3. Critical points of 3x3 system
Computation of critical points

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Our system modeling three species competing for the same resources

$$\begin{aligned}\dot{x} &= x - x^2 - axy - bxz = x(1 - x - ay - bz)\\ \dot{y} &= y - y^2 - bxy - ayz = y(1 - y - bx - az)\\ \dot{z} &= z - z^2 - axz - byz = z(1 - z - ax - by)\end{aligned}$$

has $2^3 = 8$ critical points. Seven of these critical points are

Equation(s) satisfied	**Critical point(s)**
$x = y = z = 0$	$\begin{pmatrix}0\\0\\0\end{pmatrix}$
$y = z = 0, \quad x = 1$	$\begin{pmatrix}1\\0\\0\end{pmatrix}$
$x = z = 0, \quad y = 1$	$\begin{pmatrix}0\\1\\0\end{pmatrix}$
$x = y = 0, \quad z = 1$	$\begin{pmatrix}0\\0\\1\end{pmatrix}$
$z = 0, \quad \begin{cases}1 - x - ay = 0\\1 - y - bx = 0\end{cases}, \quad ab \neq 1$	$\frac{1}{1-ab}\begin{pmatrix}1-a\\1-b\\0\end{pmatrix}$
$y = 0, \quad \begin{cases}1 - x - bz = 0\\1 - z - ax = 0\end{cases}, \quad ab \neq 1$	$\frac{1}{1-ab}\begin{pmatrix}1-b\\0\\1-a\end{pmatrix}$
$z = 0, \quad \begin{cases}1 - y - az = 0\\1 - z - by = 0\end{cases}, \quad ab \neq 1$	$\frac{1}{1-ab}\begin{pmatrix}0\\1-a\\1-b\end{pmatrix}$

$x, y, z \neq 0$	(Find as an exercise.)

Identify the critical point

3 points possible (graded, results hidden)
Identify the last critical point at which all populations are positive and $b > a > 0$.

(This can be done by hand or using MATLAB or other software. If using MATLAB, you may find it helpful to use symbolic math toolbox. For example, to create positive, real number symbols a and b using the MATLAB commands `a = sym('a','positive');` and `b = sym('b','positive');` . See more information in the two MATLAB videos below.)

$x =$ 1/(a + b + 1)

$\frac{1}{a+b+1}$

$y =$ 1/(a + b + 1)

$\frac{1}{a+b+1}$

$z =$ 1/(a + b + 1)

$\frac{1}{a+b+1}$

FORMULA INPUT HELP

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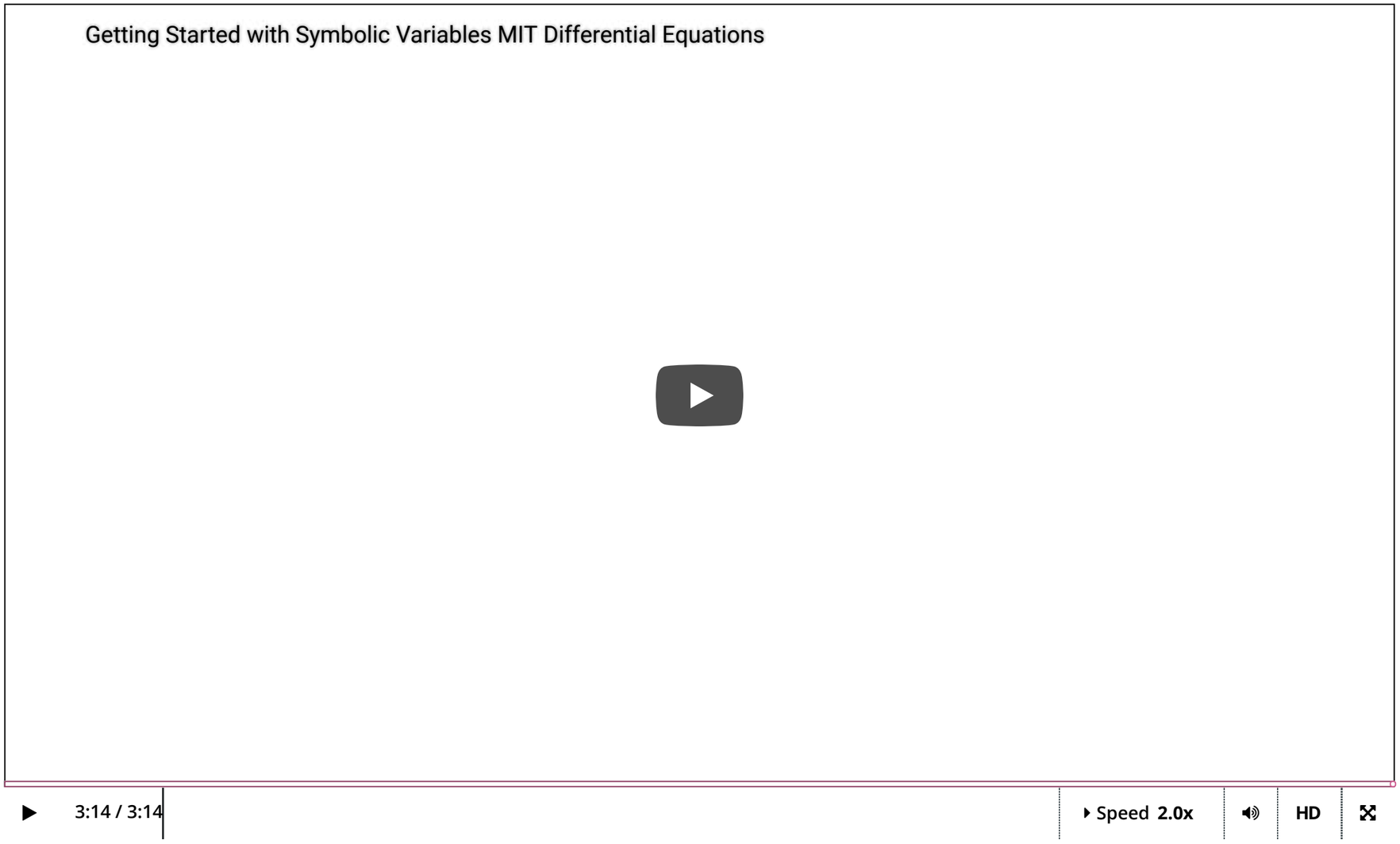
Answer submitted.

Getting started with symbolic variables in MATLAB



Working with symbolic expressions and functions in MATLAB

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