NPTEL

NPTEL ONLINE CERTIFICATION COURSE

Discrete Mathematics
Graph Theory – 3 &
Generating Functions

Definition of Generating function

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We saw that polynomials are surprisingly connected to counting,
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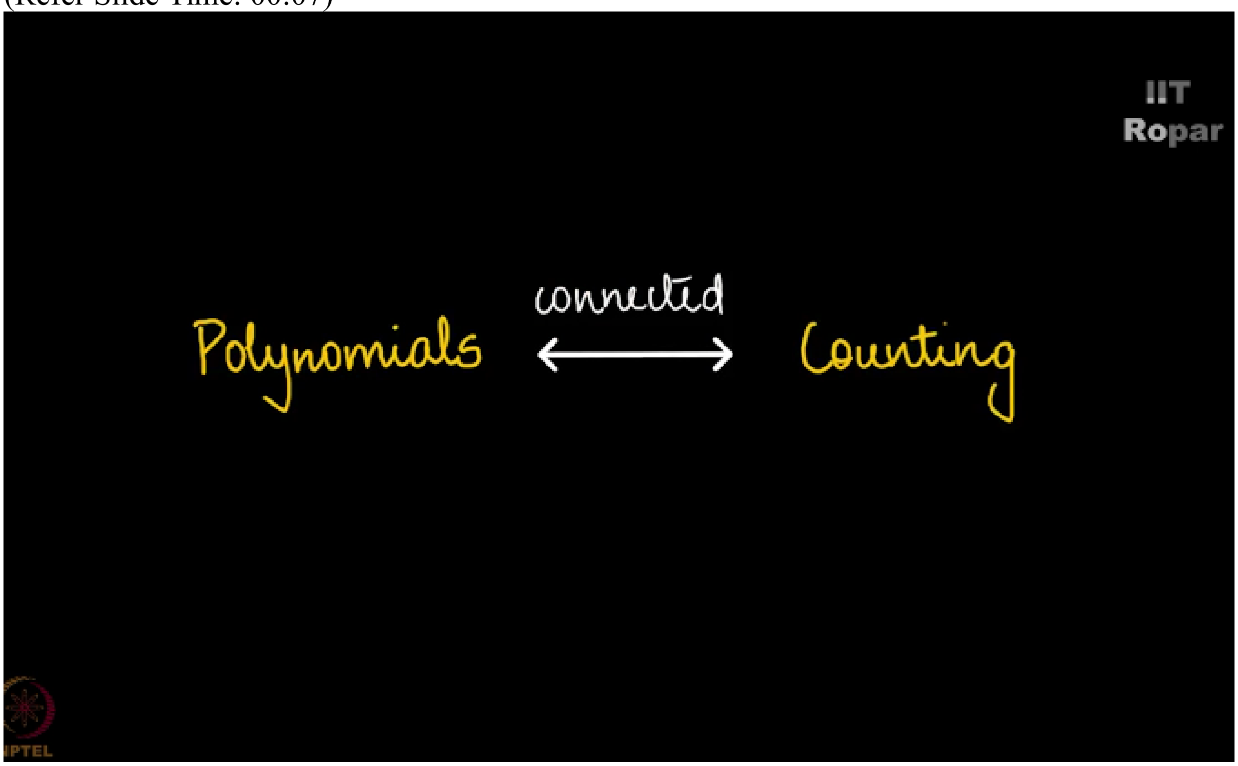

let me go ahead and tell you some of the popular definitions related to polynomials, look at this 1 + X + X square + X cube + X to the 4 up to infinity, this is not a polynomial actually, but this looks like a polynomial,
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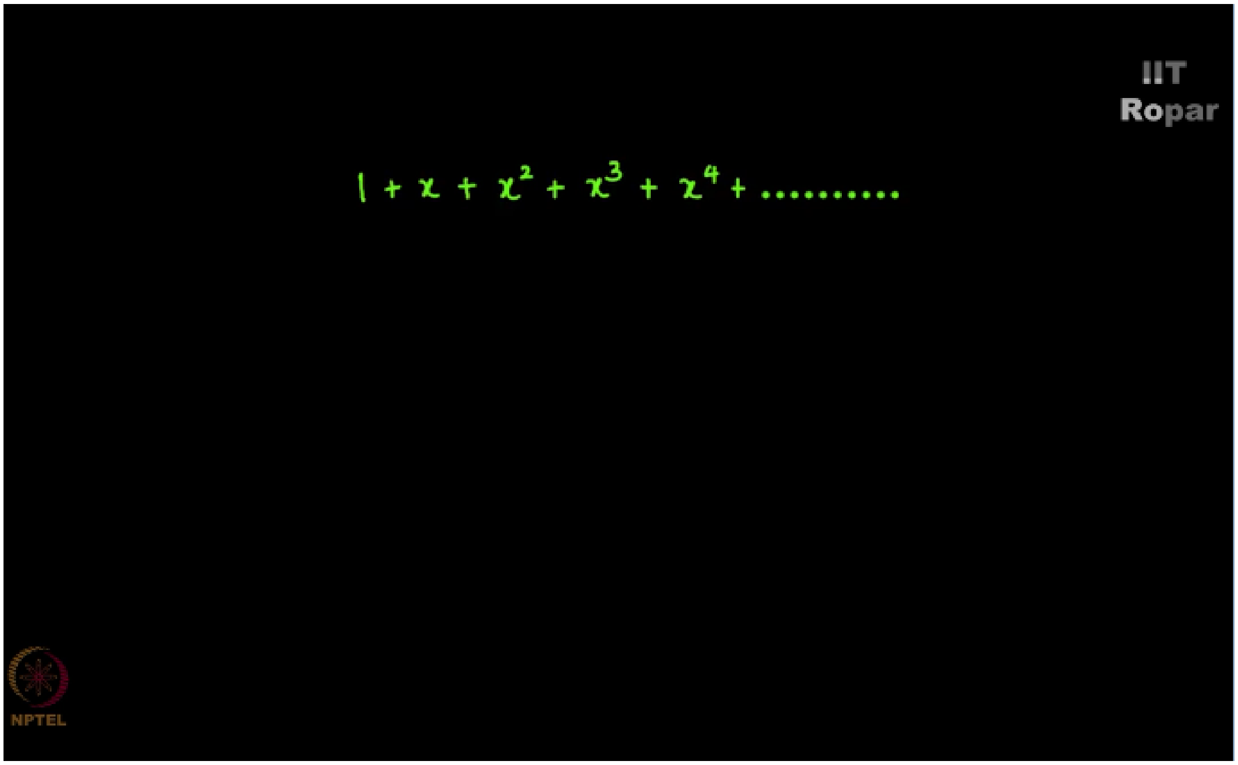

if its stops at a finite stage, finite position it's called a polynomial, right, a polynomial basically is the form A naught + A1X + A2X square so on up to AN X to the N, and degree polynomial,

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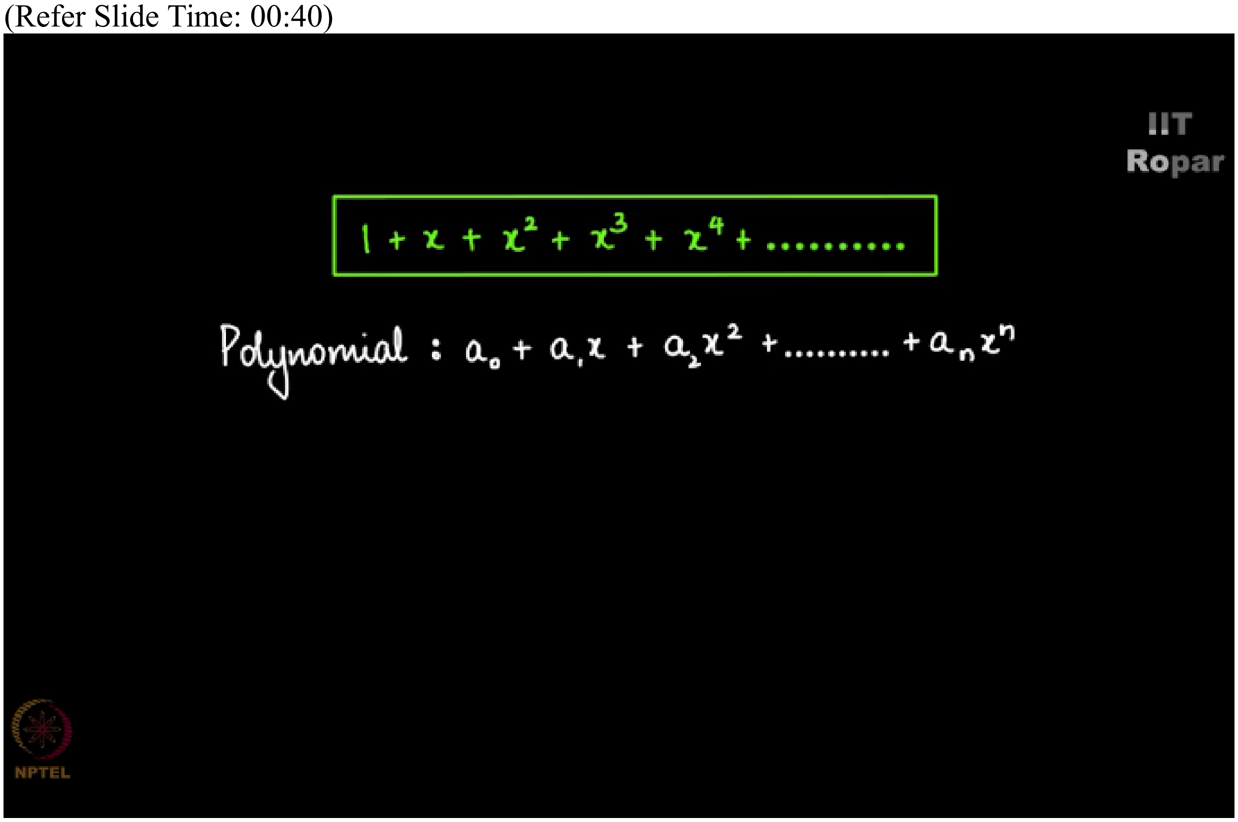

right, but this stuff whatever I'm showing you right now is going up to infinity, I'm sure you all know that this is actually 1 over 1 – X,

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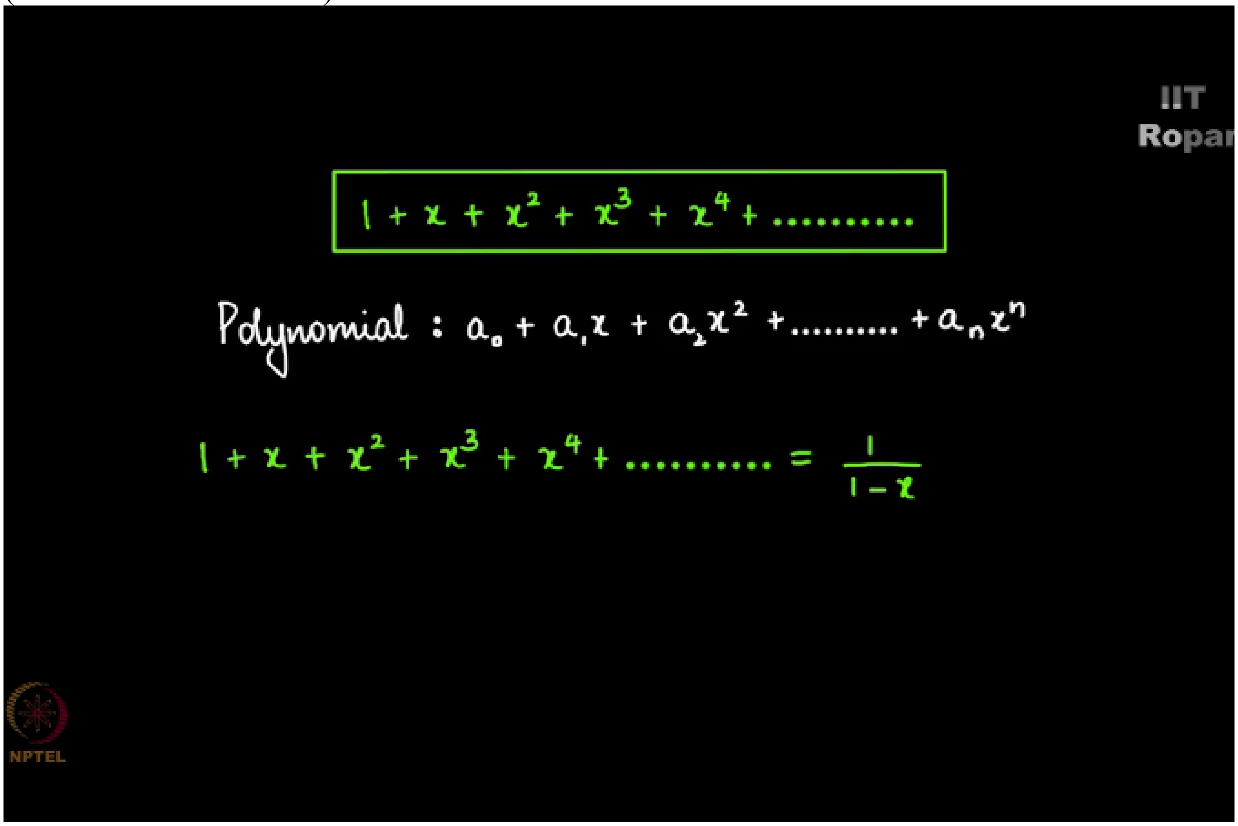

so called the infinite geometric series, and this is true only when mode X is less than 1, not otherwise if X is even equal to 1 as you can see there is a 0 in the denominator and this infinite series becomes 1 + 1 + 1 and goes to infinity,

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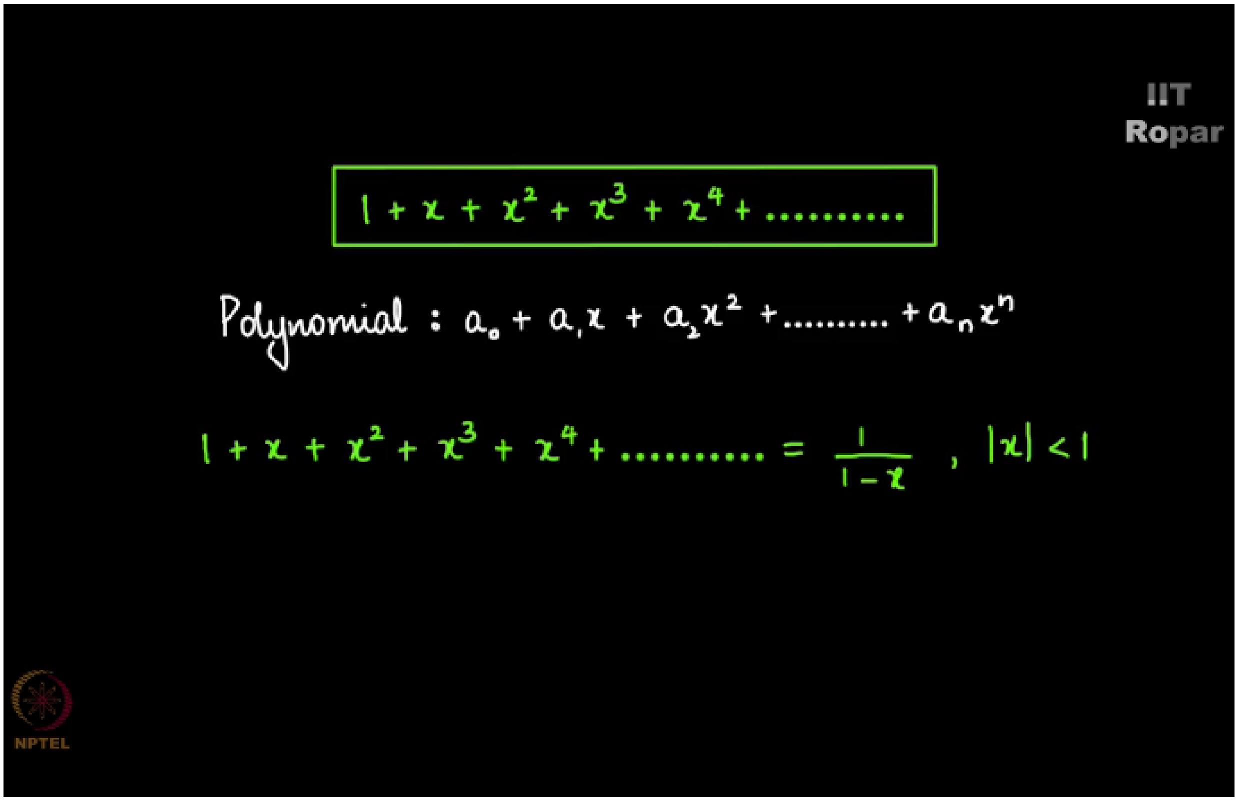

let me not bother you with all those things, all that you got to know is 1 over 1 – X is equal to 1 + X + X square up to infinity.

So let me now differentiate both the sides, I then get derivative of 1 over 1 – X, some simple calculus tells me it is 1 over 1 – X the whole square,
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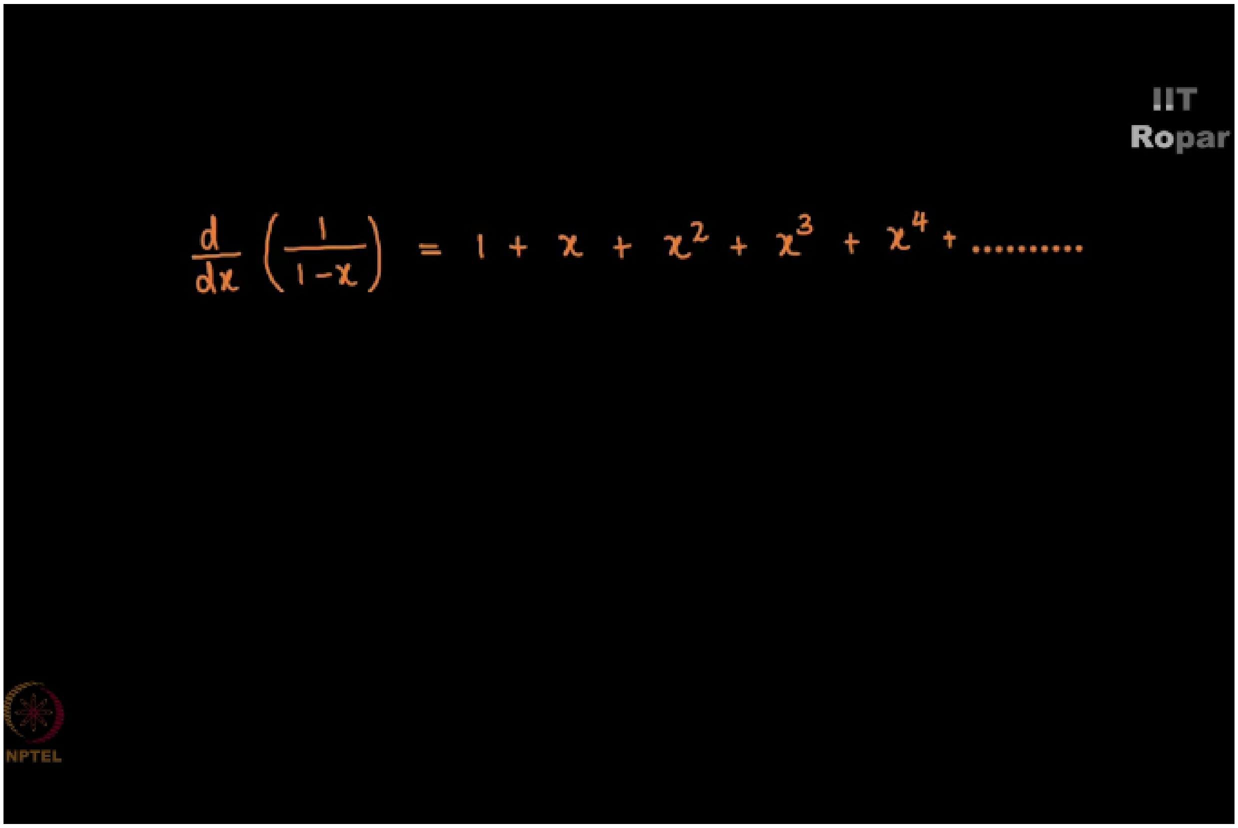

but then derivative of 1 happens to be 0, derivative of X will be 1, X square will be 2X, X cube will be 3X square, and so on, you see look at the coefficients of this particular thing 1 + X + X square it was 1, 1, 1, 1, 1, 1, 1,

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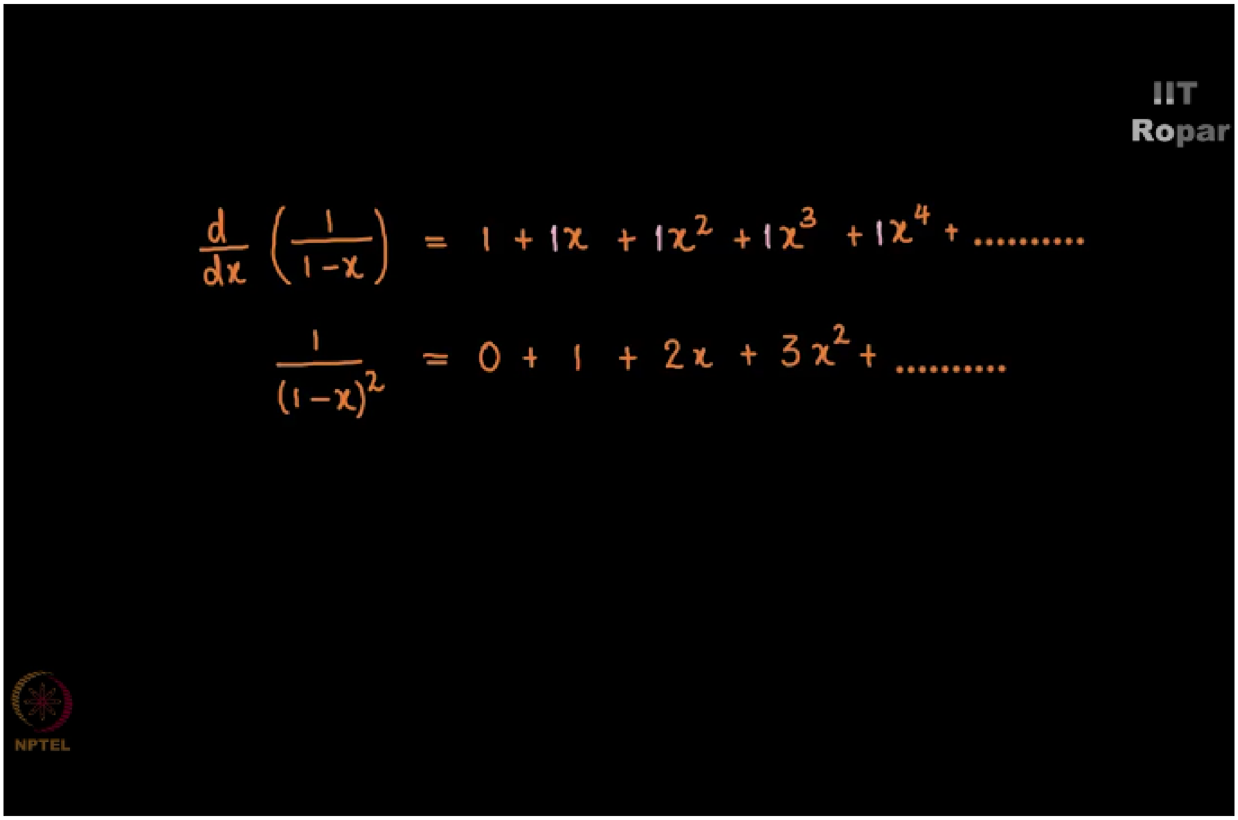

so the language we use is 1 over 1 – X generates, what we say, generates 1, 1, 1, 1, 1, okay, 1 over 1 – X the whole square generates 1, 2, 3, 4, and so on, correct, so this is called a generating function of this infinite sequence, 1, 2, 3, 4, etcetera.

Now can you people think and tell me what would be the generating function which generates 1 square, 2 square, 3 square, 4 square and so on?

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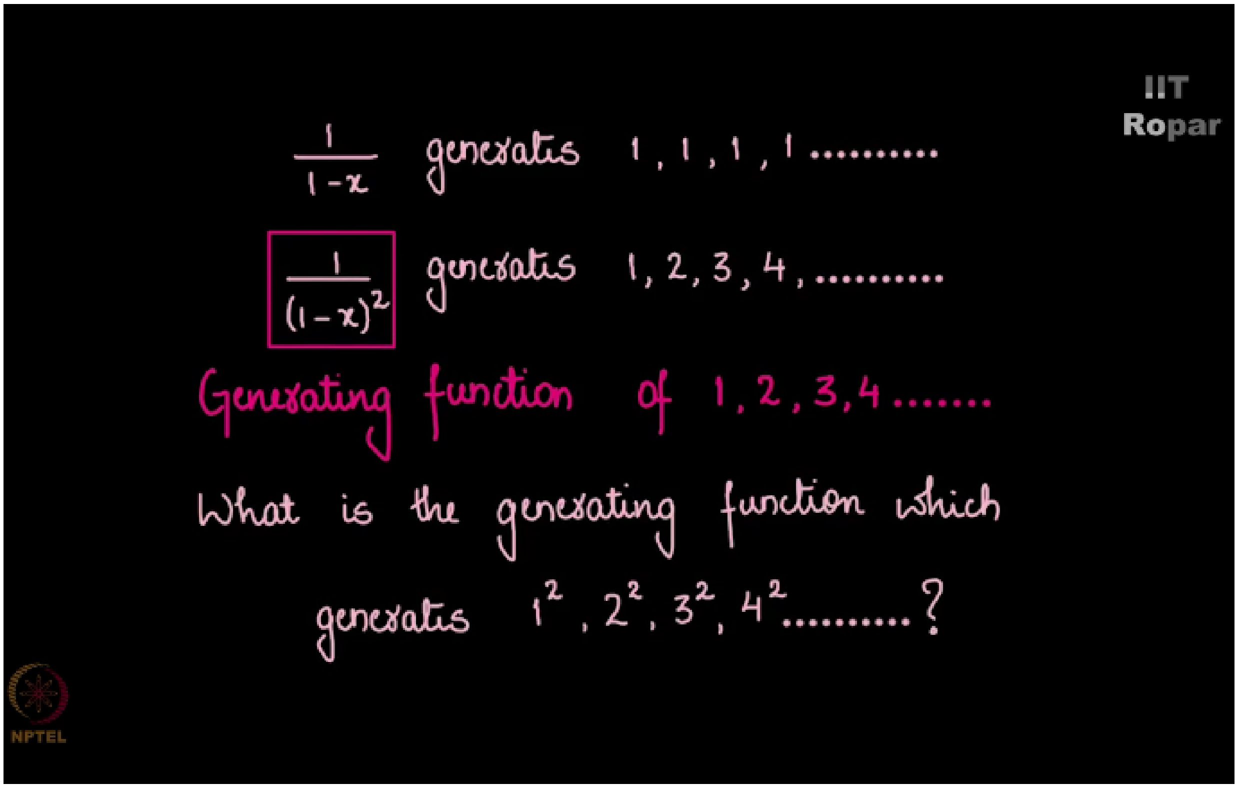
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$\frac{1}{1-x}$ generates 1, 1, 1, 1 ....
$\frac{1}{(1-x)^2}$ generates 1, 2, 3, 4, ...
Generating function of 1, 2, 3, 4 ....
What is the generating function which
generates $1^2, 2^2, 3^2, 4^2$.......... ?
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