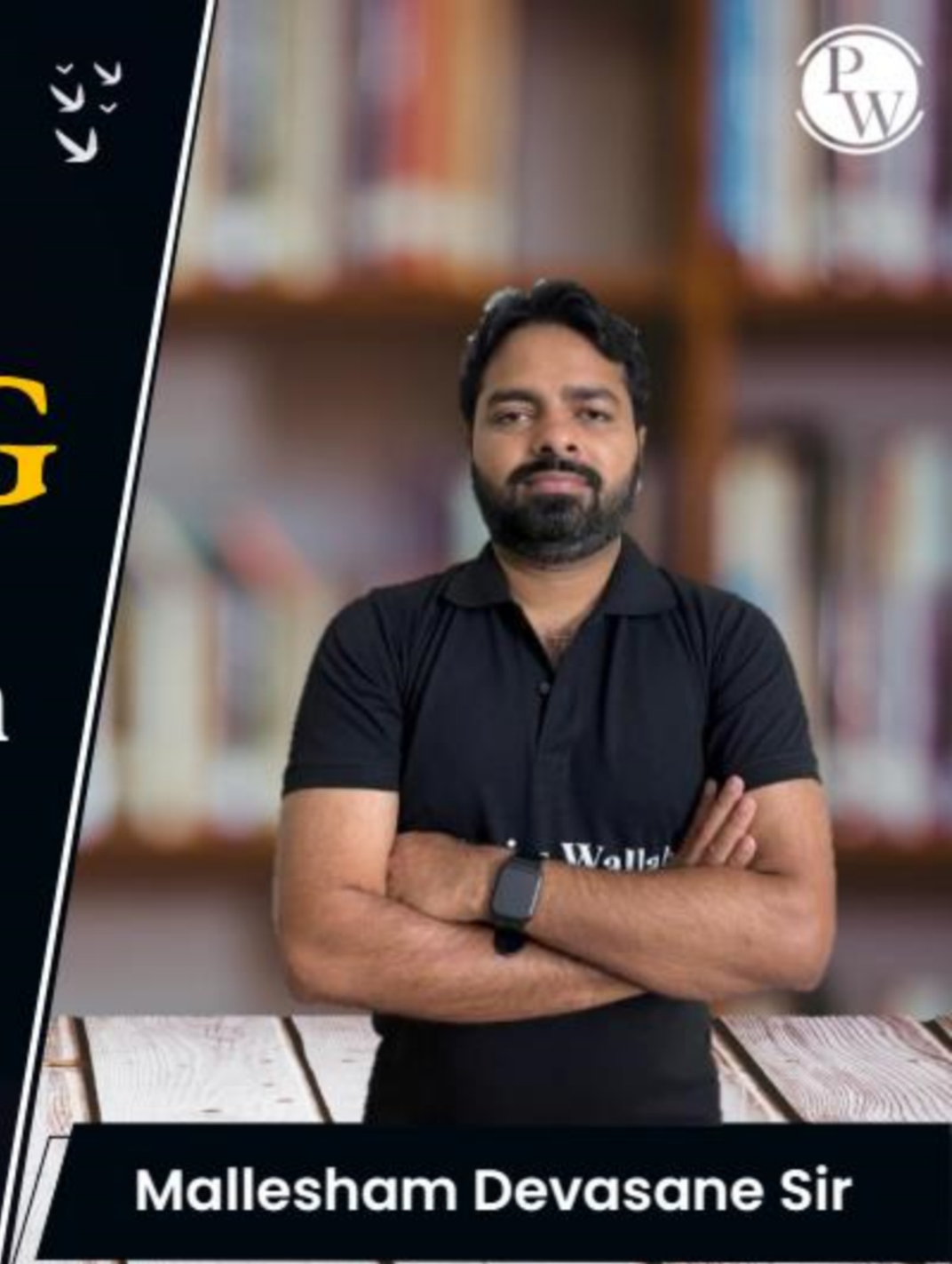
CS & IT ENGINEERING

Theory of Computation

Regular Languages

Lecture No.- 05



Mallesham Devasane Sir

Recap of Previous Lecture

Topic Regular Expressions

- OR
- Concatenation

$2 + \varepsilon = 2 + \varepsilon$

$2 + \phi = 2$

$2 = 2\varepsilon = \varepsilon 2 = \varepsilon\varepsilon 2\varepsilon\varepsilon\varepsilon$

$2\phi = \phi = 2 \cdot \varepsilon \cdot 2 \cdot \phi = \phi$

Topics to be Covered

Topic Regular Expressions

- Kleene star
- Kleene plus

$\varepsilon + a$

Zero length string is not a symbol

$\{\varepsilon, a\}$

$\varepsilon = \{a\}$

$a\varepsilon a = a\varepsilon\varepsilon a = aa$

$\varepsilon\varepsilon\varepsilon\varepsilon = \varepsilon = \varepsilon^{1000} = \varepsilon^{23} = \varepsilon^{1} = \varepsilon^{0}$

TOPIC: Kleene star

R^*

$R^{\geq 0}$

Kleene star of R

Kleene closure of R

R closure

TOPIC:

a^*

0 or more a's

$a^* = \varepsilon + a + aa + a^3 + a^4 + \cdots$

$\{a^n \mid n \geq 0\}$

$\{a^0, a^1, a^2, a^3, \cdots\}$

$\{\varepsilon, a, aa, aaa, \cdots\}$

TOPIC:

$\phi^0 = \varepsilon$

$\varepsilon^0 = \varepsilon$

$a^0 = \varepsilon$

$b^0 = \varepsilon$

$(ab)^0 = \varepsilon$

$R^0 = \varepsilon$

TOPIC:

$\phi' = \phi$

$\varepsilon' = \varepsilon$

$a' = a$

$(ab)' = ab$

$(aaa)' = aaa$

$\phi^2 = \phi \cdot \phi = \phi$

$\varepsilon^2 = \varepsilon \cdot \varepsilon = \varepsilon$

$a^2 = a \cdot a = aa$

$(ab)^2 = ab \cdot ab = abab$

$(aaa)^2 = aaa \cdot aaa = a^6$

TOPIC:

$$R^* = R^0 + R^1 + R^2 + R^3 + \cdots$$

$$\phi^* = \boxed{\phi^0} + \underbrace{\phi^1 + \phi^2 + \cdots} = \varepsilon + \phi = \varepsilon$$

$$\varepsilon^* = \varepsilon^0 + \varepsilon^1 + \varepsilon^2 + \cdots = \varepsilon$$

$$a^* = a^0 + a^1 + a^2 + a^3 + \cdots = \boxed{\varepsilon + a + aa + aaa + \cdots}$$

$$(ab)^* = \varepsilon + ab + abab + (ab)^3 + \cdots$$

TOPIC: Kleene plus

R^+

$R^{\geq 1}$

Kleene plus of R

Positive closure of R

one or more times of R

TOPIC:

$$R^+ = R^1 + R^2 + R^3 + R^4 + \cdots$$

$$\phi^+ = \phi^1 + \phi^2 + \phi^3 + \phi^4 + \cdots = \phi$$

$$\varepsilon^+ = \varepsilon$$

$$a^+ = a + aa + a^3 + a^4 + \cdots$$

$$(ab)^+ = ab + abab + (ab)^3 + ababababab + \cdots$$

TOPIC:

$$R^* = R^+ + R^0$$

$$R^* = R^+ + \varepsilon$$

$$R^* = R^0 + \underbrace{R^1 + R^2 + \cdots}_{R^+}$$

TOPIC:

Is $R^* = R^+$ possible ?

If $R = \varepsilon \Rightarrow$ $R^* = \varepsilon^* = \varepsilon$

$R^+ = \varepsilon^+ = \varepsilon$

TOPIC:

$R_1 + R_2$	R_1 or R_2
$R_1 \cdot R_2$	R_1 followed by R_2
R^*	Zero or more times of R
R^+	One or more times of R

[MSQ]

#Q1. $a^{+} + \varepsilon =$

A a^{+}

B a^{*}

C $(aa)^{+}$

D None of these

[MSQ]

#Q2 $(a^*)^0 =$

A a^*

B a^+

C ε

D ϕ

[MSQ]

#Q3. $(ab + aaa)^*$ generates _____ minimum string

A ε

B a

C b

D ab

[MSQ]

#Q4 $(ab+aaa)^+$ generates ___ min string

A ε

B a

C ab

D aaa

[MSQ]

#Q5. If $\Sigma = \{a, b\}$ then $\Sigma^* =$

A a^*

B b^*

C $(a+b)^*$

D $(ab)^*$

2 mins Summary

Topic Operators ✓

Topic Properties ✓

Topic Simplification ✓

} Next

THANK - YOU