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**a.**

The pumping length could not be 3 as 000 being in the language it cannot be pumped. Consider the string length be 4 or more and divide in $xyz$ as $x$ being $000$, $y$ being the first $1$ and $z$ being everything after then it satisfies every condition of pumping lemma.

**Hence the minimum pumping length is 4.**

**b.**

String $\varepsilon$ is in the language but it could not be pumped so the pumping length could not be 0. According to pumping lemma's three condition arises which are as follows:

• If user divide the string in $xyz$ as $x$ is $\varepsilon$

• $y$ is first symbol $(0|1)$

• $z$ being the everything after then it holds.

**Hence the minimum pumping length is 1.**

**c.**

The string $001$ is in the language but if it is generated by **001** then it cannot be pumped. If string $s$ is larger than 3 and in the language, then it is generated by $0^*1^*$. Dividing the string according to Pumping Lemma's condition into a string $xyz$ where $x$ is $\varepsilon$, $y$ be the first symbol and $z$ be the remaining, user can pump the string.

**Hence the minimum pumping length is 4.**

**d.**

The string $11$ is in the language but it cannot be pumped so the length is not 2. Let $s$ be the string in the language of length at least 3. If $s$ is generated by $0^*1^+0^+1^*$ it can be divided in $xyz$ as $x$ is $\varepsilon$, $y$ is the first string and z is everything else so it can be pumped.

Again if $s$ is generated by $10^*1$ then also user can write it as $xyz$ where $x$ is $1$, $y$ is $0$, and $z$ is the remainder so it could be pumped.

**Hence the minimum pumping length is 3.**

**e.**

Let $s$ be a string in the language.

Now $s$ could be $\varepsilon$ but it cannot be pumped so the length is not 0. Next $s$ could be $01$ which if divide in $xyz$ as $x$ is empty string $\varepsilon$, $y$ is $01$, and $z$ is everything after then it satisfies the three conditions of pumping lemma.

Pumping length is not 1 because since there is no string of length 1 in the language.

**Hence the minimum pumping length is 2.**

**f.**

Let $s$ be a string in the language then $s$ is $\varepsilon$ and according to pumping lemma it cannot be pumped. As per the pumping lemma, pumping length should greater then equal to 1.

**Hence the minimum pumping length is 0.**

**g.**

The minimum pumping length of the language could not be 2 as $00$ being in the language it could not be pumped. Let $s$ be the string of length at least 3 in the language so minimally $s$ could be $100$ or $010$ or $001$.

Now dividing $s$ in $xyz$ in all the three cases user get, for $100$ $x$ is $\varepsilon$, $y$ is $1$, and $z$ is the remainder, for $010$ $x$ is $0$, $y$ is $1$, and $z$ is the remainder and for $001$ $x$ is $00$, $y$ is $1$, and $z$ is the remainder. All satisfies Pumping Lemma's three conditions.

**Hence the minimum pumping length is 3.**

**h**.

The minimum length string in the given language is $100$ but it cannot be pumped. Next minimum length string is 10100. If divide it according to the pumping lemma in $xyz$ then $x$ be 10, $y$ be 10, and $z$ be the rest of the string then $y$ can be pumped.



**Hence the minimum pumping length is 4.**

i.

If $s$ be a string in the language then $s$ is $1011$. If set p = 4, then claim $s$ is pumpable (which it is not, as it is the only string in the language). This should be 5.

**Hence then the minimum pumping length is 5.**

**j.**

Say $s$ be a string in the language $\Sigma^*$. According to pumping lemma if divide $s$ in $xyz$ then $x$ be the empty string, $y$ is $(\varepsilon \mid 0 \mid 1)$ and $z$ is empty string. Now $\varepsilon$ could not be pumped.

**Hence the minimum pumping length is 1.**