Choose any 2 of the 3 problems.

1). Let A be the language of all palindromes over {0, 1} containing equal numbers of 0's and 1's. Is A context free? If yes, then give the corresponding context free grammar for A. If not, please prove it. (Palindrome is a string that reads the same backward as forward, for example, 0110.).

## Pumping lemma:

According to pumping lemma, A language is contextfree if for a pumping length 'p' a string 'w' in L, when divided into 5 parts u, v, x, y, z such that the following 3 conditions are satisfied.

(i) $|vy| \geq 1$

(ii) $|vxy| \leq p$

(iii) $uv^ixy^iz \ \forall i \in L$.

Generally, pumping lemma is used to prove a language is not context free. we do this by proof by contradiction we will assume first language is context free, if any of the above conditions fail, then the Assumption made by us is wrong. And language is Not contextfree.

1) $A = \{ w \mid w \in \{0,1\}^* \text{ and } w = w^R \text{ and no. of 0's = no. of 1's} \}$

No, A is not context free language.

We prove this using pumping lemma for context free.

Proof:

By contradiction, let us assume that A is context free. Let p be pumping length. Choose a string s to be $a^p b^p b^p a^p$ in language A with length at least p. Pumping lemma guarentees that s can be divided into five parts at least p. Pumping lemma guarentees that s can be divided into five parts $s = uvxyz$, where for each $i \geq 0$ $uv^i xy^i z$ is in A.

Now we consider few cases to show that A is not context free.



1) Sub-strings y and v contains all a's:

In this case, u and v parts share first part of a's and y and z parts share last part of a's. If v and y are not having equal number of a's the

1) Sub-strings $u$ and $v$ contains all a's:

In this case, $u$ and $v$ parts share first part of 0's and $y$ and $z$ parts share last part of 0's. If $v$ and $y$ are not having equal number of 0's then for $i=0$, $uv^0xy^0z$ does not belong to A as there will be different number of 0's and that is not having equal number of 0's and 1's. This is a contradiction. $\left(\underbrace{0^{p-k_1}}_{u}\,\underbrace{0^{k_1}}_{v}\,\underbrace{1^{p}}_{x}\,\underbrace{0^{p-k_2}}_{y}\,\underbrace{0^{k_2}}_{z}\right)$

2) Sub-string $v$ contains all 0's and $y$ contains all 1's:

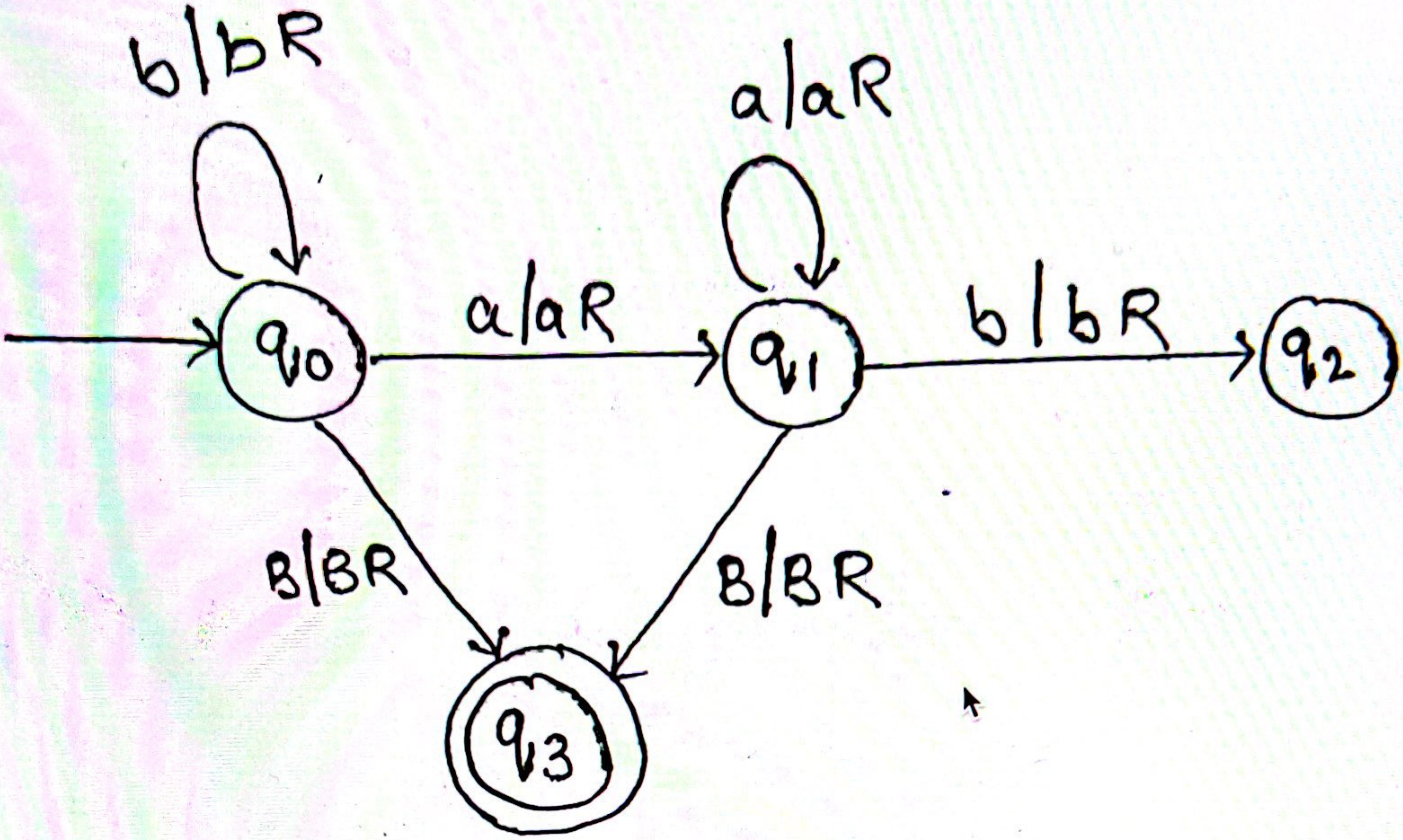
$(0^{p-k_1}\, 0^{k_1} \ldots$

2) Sub-string $v$ contains all 0's and $y$ contains all 1's:

$$\left(\underbrace{0^{p-k_1}}_{u}\underbrace{0^{k_1}}_{v}\underbrace{1^{k_2}}_{x}\underbrace{1^{k_3}}_{y}\underbrace{1^{p-k_2-k_3}1^{p}0^{p}}_{z}\right)$$

where $k_1+k_2+k_3 \leq p$. In this case, for $i=0$, $uv^ixy^iz$ does not belong to $A$ as there will be mismatch of number of 0's.

2). Give the state diagram for a Turing machine that decides the following language $B = \{w :$ $w$ does not contain the substring "ab"$\}$ over $\Sigma = \{a, b\}$.




Initial state - $q_0$

Accept state - $q_3$

Reject state - $q_2$

Idea is -

1 - In starting, any number of 'b' can come, we will just keep 'b' as it is and will move right.

2 - After b, if 'a' will come then will keep 'a' as it is and will move to the right of it.

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Idea is -

1 - In starting, any number of 'b' can come, we will just keep 'b' as it is and will move right.

2 - After b, if 'a' will come then will keep 'a' as it is and will move to the right of it.

3 - If after 'a', b will come then we will simply reject it by going to state $q_2$.

4 - From state $q_0$ and $q_1$, if we will get any 'blank' then we will simple move to the q3 state and accept the string.

Choose any 2 of the 3 problems.

1). Let A be the language of all palindromes over {0, 1} containing equal numbers of 0's and 1's. Is A context free? If yes, then give the corresponding context free grammar for A. If not, please prove it. (Palindrome is a string that reads the same backward as forward, for example, 0110.).

2). Give the state diagram for a Turing machine that decides the following language B = {w : w does not contain the substring "ab"} over $\Sigma = \{a, b\}$.

3). a. Completely and briefly define the class "P".

b. Is this true or false? "If $A \leq_p B$ and $B \in P$, then $A \in P$." Please prove your answer.

4. **NP hard**
5. **NP complete**

## P Class

The P in the P class stands for **Polynomial Time.** It is the collection of decision problems(problems with a "yes" or "no" answer) that can be solved by a deterministic machine in polynomial time.

**Features:**

1. The solution to P problems is easy to find.
2. P is often a class of computational problems that are solvable and tractable. Tractable means that the problems can be solved in theory as well as in practice. But the problems that can be solved in theory but not in practice are known as intractable.

This class contains many natural problems like:

1. **Calculating the greatest common divisor.**
2. **Finding a maximum matching.**
3. **Decision versions of linear programming.**

## NP Class

The NP in NP class stands for **Non-deterministic Polynomial Time**. It is the collection of decision problems that can be solved by a non-deterministic machine in polynomial time.

**Features:**

1. The solutions of the NP class are hard to find s[...]e they are being solved by a non-

time . If answer to any problem in the form of true and false or yes and no can be determined with finite amount of time and the problems which comes under this class is consider as a class p probl
.

(b) Given ,

A is greater than or equals to pB and B is clearly belongs to P .

To prove : A also belongs to P.

Proof : If A <= PB ,

Suppose A=PB , B belongs to P class .

Or A<PB , B belongs to P .

Then according to P class rules , the problem that intersect with the p class will belongs to P class.

Therefore, A also belongs to P class .

**Was this answer helpful?** 0 0

## Questions viewed by other students

**Q:** a. Completely and briefly define the class "P".b. Is this true or false? "If A $\leq_p$ B and B $\in$ P, then A $\in$ P."Please prove your answer.