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The answers must be the original work of the author. While discussion with others is permitted and encouraged, the final work should be done individually. You are not allowed to work in groups. You are allowed to build on the material supplied in the class. Any other source must be specified clearly.

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**1.** (80 points, 10+10 points each)

For each of the following languages:

- (i) Construct a regular expression that describes the language, and
- (ii) Build a DFA that accepts the described language. Explain how the machine works.  
**No points will be given to machines without accompanying “comments”.**

(a) The empty set (over  $\{a, b\}$ ).

(b) The empty string (over  $\{a, b\}$ ).

(c) The strings that contain substring ‘*abba*’ over  $\{a, b\}$ .

(d) The strings that begin with *a*, and do not contain ‘*bc*’ over  $\{a, b, c\}$ .

**2.** (20 points) Use the procedure described in class to construct the machine  $M3$  that corresponds to the “product” of machines  $M1$  and  $M2$ . In other words,  $L(M3) = L(M1) \cap L(M2)$ .

$M1$  accepts the strings that do not contain ‘*aa*’.

$M2$  accepts the strings that end with ‘*ab*’.

Test all three machines with the four strings *aa*, *ab*, *aba*, *aab* and state whether they are accepted.

