Finite Automata and Formal Language MA31004
And
Switching and Finite Automata MA30006/MA60036

Time 2Hr   Spring09

Instruction: There are 17 questions on 2 printed sides. Every question carries 2 marks. There is no part marking. In a question a student will get either 2 marks or 0 marks.
In case of any doubt or mistake any query should not be made. In case of wrong question full marks will be awarded later.

Use of calculators is not permitted. Rough work involved in the question must be shown. However final answer should be written in a box. If a question has more than one possible answer then all of them should be written in the same box.
Rough work must be shown along with the answer. Only answer will carry 0 marks.

1. A person has made automata to add 'x' in a positive number (right to left processing). It needs 3660 states. How many states are there in the automata to add '3917x'? [Let y=15200. In automata to add 'y' there are 8 states. In automata to add '67y' i.e. 6715200 there are 13 states]

2. A person has written regular expression $(pq+q)^*p$ for "the set of strings without consecutive p's ". Give example of a string of length 3689 which violates it. The string should have maximum number of p's. [Write answer in the form $p^{213}q(pqp)^{11}q^{412}pp$][Notation: $(pq)^4pp=pqpqpqpqpp$]

3. A person has designed automata to accept those numbers, whose sum of digits is divisible by 343. He has used states s_i (i=0,1,2,...342). $\delta(s_i,x)=s_j$ where j=(i+x) mod 343. Here x=0..9. Let 'w' be some number (string) and $\delta(s_0,w)=s_{309}$ and $\delta(s_k,w)=s_{66}$. What is k?

4. M and N are two deterministic finite state automata with set of states P={A,W,U,S} and Q={E,F,G}. Their initial states are A and E respectively. The automata N has got only one final state. It is F. Let $\delta(G,x)=G$ for $x \in \Sigma$. A student has designed automata for $L(M) \cap L(N)$ by taking R=PxQ. Which states are certainly equivalent states in R? [Write answer in the form EG,AE,AF]

5. There is a 2-way automata. The set of states is {A,B,...Z}. The set of input symbols is {a,b,c,d,..z}. A step during run of the automata is fTgyuu. What was the previous step? Write all possible answers (in the same box) using following incomplete transition function.
[$\delta(M,y)=(T,L)$ $\delta(T,f)=(Z,R)$ $\delta(K,f)=(T,R)$ $\delta(T,y)=(C,L)$ $\delta(B,d)=(B,L)$ $\delta(T,x)=D$]
[Hint: If aBcde is a step then previous step was acBde]

6. Let M=$<Q,\Sigma,\delta,A,\{A,B,K\}>$ and N=$<Q,\Sigma,\delta,B,\{A,B,K\}>$ be two deterministic finite state automata. Let $\Sigma=\{a,b\}$ and $\delta(B,a)=A$ and $\delta(B,b)=B$. Express L(N) in terms of L(M). [Write answer in the form $L(N)=L(M)gg+\{\varepsilon\}$]

7. Let 'x' be a number. It leaves remainder 1 when divided by 3. Let last 5 digits of 'x' be 46352. What shall be the last 5 digits of the quotient when 'x' is divided by 3?

8. An automata is made to divide a number by 25. It has states A, B, ..,Y corresponding to remainder 0,1,..,24. What will be the output if H5396 is processed? [Hint: when A316 is processed then output is 012r16]

P.T.O.

9. An automata is supposed to add 1720 (right to left processing). Runs on input 88888 is W8K8S8A8C8B. Run on input 22 is G2C2B. What is run on input 55555?

10. A person has designed automata to exchange 2nd and 5th last letters of a input. Processing of an input is shown: ApBqCpDrEuFtGpHrIzJpKqL. If we end on state 'L' then output is "przpq". What is the output if we end on state 'G'? [Hint: input abcefghij output abcdeighfj][Caution: the number of the states are more than 26, they are beyond A,B,..Z]

11. Runs of a NFA on strings 0110, 101101, 00001 are A0Q1Z1D0R, A1P0W1D1B0P1Y and A0Z0D0F0A1Q respectively. Rough work to find run on 11010 is A1PQR1XYZW0CDEF1B0U. What is run on 11010? Assume all strings described above are accepted by NFA.

12. Let L(N)=L(M)$\cap$(aab+ba)*. The deterministic automata (M) has 676 states. How many states are in automata (N)?

13. An automata has transition function [δ(A,a)=B δ(A,u)=C δ(B,b)=B δ(C,k)=B δ(C,m)=C], the initial state A, the set of final states is {B}. Let regular expression for the set of strings accepted by the automata is 'r'. Another automata is similar to it except the set of final states is {B,C}. The regular expression for that is 'r+"missing"'. What is "missing"? Write smallest possible answer.

14. Let <{A,B},{p,q},A,δ,Z,{Y,Z},{A,B}> be a pushdown automata (acceptance by final state). Give string of smallest possible length, which will be rejected by it.

	(p,Z)	(q,Z)	(p,Y)	(q,Y)
A	A,nop	A,pushY	B,pushY	A,nop
B	B,pop	B,pushZ	A,pushY	B,pop

15. Let w=(011)^{579}t(101)^{366} is accepted by infinite state automata <Q,{0,1},δ,q$_0$,{q$_0$}>. What is string 't' (smallest possible length)? [Notation: (010)^{4}00(10)^{3}=01001001001000101010]
The transition function is: δ(q$_i$,0)=q$_{i+2}$ for even i δ(q$_i$,1)=q$_{i+2}$ for odd i
δ(q$_1$,0)=q$_0$ δ(q$_i$,0)=q$_{i-2}$ for odd i>1 δ(q$_0$,1)=q$_1$ δ(q$_i$,1)=q$_{i-2}$ for even i>1

16. The program K on input X outputs 4*(output of S$_X$ on X)+1884. What is output of K on N$_K$? [Example: Let program P on input N$_P$ outputs −13 and program G on input X outputs 2*(output of S$_X$ on X). Now program G on N$_P$ will output 2*(output of P on N$_P$). It is -26.]

17. FSA to accept those strings (Σ={0,1}), whose 3rd last symbol is '0' is made in standard manner. However by mistake 'R' is made the initial state in place of 'S'. What harm will it make? [Notation: δ(x,w110)=R for any state x and any string w.][Write answer in the form 0110, 1100111 will be accepted and 1010 will be rejected]