

## Section 1: Regular Expressions

Regular Expression Reference Table

Symbol	Meaning	Example(s)
$a$	Literal character	$a$ , any symbol in your alphabet $\Sigma$
$ab$	Concatenation of regex's (or literal characters) $a$ and $b$	$ab$ , $(abc)(def)$
$\epsilon$	Empty string	$\epsilon$
$a b$	$a$ or $b$	$a, b$
$a^*$	0 or more $a$ 's	$\epsilon, a, aaaa, aaaaa$
$a^+$	1 or more $a$ 's	$a, aaa, aaaaa$
$a?$	0 or 1 $a$ 's	$\epsilon, a$
$[a-z]$	1 character in range $a-z$ : ( $a   b   \dots   z$ )	$a, b, c, d, e, f, \dots, z$
$[skj]$	1 of characters in bracket: ( $s   k   j$ )	$s, k, j$

1) Describe the meaning of each of the following regular expressions in English and give two different strings it can produce:

i)  $(1 | 0)^* 0$

Non-empty strings of binary digits ending with 0  
0, 10, 111100000, 01010

ii)  $([A-Z][a-z]^* | [0-9]^+)$

Sequence of letters starting with an upper-case A-Z followed by 0 or more lower-case letters, or non-empty sequence of decimal digits  
A, Aa, Abczzz, 0, 3, 42, 17

iii)  $(\epsilon | 4?0+1^* X 3^+)$

Empty string or sequence of letters and digits made from the characters 0, 1, 4, X, and 3 that optionally begin with 4, contain at least one 0 followed by 1's followed by an X and ending in one or more 3's (i.e., it's hard to describe this collection of strings succinctly)  
 $\epsilon$ , 0X3, 401X333, 40000111X333

2) Write a regular expression for each of the following specifications:

i) All strings consisting of 0's and 1's (binary digits) with an even number of 0s

$1^* (0 1^* 0 1^*)^*$

ii) camelCase variable name in Java, where the alphabet is upper and lower-case letters with no digits or underscores

$[a-z]^+([A-Z][a-z]^*)^*$

Note: this solution allows multiple upper-case letters to appear adjacent to each other. Challenge: produce a solution that does not allow adjacent upper-case letters.

- iii) Non-empty strings of binary digits where each 1 directly follows a 0 (challenge: only use symbols in table up until \*)

Challenge 1:  $(0 | 01)^*$

Challenge 2 (no or):  $0(0^*(01))^*0^*$

Normal:  $(0+1)^+$