

CALCULATION OF VIRUS SPREAD MODEL BY SOLVING THE THREE COUPLED ODES

The US Population =====	$M := 10^6$ $Nus := 330 \cdot M$
The virus Removal Parameter (Recovery or Death) days ⁻¹ =	$\gamma := \frac{1}{14}$
The Basic Reproduction Number =====	$R_0 := 4.7$
The Interaction Parameter [days ⁻¹] =====	$\beta := R_0 \cdot \gamma$ $\beta = 0.336$
The initial number of infected persons =====	$i_0 := 1$
Steps in the Odesolve solution process =====	$n := 500$
Number of days in the calculation =====	$T := 360$

$$S_0 := Nus$$

Use the Odesolve solve block to solve the three coupled ODEs:

Guess Values: $N := Nus + i_0 + R_0$ $s_0 := Nus$ $i_0 := 1$ $r_0 := 0$

Given

$$\frac{d}{dt} S(t) = \frac{-\beta \cdot I(t) \cdot S(t)}{N} \qquad S(0) = s_0$$

$$\frac{d}{dt} I(t) = \frac{\beta \cdot I(t) \cdot S(t)}{N} - \gamma \cdot I(t) \qquad I(0) = i_0$$

$$\frac{d}{dt} R(t) = \gamma \cdot I(t) \qquad R(0) = r_0$$

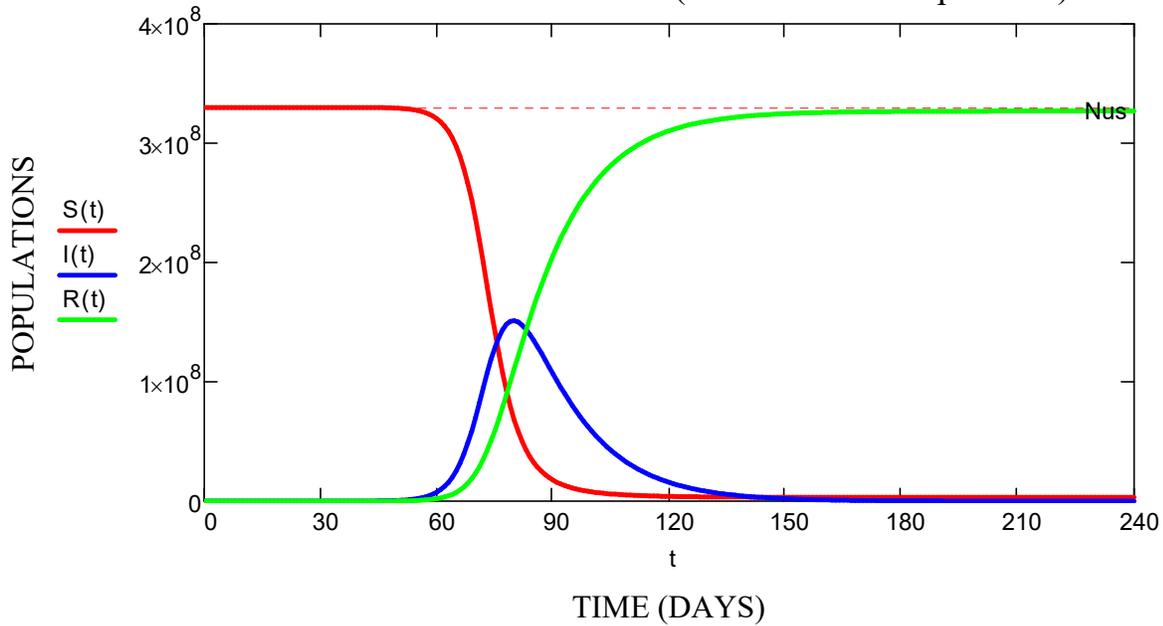
$$SIR(s_0, i_0, r_0, R_0, \gamma, T) := \text{Odesolve} \left[\begin{pmatrix} S \\ I \\ R \end{pmatrix}, t, T \right]$$

$$\begin{pmatrix} S \\ I \\ R \end{pmatrix} := \text{Odesolve} \left[\begin{pmatrix} S \\ I \\ R \end{pmatrix}, t, T, n \right]$$

t := 0, 1 .. 240

$$\begin{pmatrix} S \\ I \\ R \end{pmatrix} := \text{SIR}(\text{Nus}, I_0, 0, R_0, \gamma, 960)$$

VIRUS SPREAD MODEL (For Nus = US Population)



- Susceptible
- Infected
- Removed

$$I_{\text{total}}(t) := I(t) + R(t)$$

$$I_{\text{total}}(240) = 327 \cdot M$$

$$\frac{I_{\text{total}}(240)}{\text{Nus}} = 0.99$$

$$I_{\text{total}}(39) = 38034$$

$$R_{20} := 1.5 \quad \beta := R_{20} \cdot \gamma \quad \beta = 0.107$$

$$\begin{pmatrix} S2 \\ I2 \\ R2 \end{pmatrix} := \text{SIR}(S(39), I(39), R(39), R_{20}, \gamma, 960 - 36)$$

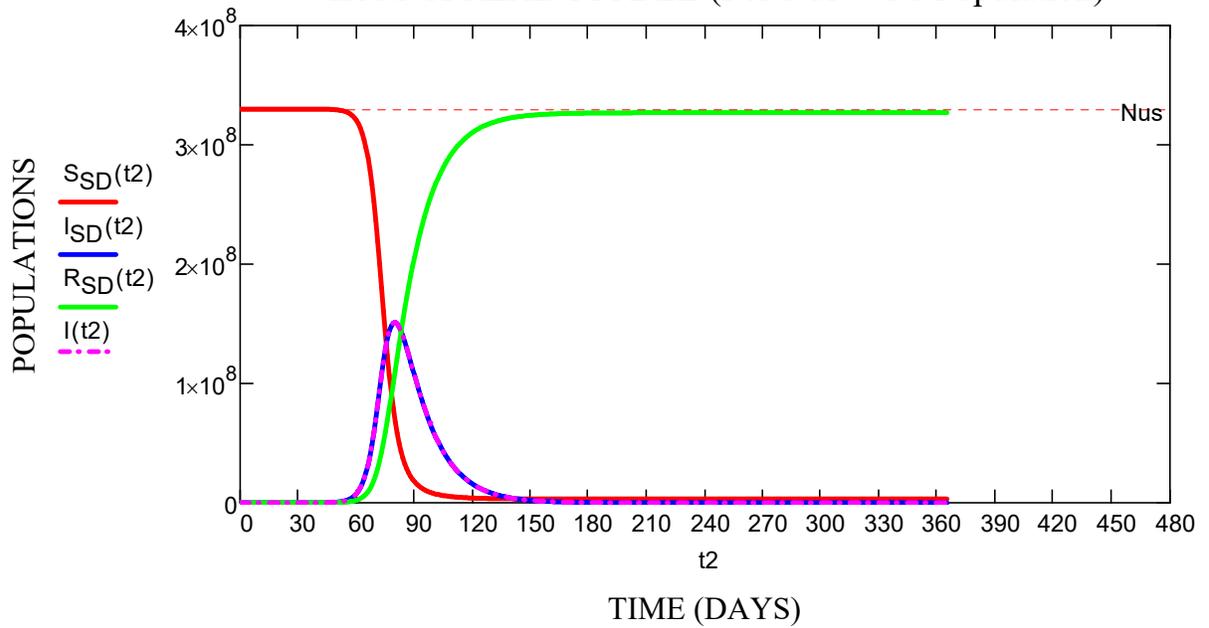
t2 := 0, 1 .. 365

$$S_{SD}(t) := S(\min(t, 39)) + \Phi(t - 39) \cdot (S2(\max(0, t - 39)) - S(39))$$

$$I_{SD}(t) := I(\min(t, 39)) + \Phi(t - 39) \cdot (I2(\max(0, t - 39)) - I(39))$$

$$R_{SD}(t) := R(\min(t, 39)) + \Phi(t - 39) \cdot (R2(\max(0, t - 39)) - R(39))$$

VIRUS SPREAD MODEL (For Nus = US Population)



- Susceptible
- Infected
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