

## 1 Regular Expressions

Give regular expressions for each of the following languages over the alphabet  $\{0, 1\}$ .

1. All strings containing the substring  $000$ .
2. All strings *not* containing the substring  $000$ .
3. All strings in which every run of  $0$ s has length at least 3.
4. All strings in which  $1$  does not appear after a substring  $000$ .
5. All strings containing at least three  $0$ s.
6. Every string except  $000$ . [*Hint: Don't try to be clever.*]
7. All strings  $w$  such that *in every prefix of  $w$* , the number of  $0$ s and  $1$ s differ by at most 1.
8. Any string not in  $0^* + 1^*$
- \*9. All strings containing at least two  $0$ s and at least one  $1$ .
- ★10. All strings in which the substring  $000$  appears an even number of times.  
(For example,  $0001000$  and  $0000$  are in this language, but  $00000$  is not.)