Student Name:

Please write on this test. Mark all answers clearly. **Closed book. No notes.** No time limit. Work strictly from memory. **No calculators.** Please do not discuss this test with other students until the test "closes" at the testing center on Saturday afternoon.

Yes or No: does the string match the regular expression? Circle the right answer.

1/1p.	yes	no	Does the empty string match the regular expression "`y+a`"?
2/1p.	yes	no	Does the string "`n`" match the regular expression "`n|ww`"?
3/1p.	yes	no	Does the string "`bff`" match the regular expression "`bc*|ff`"?
4/1p.	yes	no	Does the string "`ccus`" match the regular expression "`c?|us`"?
5/1p.	yes	no	Does the string "`ttg`" match the regular expression "`t+tg`"?
6/1p.	yes	no	Does the string "`kqkqkc`" match the regular expression "`kq+|kc`"?
7/1p.	yes	no	Does the empty string match the regular expression "`(hs)*t`"?
8/1p.	yes	no	Does the string "`dss`" match the regular expression "`d?s*`"?
9/1p.	yes	no	Does the string "`kr`" match the regular expression "`kr*|bh`"?
10/1p.	yes	no	Does the string "`gpuu`" match the regular expression "`gn*|(pu)+`"?
11/1p.	yes	no	Does the string "`hufsfs`" match the regular expression "`hu|(fs)?`"?
12/1p.	yes	no	Does the string "`xxxwzz`" match the regular expression "`((xx)?wz)*`"?
13/1p.	yes	no	Does the string "`cs`" match the regular expression "`cs+|t(rt)+`"?
14/1p.	yes	no	Does the empty string match the regular expression "`by+hs`"?
15/1p.	yes	no	Does the string "`d`" match the regular expression "`(td)?|t|(d*)?`"?
16/1p.	yes	no	Does the string "`phgbphg`" match the regular expression "`(ph?gb?)*`"?
17/1p.	yes	no	Does the string "`hzzz`" match the regular expression "`(xd|hz+)?`"?
18/1p.	yes	no	Does the string "`hrhrzxhrhrzx`" match the regular expression "`(hr+|zx|pu*)*`"?
19/1p.	yes	no	Does the string "`kykygr`" match the regular expression "`ky+(yd)+|y+gr`"?
20/1p.	yes	no	Does the string "`krn`" match the regular expression "`(zx)?kr*nq+`"?
21/1p.	yes	no	Does the string "`hpp`" match the regular expression "`hp?p(tu)*`"?
22/1p.	yes	no	Does the string "`wxxy`" match the regular expression "`wx+y?|(at)?r`"?
23/1p.	yes	no	Does the string "`fa`" match the regular expression "`f*|(db|fa)?|c+`"?
24/1p.	yes	no	Does the string "`chhquggfs`" match the regular expression "`(ch*|qu|p)+|g?fs`"?
25/1p.	yes	no	Does the string "`gt`" match the regular expression "`(pp)?gt(b*)*`"?
26/1p.	yes	no	Does the string "`ntaht`" match the regular expression "`n?t|f|(ah+t)*`"?
27/1p.	yes	no	Does the string "`fbfbu`" match the regular expression "`(k*fb+|nk|uz?)*`"?
28/1p.	yes	no	Does the string "`zwzwccsaabqzwzwccsaabq`" match the regular expression "`((zw*|cw?)*|sa*bq)+`"?
29/1p.	yes	no	Does the string "`w`" match the regular expression "`((h?ub)*|pb)*|w|aa`"?
30/1p.	yes	no	Does the string "`pnttxwuunttxwuu`" match the regular expression "`d+p|((nt)*x(wu)*)+`"?

On the following problems, please answer in the space provided if possible. Write neatly.

31/3p. ____ What is a language (in this course)?

32/3p. ____ What is an automaton?

33/3p. ____ What meaning(s) does the "+" sign have (in this course)?

34/3p. ____ Give a regular expression that recognizes the language of strings over `{a b}` that include exactly two `b`s.

35/3p. ____ Give a finite automaton (DFA) that recognizes the language of strings over `{a b}` that include exactly two `b`s.

36/3p. ____ Is the language `{a ab aba bab}` regular? Why or why not?

The "Canonical Order" of a language is a listing of all the strings in that language, from shortest to longest. Within each length class, in alphabetical order.

37/3p. ____ List the first five strings (in canonical order) of the language accepted by the regular expression "a*bab".

38/7p. ____ What does set **intersection**, **union**, **subtraction**, **subset-of**, and **complement** have to do with regular languages?

39/7p. ____ Given two arbitrary regular expressions, can we tell whether they accept exactly the same language? How or why not? ("arbitrary" means "chosen by your worst enemy.")

40/7p. ____ Explain the Kleene closure.

41/7p. ____ Explain why every NFA can be converted into a DFA that recognizes the same language. (One way to do this is by explaining how to convert an NFA into a DFA.)

42/7p. _____ Kleene's Theorem unifies what things? How does it work?

43/7p. _____ What is the pumping lemma? What is the Myhill-Nerode theorem?

44/7p. _____ Prove that every DFA has a minimal version, or tell why some might not. By minimal, we mean it has the smallest number of states possible and still accepts the exact same language.

Extra Credit:
45/5p. _____ Given a DFA, how can it be converted into a minimal DFA? (We did not discuss this in class, but I want to see how you apply your knowledge to a fresh situation.)

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