | ε
$B \rightarrow$ **e** A' **a g** B' | **c g** B' | **h** B'
$B' \rightarrow$ **f** B' | **b g** B' | ε

Exercise 3

Specify the BNF equivalent to the following grammar

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow A$ **a** | **b**
$B \rightarrow B$ **b** | S **a** | **a**

such that the corresponding language can be treated by a recursive-descent parser.

Exercise 3

Specify the BNF equivalent to the following grammar

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow A$ **a** | **b**
$B \rightarrow B$ **b** | S **a** | **a**

such that the corresponding language can be treated by a recursive-descent parser.

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow A$ **a** | **b**
$B \rightarrow B$ **b** | S **a** | **a**

⇨

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow$ **b** A'
$A' \rightarrow$ **a** A' | ε
$B \rightarrow B$ **b** | S **a** | **a**

⇨

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow$ **b** A'
$A' \rightarrow$ **a** A' | ε
$B \rightarrow B$ **b** | A **b a** | B **a a** | **c a** | **a**

⇨

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow$ **b** A'
$A' \rightarrow$ **a** A' | ε
$B \rightarrow B$ **b** | **b** A' **b a** | B **a a** | **c a** | **a**

⇨

$S \rightarrow A$ **b** | B **a** | **c**
$A \rightarrow$ **b** A'
$A' \rightarrow$ **a** A' | ε
$B \rightarrow$ **b** A' **b a** B' | **c a** B' | **a** B'
$B' \rightarrow$ **b** B' | **a a** B' | ε

Exercise 4

Given the following table of operators, with increasing precedence from top to bottom,

Operators	Associativity
`&&`, `||`	left
`==`, `!=`	nonassoc
`+`, `-`	right

specify the BNF of a corresponding language for expressions based on the following requirements:

- parentheses can be used for arithmetic operators (`+`, `-`);
- parentheses cannot be used for logical operators (`&&`, `||`);
- atomic elements of the expression are either constants or identifiers.

Exercise 4

Given the following table of operators, with increasing precedence from top to bottom,

Operators	Associativity
`&&`, `||`	left
`==`, `!=`	nonassoc
`+`, `-`	right

specify the BNF of a corresponding language for expressions based on the following requirements:

- parentheses can be used for arithmetic operators (`+`, `-`);
- parentheses cannot be used for logical operators (`&&`, `||`);
- atomic elements of the expression are either constants or identifiers.

Operators	Associativity	Nonterminal
`&&`, `||`	left	E
`==`, `!=`	nonassoc	T
`+`, `-`	right	S
		F

$$E \rightarrow E \;\&\&\; T \mid E \;||\; T \mid T$$
$$T \rightarrow S == S \mid S \;!=\; S \mid S$$
$$S \rightarrow F + S \mid F - S \mid F$$
$$F \rightarrow \mathbf{id} \mid \mathbf{num} \mid (\, S \,)$$