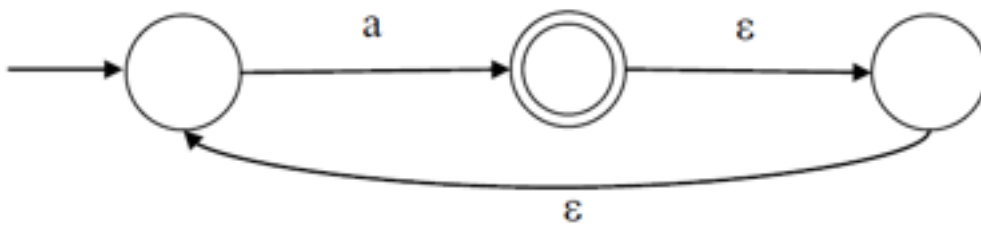


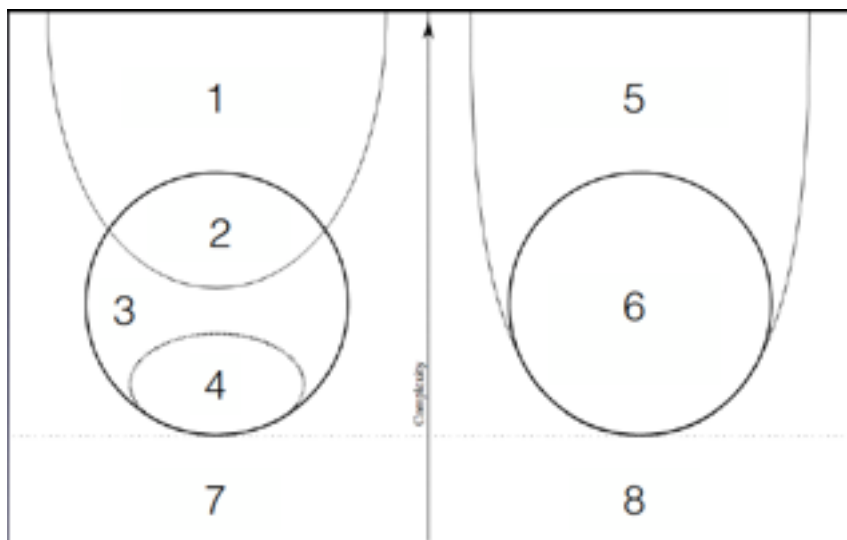
Computer Science IV Final Exam
May 2017
Indian Statistical Institute

Part I - Answer any four of the following - 5 marks each, total 20

1. Consider the languages $L_1 = \Phi$ and $L_2 = \{a\}$. What is $L_1 L_2^* \cup L_1^*$. Elaborate the steps.
2. Given the NFA shown below, what is the language accepted by it and what is the complement of the language ?



3. Answer the following:
 1. What do P and NP refer to ?
 2. Given the diagram below,
 1. Label the different areas 1 - 6 to indicate where the different types of P and NP problems lie
 2. Label the two halves of the diagram 7, 8 correctly to indicate the relationship between P and NP.

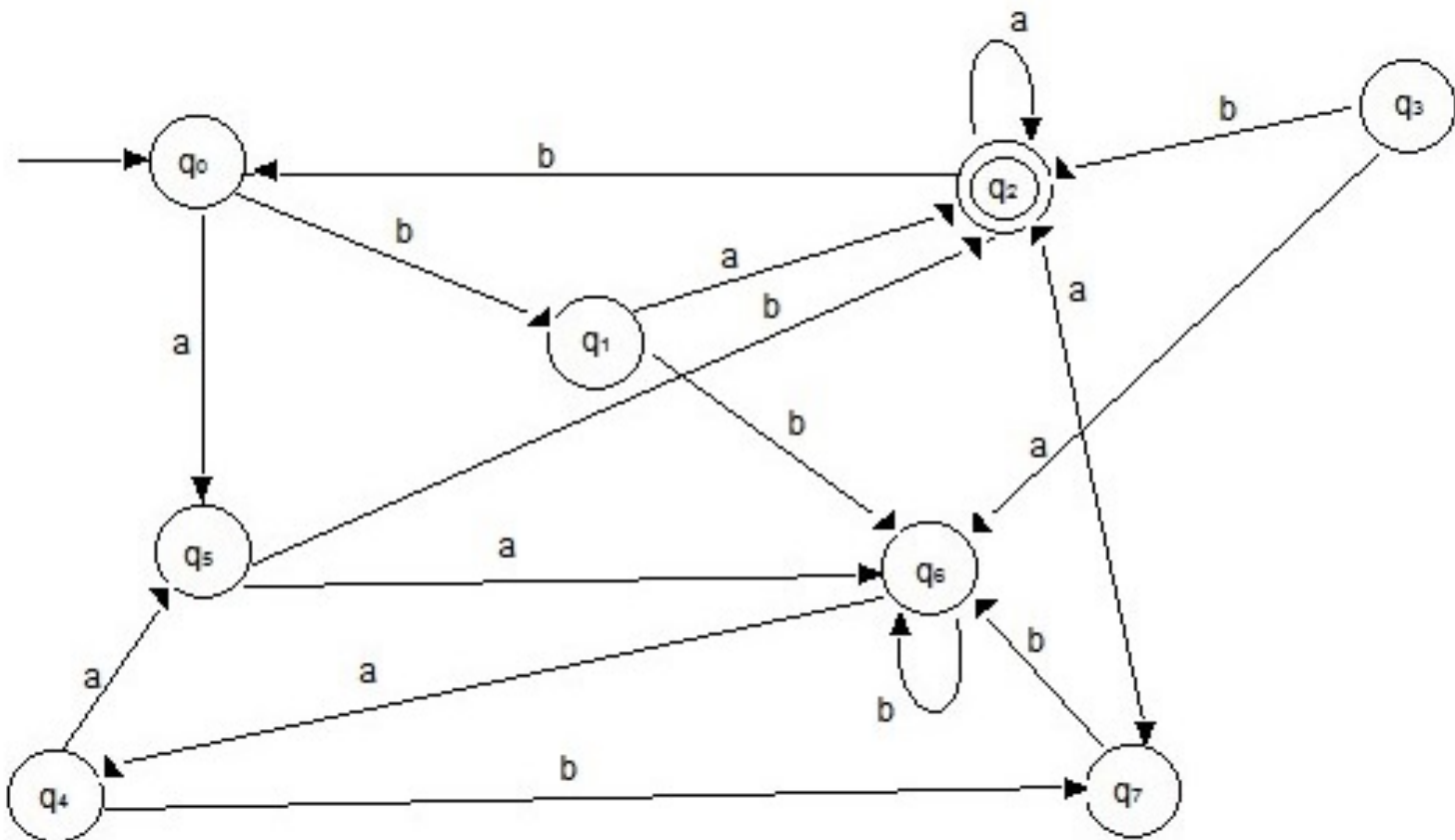


4. Explain how the Fast Fourier Transformation reduces the number of computational steps ? What is the resulting time complexity ?
5. Why is the Halting problem undecidable ? Explain with program illustrations.

Part II - Answer the following - total 30

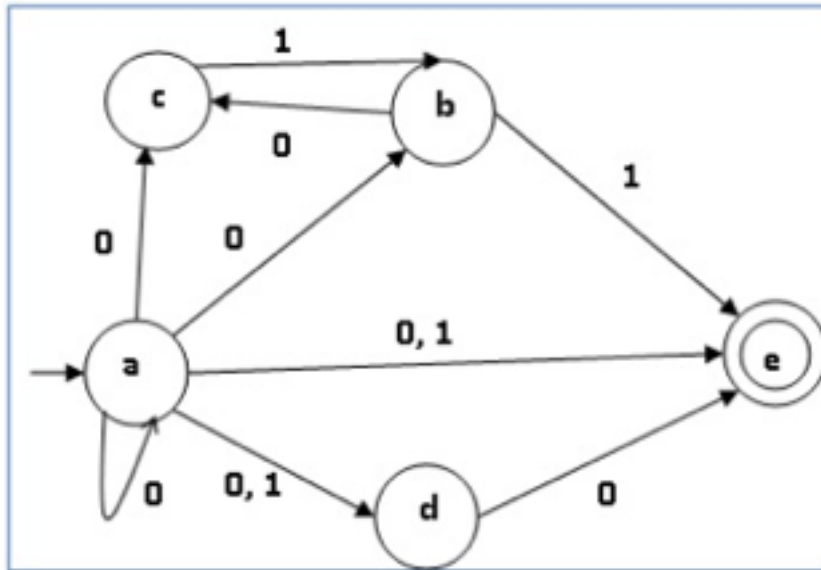
6. Design a DFA for the language $L = \{w \in (a,b)^* : n_b \% 3 > 1\}$ - 15 marks
 n_b represents the number of 'b's in the string. $n_b \% 3$ gives the remainder when n_b is divided by 3.

7. Show the minimization steps in the given DFA using either the equivalence or table filling method – 15 marks

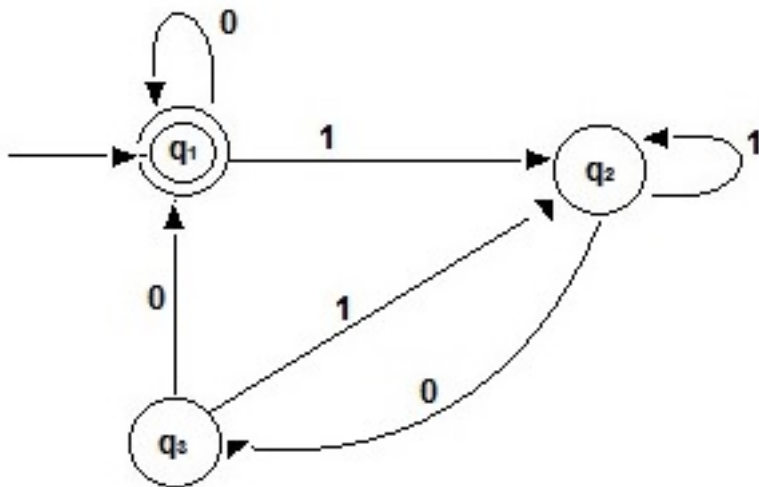


Part III - Answer any of the following for a total of 50 marks

8. Convert the following NFA to its equivalent DFA. Elucidate the steps clearly. - 10 marks



9. Derive the regular expressions corresponding to the automata given below. Provide all the equations - 10 marks



10. Construct a PDA from the following CFG, - 20 marks

$$G = (\{S, X\}, \{a, b\}, P, S), \text{ where } P = \{S \rightarrow XS \mid \epsilon, A \rightarrow aXb \mid Ab \mid ab\}$$

11. Consider the regular grammar $G = (N, T, P, S)$, where $N = \{A, B, S\}$, $T = \{a, b\}$ and $P = \{S \rightarrow abA, S \rightarrow B, S \rightarrow baB, S \rightarrow \epsilon, A \rightarrow bS, B \rightarrow aS, A \rightarrow b\}$. Reduce G to Chomsky Normal Form - 20 marks

12. Design and construct a Turing Machine for the subtraction operation $5 - 2$. - 10 marks