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Article

An Approximate Numerical Methods for Mathematical and Physical Studies for Covid-19 Models

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Abstract: The advancement in numerical models of serious resistant illnesses is a key research territory in different fields including the nature and the study of disease transmission. One of the aims of these models is to comprehend the elements of conduction of these infections. For the new strain of Covid-19 (Coronavirus), there has been no immunization to protect individuals from the virus and to forestall its spread so far. All things being equal, control procedures related to medical services, for example, social distancing or separation, isolation, and travel limitations can be adjusted to control this pandemic. This article reveals some insights into the dynamic practices of nonlinear Coronavirus models dependent on the homotopy annoyance strategy (HPM). We summon a novel sign stream chart that is utilized to depict the Coronavirus model. Through the numerical investigations, it is uncovered that social separation of the possibly tainted people who might be conveying the infection and the healthy virus-free people can diminish or interrupt the spread of the infection. The mathematical simulation results are highly concurrent with the statistical forecasts. The free balance and dependability focus for the Coronavirus model is discussed and the presence of a consistently steady arrangement is demonstrated.

Keywords: Covid-19 model; optimal control; existence of uniformly stable; signal stream chart; homotopy perturbation technique

1 Introduction

Over the most recent couple of years, various numerical models have been created to give smart subtleties into numerous issues of interest including the transmission and control of irresistible illnesses [1–3]. The description of the ongoing pandemic of Coronavirus, as viral pneumonia in late 2019 in Wuhan-China which has spread worldwide across 210 countries is "SARS-CoV-2" [4–6]. It is seething around the world with a tremendous cost as far as human, financial, and social effects [7–9]. Within a limited ability to focus, this brings a caution up in each country everywhere in the world like a pandemic sickness, which encourages every country to estimate the beneficiary preparatory activities to control and contain the wild spread of the infection as the seriousness of the illness will hurt human existence severely [10–12]. Since the novel Covid is new to the world to figure some effect of the pandemic circumstance and to fabricate an alleviation plan, the similitude impacts of Severe Acute Respiratory Syndrome (SARS) and (Center East Respiratory Condition) scourges in 2003 and 2009 were utilized for study and investigation [13–15]. From the investigation of the underlying spread of Coronavirus, a considerable lot of numerical models were utilized in the demonstration from benefactors across the world to decide the seriousness of the spread [16–18]. At whatever point an infectious sickness expands its feeder, it follows certain examples of spread, which broadly assist us with distinguishing and screening the elements of the illness flare-ups [19–21]. The strategy we used to appraise the spread of the sickness is a factor that drives us to finish the actions to dispose of irresistible infections [22–24]. The episode of the infection inside the country or state for time is normally nonlinear, which moves us to plan the framework where we can contemplate those dynamic nonlinear wonders [25–27]. By this framework, we can be ready to characterize the transmission of such a viral infection, which assists us to interpret the medicinal measures to stop or contain the spread of this infectious illness [28–30].

Recently, the quantity of passings throughout the planet has expanded significantly because of the spread of the new infection known as Covid-19 (Coronavirus). The quick heightening of cases in practically all nations has created a genuine test for the whole world particularly when the World Health Organization proclaimed that this infection has turned into a pandemic since its outbreak and quickly spread from China to the rest of the world. Most nations throughout the whole planet have implemented the recommended protocols to contain the development of the virus and to limit the spread of its conceivably lethal infection in all countries. Regardless of the adverse consequences on local economies and financial well-being, limiting the virus development is viewed as quite possibly the best approach to slow the infection transmission both locally and across the world. The number of infected cases globally has increased reaching 29 million so far. Consequently, the spread of Covid-19 is perceived as being quite possibly the worst disease outbreak over the last forty years. At this stage, there is no antibody against Covid-19 and most people have not yet acquired the resistance that can protect them against such a disease. As such, it is vital to address the current conditions of Covid-19 in order to forestall the disease and to take the necessary steps to contain any additional spread of its infection. In view of the reports of immunologists and clinical experts, the virus mainly spreads through respiratory droplets when an infected person coughs, sneezes, or speaks in close proximity to healthy people. Accordingly, scientists have been strongly advocating social separation between possibly contaminated people and healthy individuals to mitigate or reduce the transmission rate among local communities across countries. The test of Coronavirus is presently attracting specialists from medicine and atomic science to apply math in numerical displaying that can assume a huge part in anticipating, evaluating, and controlling the likely situations. For more extra solving the modelling mathematics [31–50].

Avoidance of Coronavirus, other than the significance of forcing general wellbeing and contamination control measures to forestall or diminish the transmission of SARS-CoV-2, the way to containing this worldwide pandemic is by inoculation to forestall SARS-CoV-2 disease in masses across the world. Exceptional endeavors in worldwide examination during this pandemic have brought about the advancement of novel immunizations against SARS-CoV-2 at a phenomenal speed to contain this viral ailment that has crushed nations worldwide and has had a descending spiraling impact on the worldwide economy.

Inoculation triggers the insusceptible framework prompting the creation of killing antibodies against SARS-CoV-2. Consequences of a progressing global, fake treatment controlled, eyewitness, dazed, urgent adequacy preliminary announced that people 16 years old or more established getting two-portion routine the preliminary immunization BNT162b2 (mRNA-based, BioNTech/Pfizer) when given 21 days separated presented 95% insurance against Coronavirus with a wellbeing profile like other viral vaccines. Results from another multicenter, Stage 3, randomized, spectator dazed, fake treatment controlled preliminary exhibited that people who were randomized to get two dosages of mRNA-1273 (mRNA based, Moderna) antibody given 28 days separated showed 94.1% viability at forestalling Coronavirus sickness, and no security concerns were noted other than mild fever and transient reactions. In light of the aftereffects of these antibody adequacy preliminaries, the FDA gave two EUAs, one on December 11, 2020, allowing the utilization of the BNT162b2 immunization, and another on December 18, 2020, conceding the utilization of the mRNA-1273 antibody for the avoidance of Coronavirus. A third immunization, Ad26. COV2.S for the avoidance of Coronavirus got EUA by the FDA on February 27, 2021, in light of a multicenter, fake treatment control, stage preliminary showed that a solitary portion of Ad26.COV2.S antibody presented 73% viability in the US in forestalling Coronavirus (information not yet distributed).

Therefore, the present study was undertaken to fill in this gap of knowledge.

$$\begin{aligned}
\dot{S} &= -u_1\left(\beta C - C_q(1-\beta)\right)\mathrm{S}(I+\theta A) + \lambda u_2 S_q,\\
\dot{E} &= \beta u_1(1-q)\mathrm{S}(I+\theta A) - \sigma E,\\
\dot{I} &= \sigma\rho E - (\delta_I + \alpha + \gamma_I)I,\\
\dot{A} &= \sigma(1-\rho)E - \gamma_A A,\\
\dot{S}_q &= u_1(1-\beta)C_q S(I+\theta A) - \lambda u_2 S_q,\\
\dot{E}_q &= u_1\beta C_q S(I+\theta A) - \delta_q E_q,\\
\dot{H} &= \delta_I I + \delta_q E_q - (\alpha + \gamma_H)H,\\
\dot{R} &= \gamma_I I + \gamma_A A + \gamma_H H.
\end{aligned} \tag{1}$$

Fig. 1, shows the sign stream chart $\vec{G}$ of the structure in which each vertex speaks with the case of the framework. There is an edge (v_1, v_2) if the state v_1 straightforwardly influences the state v_2.

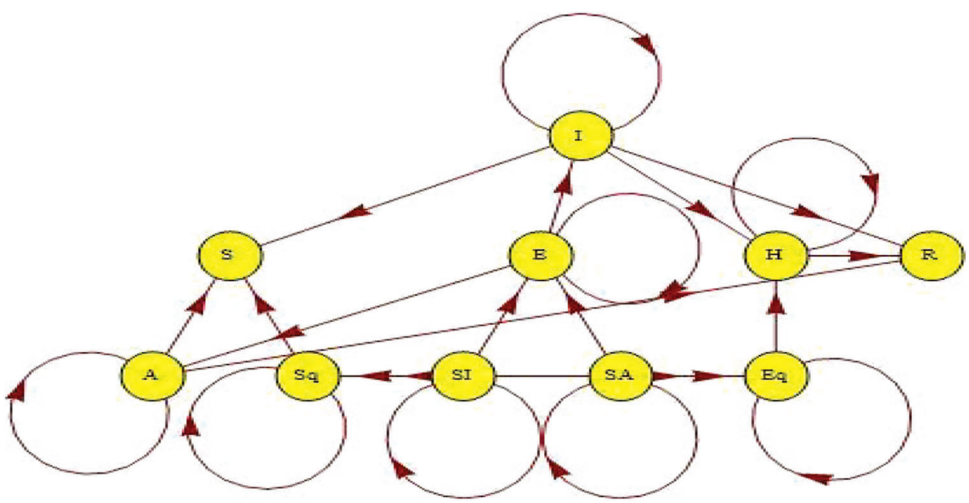

Figure 1: Suggestion signal stream chart of the model

Using a signal stream chart to act the dynamical systems is much profitable to view, for example [9,13].

A signal stream chart is a scheme agent that is used to display the interrelation among the system states and become possible to utilize scheme-theoretic stuff to find novel brow of the system.

2 Optimal Control for Covid-19 Modeling

Consider the state presented (1), in R^8, with control functions admissible [12,13]:

$$\Omega = \left\{(u_1(.), u_2(.)) \in \left(L^\infty\left(0, T_f\right)^2\right) | 0 \le u_1(.), u_2(.) \le 1, \quad \forall t \in \left[0, T_f\right]\right\},$$

where T_f is time final, $u_1(.)$ and $u_2(.)$ are functions controls.

Defined the functional objective is (quadratic is the control variable)

$$J_1(\zeta_1,\zeta_2) = \int_0^{T_f} \left[B_1 S_q + B_2 I + B_3 u_1^2 + B_4 u_2^2\right] dt, \tag{2}$$

Minimizes function objective at it [28–34]:

$$J_2(\zeta_1,\zeta_2) = \int_0^{T_f} \eta\left(S,E,I,A,S_q,E_q,H,R,\zeta_1,\zeta_2,t\right) dt, \tag{3}$$

where $\eta\left(S,E,I,A,S_q,E_q,H,R,\zeta_1,\zeta_2,t\right) = \left[B_1 S_q + B_2 I + B_3 u_1^2 + B_4 u_2^2\right]$ subjected to the constraint

$$DS = b_1, DE = b_2, DI = b_3, DA = b_4, DS_q = b_5, DE_q = b_6, DH = b_7, DR = b_8. \tag{4}$$

The following initial conditions are satisfied:

$$S = S_0, \quad E = E_0, \quad I = I_0, \quad A = A_0, \quad S_q = S_{q0}, H(0) = H_0, R(0) = R_0. \tag{5}$$

OCP is defined, consider the a modified objective function:

$$\bar{\phi} = \int_0^{T_f} \left[\chi - \sum_{j=1}^{8} \lambda_j w_j\right] dt, \tag{6}$$

where the objective function of Hamiltonian (6) as follows:

$$\chi = \eta + \sum_{j=1}^{8} \lambda_j w_j, \tag{7}$$

$$\begin{aligned} \chi = &B_1 S_q + B_2 I + B_3 u_1^2 + +B_4 u_2^2 + +B_5 RC + \lambda_1\left(-u_1\left(\beta C - C_q(1-\beta)\right)\mathrm{S}(I+\theta A) + \lambda u_2 S_q\right) \\ &+\lambda_2(\beta u_1(1-q)\mathrm{S}(I+\theta A) - \sigma E) + \lambda_3(\sigma\rho E - (\delta_I + \alpha + \gamma_I)I) + \lambda_4(\sigma(1-\rho)E - \gamma_A A) \\ &+\lambda_5\left(u_1(1-\beta)C_q S(I+\theta A) - \lambda u_2 S_q\right) + \lambda_6\left(u_1\beta C_q S(I+\theta A) - \delta_q E_q\right) \\ &+\lambda_7\left(\delta_I I + \delta_q E_q - (\alpha + \gamma_H)H\right) + \lambda_8(\gamma_I I + \gamma_A A + \gamma_H H). \end{aligned} \tag{8}$$

Applying Pontryagin's maximum principal, from (6) and (8), conditions necessary and sufficient OPC is

$$\begin{aligned} &D\lambda_1 = \frac{\partial\chi}{\partial S}, \quad D\lambda_2 = \frac{\partial\chi}{\partial E}, \quad D\lambda_3 = \frac{\partial\chi}{\partial I}, \quad D\lambda_4 = \frac{\partial\chi}{\partial A}, \quad D\lambda_5 = \frac{\partial\chi}{\partial S_q}, \\ &D\lambda_6 = \frac{\partial\chi}{\partial E_q}, \quad D\lambda_7 = \frac{\partial\chi}{\partial H}, \quad D\lambda_8 = \frac{\partial\chi}{\partial R}. \end{aligned} \tag{9}$$

$$0 = \frac{\partial\chi}{\partial\xi_1}, 0 = \frac{\partial\chi}{\partial\xi_2}. \tag{10}$$

$$\begin{aligned} &DS = \frac{\partial\chi}{\partial\lambda_1}, \quad DE = \frac{\partial\chi}{\partial\lambda_2}, \quad DI = \frac{\partial\chi}{\partial\lambda_3}, \quad DA = \frac{\partial\chi}{\partial\lambda_4}, \quad DS_q = \frac{\partial\chi}{\partial\lambda_5}, \\ &DE_q = \frac{\partial\chi}{\partial\lambda_6}, \ DH = \frac{\partial\chi}{\partial\lambda_7}, \ DR = \frac{\partial\chi}{\partial\lambda_8} \end{aligned} \tag{11}$$

$$\lambda_{\mathrm{j}}, \left(\mathrm{T_j}\right) = 0, \quad \mathrm{j} = 1, \ldots, 8. \tag{12}$$

where λ_j are multipliers Lagrange. Eqs. (10), (11) exemplify the conditions necessary of Hamiltonian for the OPC.

We construct the theorem at similar [12,13,30,31]:

Theorem 1.

If u_1 and u_2 are controls optimal with state corresponding variables, consequently they work out adjoint variables λ_j^*, $j = 1, \ldots, 8$, accepts:

(i) Co-state equation

$$
\begin{aligned}
D\lambda_1 &= \lambda_1^*\left(-u_1\left(\beta C + C_q(1-\beta)\right)\mathrm{S}(I+\theta A)\right) + \lambda_2^*(\beta u_1(1-q)\mathrm{S}(I+\theta A)) + \lambda_5^*\left(u_1(1-\beta)C_qS(I+\theta A)\right)\\
&\quad + \lambda_6^*\left(u_1\beta C_q S(I+\theta A)\right),\\
D\lambda_2 &= \lambda_2^*(-\delta) + \lambda_3^*(\delta\rho) + \lambda_4^*(\delta(1-\rho)),\\
D\lambda_3 &= B_2 + \lambda_1^*\left(-u_1\left(\beta C + C_q(1-\beta)\right)\mathrm{S}\right) + \lambda_2^*(\beta u_1(1-q)\mathrm{S}) + \lambda_3^*(-(\delta_I + \alpha + \gamma_I))\\
&\quad + \lambda_5^*\left(u_1(1-\beta)C_qS\right) + \lambda_6^*\left(u_1\beta C_qS\right) + \lambda_7^*(\delta_I) + \lambda_8^*(\gamma_I),\\
D\lambda_4 &= \lambda_1^*\left(-u_1\left(\beta C + C_q(1-\beta)\right)\mathrm{S}\theta\right) + \lambda_2^*(\beta u_1(1-q)\mathrm{S}\theta) + \lambda_4^*(-\gamma_A)\\
&\quad + \lambda_5^*\left(u_1(1-\beta)C_qS\theta\right) + \lambda_6^*\left(u_1\beta C_qS\theta\right) + \lambda_8^*(\gamma_A),\\
D\lambda_5 &= B_1 + \lambda_1^*(-u_2\lambda) + \lambda_2^*(-\lambda u_2),\\
D\lambda_6 &= \lambda_7^*\left(\delta_q\right) + \lambda_6^*\left(-\delta_q\right),\\
D\lambda_7 &= \lambda_7^*(-(\alpha + \gamma_H)) + \lambda_8^*(\gamma_H),\\
D\lambda_8 &= B_5.
\end{aligned}
\tag{13}
$$

(ii) With condition transversality:

$$\lambda_j^*(\mathrm{T_f}) = 0. \tag{14}$$

(iii) Optimality conditions

$$\chi = \min_{0 \le u_V^*, u_R^* \le 1} \chi, \tag{15}$$

So, the functions control u_1^*, u_2^* .

For a lot of optimal control and model differentials, equations for solving models see [1,29].

3 Existence of Uniformly Stable Solution

This subsection explores the existence of uniformly stable solution. Let us define

$$
\begin{aligned}
g_1 &= -u_1\left(\beta C - C_q(1-\beta)\right)\mathrm{S}(I+\theta A) + \lambda u_2 S_q,\\
g_2 &= \beta u_1(1-q)\mathrm{S}(I+\theta A) - \sigma E,\\
g_3 &= \sigma\rho E - (\delta_I + \alpha + \gamma_I)I,\\
g_4 &= \sigma(1-\rho)E - \gamma_A A,\\
g_5 &= u_1(1-\beta)C_qS(I+\theta A) - \lambda u_2 S_q\\
g_6 &= u_1\beta C_q S(I+\theta A) - \delta_q E_q\\
g_7 &= \delta_I I + \delta_q E_q - (\alpha + \gamma_H)H\\
g_8 &= \gamma_I I + \gamma_A A + \gamma_H H.
\end{aligned}
\tag{16}
$$

Let $\Delta = \left\{S, E, I, A, S_q, E_q, H, R \in \Re : \left|S, E, I, A, S_q, E_q, H, R\right| \le c,\ t \in [0, T]\right\}$.

This means such all of the 8 functions f_1, f_2 $\frac{\partial g}{\partial S}$, $\frac{\partial g}{\partial E}$, $\frac{\partial g}{\partial I}$, $\frac{\partial g}{\partial A}$, $\frac{\partial g}{\partial S_q}$, $\frac{\partial g}{\partial E_q}$, $\frac{\partial g}{\partial H}$, and $\frac{\partial g}{\partial R}$ coincide with the Lipschitz z case with regard to the 8 arguments, thereafter all of the 8 functions f_1, f_2 have absolutely continuous with regard to the 8 arguments [12,13]. For extra of fractional models [32–50].

4 Invariance and Symmetry of the Proposed Model

For system (1), the transformation

$\left(S, E, I, A, S_q, E_q, H, R\right) \rightarrow \left(S, -E, -I, -A, -S_q, -E_q, -H, -R\right)$ implies that the system is invariant.

Then if $\left(S, E, I, A, S_q, E_q, H, R\right)$ is a solution of model (1), then $\left(S, -E, -I, -A, -S_q, -E_q, -H, -R\right)$ is a solution of the same model too.

Also, we proved the divergence of the proposed paradigm (1) as follows

$$\nabla.Z = \frac{\partial \dot{S}}{\partial S} + \frac{\partial \dot{E}}{\partial E} + \frac{\partial \dot{I}}{\partial I} + \frac{\partial \dot{A}}{\partial A} + \frac{\partial \dot{S_q}}{\partial S_q} + \frac{\partial \dot{E_q}}{\partial E_q} + \frac{\partial \dot{H}}{\partial H} + \frac{\partial \dot{R}}{\partial R}$$
$$= -\left(\beta C - C_q(1-\beta)\right)\mathrm{S}(I+\theta A) - \sigma - (\delta_I + \alpha + \gamma_I) - \gamma_A - \lambda - S_q - (\alpha + \gamma_H).$$

Then proposed model paradigm (1) is dissipative such as

$$\nabla.Z = -\left(\beta C - C_q(1-\beta)\right)\mathrm{S}(I+\theta A) - \sigma - (\delta_I + \alpha + \gamma_I) - \gamma_A - \lambda - S_q - (\alpha + \gamma_H) < 0.$$

5 HPM Approximates the Solution for Nonlinear COVID-19 Model

Here, we present the scientific approximate solution to the COVID-19 (1). By utilizing MHPM procedure [22,23], we develop a homotopy $\mathrm{H}_i(\mathrm{t}, \mathrm{p}) : \mathcal{R}^+ \times [0, 1] \rightarrow \mathcal{R}^+$, which satisfies:

$$H_1 = S'(t) + p\left[(\beta c + cq(1-\beta))S(t)(I(t) + \theta A(t)) - \lambda S_q(t)\right] = 0, \tag{17}$$

$$H_2 = E'(t) + \sigma E(t)] - p[\beta c(1-q)S(t)(I(t) + \theta A(t))] = 0, \tag{18}$$

$$H_3 = I'(t) + (\delta_i + \alpha + \gamma_i)I(t) - p\sigma\rho E(t) = 0, \tag{19}$$

$$H_4 = A'(t) + \gamma_A A(t) - p\sigma(1-\rho)E(t) = 0, \tag{20}$$

$$H_5 = S_{q'}(t) + \lambda S_q(t) - p(1-\beta)cqS(t)(I(t) + \theta A(t)) = 0, \tag{21}$$

$$H_6 = E_{q'}(t) + \delta_q E_q(t) - p\beta cqS(t)(I[t] + \theta A(t)) = 0, \tag{22}$$

$$H_7 = H'(t) + (\alpha + \gamma_H)H(t) - p(\delta_I I(t) + \delta_q E_q(t) = 0, \tag{23}$$

$$H_8 = R'(t) - p(\gamma_i I(t) + \gamma_A A(t) + \gamma_H H(t)) = 0. \tag{24}$$

As per the HPM method, we guess the arrangements of conditions (17) and (24) as a force arrangement in p, where p the installing little boundary:

$$S(t) = S_0(t) + pS_1(t) + p^2 S_2(t) + p^3 S_3(t) + \ldots \tag{25}$$

$$E(t) = E_0(t) + pE_1(t) + p^2 E_2(t) + p^3 E_3(t) + \ldots \tag{26}$$

$$I(t) = I_0(t) + pI_1(t) + p^2 I_2(t) + p^3 I_3(t) + \ldots \tag{27}$$

$$A(t) = A_0(t) + pA_1(t) + p^2A_2(t) + p^3A_3(t) + \dots \tag{28}$$

$$S_q(t) = S_{q0}(t) + pS_{q1}(t) + p^2S_{q2}(t) + p^3S_{q3}(t) + \dots \tag{29}$$

$$E_q(t) = E_{q0}(t) + pE_{q1}(t) + p^2E_{q2}(t) + p^3E_{q3}(t) + \dots \tag{30}$$

$$H(t) = h_0(t) + ph_1(t) + p^2h_2(t) + p^3h_3(t) + \dots \tag{31}$$

$$R(t) = R_0(t) + pR_1(t) + p^2R_2(t) + p^3R_3(t) + \dots \tag{32}$$

Inserting Eqs. (25)–(32) into Eqs. (17)–(24) and setting the coefficient of p to be zero, we deduce the following system of ODE's as follows:

$$\mathrm{S0}'(t) = 0, \tag{33}$$

$$-\lambda \mathrm{S}_{q0}(t) + cq\theta \mathrm{A0}(t)\mathrm{S0}(t) + c\beta\theta \mathrm{A0}(t)\mathrm{S0}(t) - cq\beta\theta \mathrm{A0}(t)\mathrm{S0}(t) + cqI_0(t)\mathrm{S}_0(t)$$
$$+ c\beta I_0(t)\mathrm{S}_0(t)] - cq\beta I_0(t)\mathrm{S}_0(t)] + \mathrm{S}_{1'}(t) = 0, \tag{34}$$

$$-\lambda \mathrm{S}_{q1}(t) + cq\theta \mathrm{A}_1(t)\mathrm{S}_0(t) + c\beta\theta \mathrm{A}_1(t)\mathrm{S}_0(t) - cq\beta\theta \mathrm{A}_1(t)\mathrm{S}_0(t) + cq\mathrm{I}_1(t)\mathrm{S}_0(t)$$
$$+c\beta \mathrm{I}_1(t)\mathrm{S}_0(t) - cq\beta \mathrm{I}_1(t)\mathrm{S}_0(t) + cq\theta \mathrm{A}_0(t)\mathrm{S}_1(t) + c\beta\theta \mathrm{A}_0(t)\mathrm{S}_1(t) - cq\beta\theta \mathrm{A}_0(t)\mathrm{S}_1(t)$$
$$+cqI_0(t)\mathrm{S}_1(t) + c\beta I_0(t)\mathrm{S}_1(t) - cq\beta I_0(t)\mathrm{S}_1(t) + \mathrm{S}_{2'}(t) = 0, \dots, \tag{35}$$

$$\sigma \mathrm{E}_0(t) + \mathrm{E}_{0'}(t) = 0, \tag{36}$$

$$E_1'(t) + \sigma E_1(t) - c\beta\theta \mathrm{A}_0(t)\mathrm{S}_0(t) + cq\beta\theta \mathrm{A}_0(t)\mathrm{S}_0(t) - c\beta I_0(t)\mathrm{S}_0(t) + cq\beta I_0(t)\mathrm{S}_0(t) = 0, \tag{37}$$

$$E_2' + \sigma E_2(t) - c\beta\theta \mathrm{A}_1(t)\mathrm{S}_0(t) + cq\beta\theta \mathrm{A}_1(t)\mathrm{S}_0(t) - c\beta \mathrm{I}_1(t)\mathrm{S}_0(t) + cq\beta \mathrm{I}_1(t)\mathrm{S}_0(t)$$
$$- c\beta\theta \mathrm{A}_0(t)\mathrm{S}_1(t) + cq\beta\theta \mathrm{A}_0(t)\mathrm{S}_1(t) - c\beta I_0(t)\mathrm{S}_1(t) + cq\beta I_0(t)\mathrm{S}_1(t) = 0, \dots \tag{38}$$

$$I_{0'}(t) + (\alpha + \gamma_i + \delta_i)I_0(t) = 0, \tag{39}$$

$$I_{1'}(t) + (\alpha + \gamma_i + \delta_i)I_1(t) - \rho\sigma \mathrm{E}_0(t) = 0, \tag{40}$$

$$I_2'(t) + (\alpha + \gamma_i + \delta_i)I_2(t) - \rho\sigma \mathrm{E}_1(t) = 0, \dots, \tag{41}$$

$$\mathrm{A}_{0'}(t) + \gamma_A \mathrm{A}_0(t) = 0, \tag{42}$$

$$\mathrm{A}_{1'}(t) + \gamma_A \mathrm{A}_1(t) - \sigma \mathrm{E}_0(t) + \rho\sigma \mathrm{eE}_0(t) = 0, \tag{43}$$

$$\mathrm{A}_{2'}(t) + \gamma_A \mathrm{A}_2(t) - \sigma \mathrm{E}_1(t) + \rho\sigma \mathrm{eE}_1(t) = 0, \dots \tag{44}$$

$$\mathrm{S}_{q0}'(t) + \lambda \mathrm{S}_{q0}(t) = 0 \tag{45}$$

$$\mathrm{S}_{q1}'(t) + \lambda \mathrm{S}_{q1}(t) - cq\theta \mathrm{A}_0(t)\mathrm{S}_0(t) + cq\beta\theta \mathrm{A}_0(t)\mathrm{S}_0(t) - cqI_0(t)\mathrm{S}_0(t) + cq\beta I_0(t)\mathrm{S}_0(t) = 0 \tag{46}$$

$$\mathrm{S}_{q2}'(t) + \lambda \mathrm{S}_{q2}(t) - cq\theta \mathrm{A}_1(t)\mathrm{S}_0(t) + cq\beta\theta \mathrm{A}_1(t)\mathrm{S}_0(t) - cqI_1(t)\mathrm{S}_0(t)$$
$$+ cq\beta I_1(t)\mathrm{S}_0(t) - cq\theta \mathrm{A}_0(t)\mathrm{S}_1(t) + cq\beta\theta \mathrm{A}_0(t)\mathrm{S}_1(t) - cqI_0(t)\mathrm{S}_1(t) + cq\beta I_0(t)\mathrm{S}_1(t) = 0 \tag{47}$$

$$\mathrm{E}_{q0'}(t) + \delta_q \mathrm{E}_{q0}(t) = 0 \tag{48}$$

$$E_{q1'}(t) + \delta_q E_{q1}(t) - cq\beta\theta A_0(t)S_0(t) - cq\beta I_0(t)S_0(t) = 0 \tag{49}$$

$$E_{q2'}(t) + \delta_q E_{q2}(t) - cq\beta\theta A_1(t)S_0(t) - cq\beta I_1(t)S_0(t) - cq\beta\theta A_0(t)S_1(t)$$
$$-cq\beta I_0(t)S_1(t) = 0, \ldots \tag{50}$$

$$\alpha h0(t) + h0(t)\gamma_H + h0'(t) = 0 \tag{51}$$

$$\alpha h_1(t) + h_1(t)\gamma_H - I_0(t)\delta_i - E_{q0}(t)\delta_q + h_1'(t) = 0 \tag{52}$$

$$\alpha h_2(t) + h_2(t)\gamma_H - I_1(t)\delta_i - E_{q1}(t)\delta_q + h_2'(t) = 0, \ldots \tag{53}$$

$$R_{0'}(t) = 0, \tag{54}$$

$$-A_0(t)\gamma_A - h0(t)\gamma_H - I_0(t)\gamma_i + R_1'(t) = 0, \tag{55}$$

$$-A_1(t)\gamma_A - h_1(t)\gamma_H - I_1(t)\gamma_i + R_2'(t) = 0, \ldots \tag{56}$$

With the initial conditions:

$$S_0(0) = S_0, \quad S_1(0) = 0, \quad S_2(0) = 0, \quad S_3(0) = 0, \ldots. \tag{57}$$

$$E_0(0) = E_0, \quad E_1(0) = 0, \quad E_2(0) = 0, \quad E_3(0) = 0, \ldots. \tag{58}$$

$$I_0(0) = I_0, \quad I_1(0) = 0, \quad L_2(0) = 0, \quad I_3(0) = 0, \ldots. \tag{59}$$

$$A_0(0) = A_0, \quad A_1(0) = 0, \quad A_2(0) = 0, \quad A_3(0) = 0, \ldots. \tag{60}$$

$$S_{q0}(0) = S_{q0}, \quad S_{q1}(0) = 0, \quad S_{q2}(0) = 0, \quad S_{q3}(0) = 0, \ldots. \tag{61}$$

$$E_{q0}(0) = E_{q0}, \quad E_{q1}(0) = 0, \quad E_{q2}(0) = 0, \quad E_{q3}(0) = 0, \ldots. \tag{62}$$

$$h_0(0) = h_0, \quad h_1(0) = 0, \quad h_2(0) = 0, \quad h_3(0) = 0, \ldots. \tag{63}$$

$$R_0(0) = R_0, \quad R_1(0) = 0, \quad R_2(0) = 0, \quad R_3(0) = 0, \ldots. \tag{64}$$

Now, we solve the over system of ordinary differential Eqs. (33)–(56) with the initial conditions (57)–(64) to get the results:

The results of the first iteration are given by:

$$S_0(t) = S_0,$$

$$E_0(t) = e^{-t\sigma}E_0,$$

$$I_0(t) = e^{t(-\alpha-\gamma_i-\delta_i)}I_0,$$

$$A_0(t) = e^{-t\gamma_A}A_0,$$

$$S_{q0}(t) = e^{-t\lambda}S_{q0},$$

$$E_{q0}(t) = e^{-t\delta_q}E_{q0},$$

$$h0(t) = e^{t(-\alpha-\gamma_H)}h_0,$$

$$R_0(t) = R_0. \tag{65}$$

The results of the second iteration are given by

$$\begin{aligned}
\mathrm{S}_1(t) = & \frac{1}{\gamma_A(\alpha+\gamma_i+\delta_i)} e^{-t(\alpha+\lambda+\gamma_i+\delta_i)}(c(e^{t(\alpha+\lambda+\gamma_i+\delta_i)} - e^{t(\alpha+\lambda-\gamma_A+\gamma_i+\delta_i)}) \\
& (q(-1+\beta)-\beta)\theta A_0 S_0(\alpha+\gamma_i+\delta_i) - \gamma_A(c(e^{t\lambda} - e^{t(\alpha+\lambda+\gamma_i+\delta_i)}), \\
& (q(-1+\beta)-\beta) I_0 S_0 - e^{t(\alpha+\gamma_i+\delta_i)}(-1+e^{t\lambda})\mathrm{S}_{q0}(\alpha+\gamma_i+\delta_i)))
\end{aligned}$$

$$\begin{aligned}
\mathrm{E}_1(t) = & \frac{1}{(\sigma-\gamma_A)(\alpha-\sigma+\gamma_i+\delta_i)} c e^{-t(\alpha+\gamma_i+\delta_i)}(-1+q)\beta S_0(-(-1+e^{t(\alpha-\sigma+\gamma_i+\delta_i)})I_0(\sigma-\gamma_A) \\
& +(e^{t(\alpha-\sigma+\gamma_i+\delta_i)} - e^{t(\alpha-\gamma_A+\gamma_i+\delta_i)})\theta A_0(\alpha-\sigma+\gamma_i+\delta_i)),
\end{aligned}$$

$$\mathrm{I}_1(t) = \frac{e^{t(-\alpha-\gamma_i-\delta_i)}(-1+e^{t(\alpha-\sigma+\gamma_i+\delta_i)})\rho\sigma E_0}{\alpha-\sigma+\gamma_i+\delta_i},$$

$$\mathrm{A}_1(t) = \frac{e^{-t(\sigma-\gamma_A)-t\gamma_A}(-1+e^{t(\sigma-\gamma_A)})(-1+\rho)\sigma E_0}{-\sigma+\gamma_A},$$

$$\begin{aligned}
\mathrm{S}_{q1}(t) = & \frac{1}{(\lambda-\gamma_A)(\alpha-\lambda+\gamma_i+\delta_i)} c e^{-t(\alpha+\gamma_i+\delta_i)} q(-1+\beta)S_0(-(-1+e^{t(\alpha-\lambda+\gamma_i+\delta_i)})I_0(\lambda-\gamma_A) \\
& +(e^{t(\alpha-\lambda+\gamma_i+\delta_i)} - e^{t(\alpha-\gamma_A+\gamma_i+\delta_i)})\theta A_0(\alpha-\lambda+\gamma_i+\delta_i)),
\end{aligned}$$

$$\begin{aligned}
\mathrm{E}_{q1}(t) = & \frac{1}{(\alpha+\gamma_i+\delta_i-\delta_q)(-\gamma_A+\delta_q)}\{c e^{-t(\alpha+\gamma_i+\delta_i)} q\beta S_0((e^{t(\alpha-\gamma_A+\gamma_i+\delta_i)} - e^{t(\alpha+\gamma_i+\delta_i-\delta_q)}) \\
& \theta A_0(\alpha+\gamma_i+\delta_i-\delta_q) + (-1+e^{t(\alpha+\gamma_i+\delta_i-\delta_q)})I_0(-\gamma_A+\delta_q)),
\end{aligned}$$

$$\begin{aligned}
\mathbf{h_1(t)} = & \frac{e^{-\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H})}}{(\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\gamma}_\mathbf{i}-\boldsymbol{\delta}_\mathbf{i})(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\delta}_\mathbf{q})}((-\mathbf{1}+e^{\mathbf{t}(\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\gamma}_\mathbf{i}-\boldsymbol{\delta}_\mathbf{i})})\mathbf{i_0}\boldsymbol{\delta}_i(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\delta}_\mathbf{q}) \\
& +(-\mathbf{1}+e^{\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\delta}_\mathbf{q})})\mathbf{M_0}(\boldsymbol{\gamma}_\mathbf{H}-\boldsymbol{\gamma}_\mathbf{i}-\boldsymbol{\delta}_\mathbf{i})\boldsymbol{\delta}_\mathbf{q}),
\end{aligned}$$

$$\begin{aligned}
\mathbf{R_1(t)} = & \frac{\mathbf{1}}{(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H})(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})} e^{-\mathbf{t}(\mathbf{2}\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{A}+\boldsymbol{\gamma}_\mathbf{H}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})}(e^{\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{A}+\boldsymbol{\gamma}_\mathbf{H})}(-\mathbf{1}+e^{\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})}) \\
& \mathbf{i_0}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H})\boldsymbol{\gamma}_\mathbf{i} + e^{\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{A}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})}(-\mathbf{1}+e^{\mathbf{t}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H})})\mathbf{h_0}\boldsymbol{\gamma}_\mathbf{H}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i}) + e^{\mathbf{t}(\mathbf{2}\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})} \\
& (-\mathbf{1}+e^{\mathbf{t}\boldsymbol{\gamma}_\mathbf{A}})\mathbf{A_0}(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{H})(\boldsymbol{\alpha}+\boldsymbol{\gamma}_\mathbf{i}+\boldsymbol{\delta}_\mathbf{i})).
\end{aligned} \tag{66}$$

Using computer programs, repetitions were made up to the third order, but due to the large size of the ensuing results, they were not written to relieve to the reader and the large size of the resulting equations. Then, the approximate solutions are given by

$$\begin{aligned}
\mathrm{S}(t) = & \mathrm{S}_0 + \frac{1}{\gamma_A(\alpha+\gamma_i+\delta_i)} e^{-t(\alpha+\lambda+\gamma_i+\delta_i)}(c(e^{t(\alpha+\lambda+\gamma_i+\delta_i)} - e^{t(\alpha+\lambda-\gamma_A+\gamma_i+\delta_i)})(q(-1+\beta)-\beta) \\
& \theta A_0 S_0(\alpha+\gamma_i+\delta_i) - \gamma_A(c(e^{t\lambda} - e^{t(\alpha+\lambda+\gamma_i+\delta_i)})(q(-1+\beta)-\beta) \\
& I_0 S_0 - e^{t(\alpha+\gamma_i+\delta_i)}(-1+e^{t\lambda})\mathrm{S}_{q0}(\alpha+\gamma_i+\delta_i))) + \ldots
\end{aligned} \tag{67}$$

$$\begin{aligned}\mathbf{E}(\mathbf{t}) =& e^{-\mathbf{t}\sigma}\mathbf{E}_0 + \frac{\mathbf{1}}{(\sigma - \gamma_A)(\alpha - \sigma + \gamma_i + \delta_i)} \mathbf{c}e^{-\mathbf{t}(\alpha+\gamma_i+\delta_i)}(-\mathbf{1} + \mathbf{q})\beta\mathbf{S}_0(-(-\mathbf{1} + e^{\mathbf{t}(\alpha-\sigma+\gamma_i+\delta_i)}) \\ & \mathbf{I}_0(\sigma - \gamma_A) + (e^{\mathbf{t}(\alpha-\sigma+\gamma_i+\delta_i)} - e^{\mathbf{t}(\alpha-\gamma_A+\gamma_i+\delta_i)})\theta\mathbf{A}_0(\alpha - \sigma + \gamma_i + \delta_i)) + \ldots\end{aligned} \tag{68}$$

$$\mathrm{I}(t) = e^{t(-\alpha-\gamma_i-\delta_i)}\mathrm{I}_0 + \frac{e^{t(-\alpha-\gamma_i-\delta_i)}(-1 + e^{t(\alpha-\sigma+\gamma_i+\delta_i)})\rho\sigma E_0}{\alpha - \sigma + \gamma_i + \delta_i} + \ldots \tag{69}$$

$$\mathrm{A}(t) = e^{-t\gamma_A}A_0 + \frac{e^{-t(\sigma-\gamma_A)-t\gamma_A}(-1 + e^{t(\sigma-\gamma_A)})(-1 + \rho)\sigma E_0}{-\sigma + \gamma_A} + \ldots \tag{70}$$

$$\begin{aligned}\mathbf{S_q}(\mathbf{t}) =& e^{-\mathbf{t}\lambda}\mathbf{S}_{\mathbf{q}0} + \frac{\mathbf{1}}{(\lambda - \gamma_A)(\alpha - \lambda + \gamma_i + \delta_i)} \mathbf{c}e^{-\mathbf{t}(\alpha+\gamma_i+\delta_i)}\mathbf{q}(-\mathbf{1} + \beta)\mathbf{S}_0(-(-\mathbf{1} + e^{\mathbf{t}(\alpha-\lambda+\gamma_i+\delta_i)}) \\ & \mathbf{I}_0(\lambda - \gamma_A) + (e^{\mathbf{t}(\alpha-\lambda+\gamma_i+\delta_i)} - e^{\mathbf{t}(\alpha-\gamma_A+\gamma_i+\delta_i)})\theta\mathbf{A}_0(\alpha - \lambda + \gamma_i + \delta_i)) + \ldots\end{aligned} \tag{71}$$

$$\begin{aligned}\mathbf{E_q}(\mathbf{t}) =& e^{-\mathbf{t}\delta_q}\mathbf{E}_{\mathbf{q}0} + \frac{\mathbf{1}}{(\alpha + \gamma_i + \delta_i - \delta_q)(-\gamma_A + \delta_q)} \{\mathbf{c}e^{-\mathbf{t}(\alpha+\gamma_i+\delta_i)}\mathbf{q}\beta\mathbf{S}_0((e^{\mathbf{t}(\alpha-\gamma_A+\gamma_i+\delta_i)} - e^{\mathbf{t}(\alpha+\gamma_i+\delta_i-\delta_q)}) \\ & \theta\mathbf{A}_0(\alpha + \gamma_i + \delta_i - \delta_q) + (-\mathbf{1} + e^{\mathbf{t}(\alpha+\gamma_i+\delta_i-\delta_q)})\mathbf{I}_0(-\gamma_A + \delta_q)) + \ldots\end{aligned} \tag{72}$$

$$\begin{aligned}\mathrm{H}(t) =& e^{t(-\alpha-\gamma_H)}h_0 + \frac{e^{-t(\alpha+\gamma_H)}}{(\gamma_H - \gamma_i - \delta_i)(\alpha + \gamma_H - \delta_q)}((-1 + e^{t(\gamma_H-\gamma_i-\delta_i)}) \\ & i_0\delta_i(\alpha + \gamma_H - \delta_q) + (-1 + e^{t(\alpha+\gamma_H-\delta_q)})M_0(\gamma_H - \gamma_i - \delta_i)\delta_q)\end{aligned} \tag{73}$$

$$\begin{aligned}\mathbf{R}(\mathbf{t}) =& \mathbf{R}_0 + \frac{\mathbf{1}}{(\alpha + \gamma_H)(\alpha + \gamma_i + \delta_i)} e^{-\mathbf{t}(2\alpha+\gamma_A+\gamma_H+\gamma_i+\delta_i)}(e^{\mathbf{t}(\alpha+\gamma_A+\gamma_H)}(-\mathbf{1} + e^{\mathbf{t}(\alpha+\gamma_i+\delta_i)}) \\ & \mathbf{i}_0(\alpha + \gamma_H)\gamma_i + e^{\mathbf{t}(\alpha+\gamma_A+\gamma_i+\delta_i)}(-\mathbf{1} + e^{\mathbf{t}(\alpha+\gamma_H)})\mathbf{h}_0\gamma_H(\alpha + \gamma_i + \delta_i) + e^{\mathbf{t}(2\alpha+\gamma_H+\gamma_i+\delta_i)} \\ & (-\mathbf{1} + e^{\mathbf{t}\gamma_A})\mathbf{A}_0(\alpha + \gamma_H)(\alpha + \gamma_i + \delta_i)).\end{aligned} \tag{74}$$

From the initial values in Wuhan, China, the parameters in the approximate solutions (68)–(74) are given by as $\mathbf{c = 14.781, \beta = 2.1011; q = 1.8887 \times 10^{-8}; w = 0.13266; \lambda = 1/14; \rho = 0.86834; \delta_I = 0.3266; \delta_q = 0.1259; \gamma_I = 0.33029; \gamma_A = 0.13978; \gamma_H = 0.11624; \alpha = 1.7826 \times 10^{-5}}$, $\mathbf{S_0 = 11081000}$, $\mathbf{E_0 = 105.1; I0 = 27.679; \theta = 0.5; A0 = 53.839; \sigma = 1/7; S_{q0} = 739; E_{q0} = 1.1642; h0 = 1; \delta_i = 0.3266}$.

The approximate solutions (68)–(74) are given by:

$$\begin{aligned}\mathbf{S}(\mathbf{t}) =& \mathbf{11081000 - 8.077550840783672 \times 10^{10} e^{-0.8681163974285714t}(-0.17951293599126503e^{0.2112085714285714t}} \\ & \mathbf{- 0.8204870731575477e^{0.7283363974285714t} + 9.148812735028278 \times 10^{-9}e^{0.796687826t} + 1.e^{0.8681163974285714t})} \\ & \mathbf{+ 2.943437315081433 \times 10^{14}e^{-4.340581987142855t}(0.03223199288688491e^{3.026766335142855t}} \\ & \mathbf{+ 0.2946409779302137e^{3.543894161142855t} - 2.963183621861236 \times 10^{-9}e^{3.612245589714284t}} \\ & \mathbf{- 0.35915010013294e^{3.683674161142855t} + 0.6733473336595697e^{4.061021987142855t}} \\ & \mathbf{- 9.937923116376702 \times 10^{-9}e^{4.129373415714284t} - 0.002421207761123755 5e^{4.1977248442857125t}} \\ & \mathbf{- 1.6386489836866025e^{4.200801987142855t} + 5.104696820586916 \times 10^{-12}e^{4.269153415714284t}} \\ & \mathbf{+ 1.e^{4.340581987142855t})}.\end{aligned} \tag{75}$$

$$\begin{aligned} E(\mathbf{t}) =& \mathbf{105.1e^{-t/7} + 3.010570602728641 \times 10^{12} e^{-0.6569078259999999t}} \\ & \mathbf{(-0.006154958441363934 - 0.9938450415586361e^{0.5140506831428571t}} \\ & \mathbf{+ 1.e^{0.517127826t}) - 2.190978407569755 \times 10^{16} e^{-3.272230558571426t} (0.0004858439208714902 4e^{1.9584149065714267t}} \\ & \mathbf{+ 0.004823171677329365e^{2.4755427325714265t} - 4.952172416946539 \times 10^{-11} e^{2.543894161142855t}} \\ & \mathbf{- 0.00616582475255329e^{2.615322732571426t} + 0.01849921393298708e^{2.9926705585714264t}} \\ & \mathbf{- 4.125496904340082 \times 10^{-10} e^{3.0610219871428552t} - 1.0176424043165633e^{3.129373415714283t}} \\ & \mathbf{+ 1.e^{3.1324505585714264t} + 0.000004646764974935146e^{3.129373415714283t} t).} \end{aligned} \tag{76}$$

$$\begin{aligned} A(t) =& 53.839e^{-0.13978t} + 642.4078922934066e^{-0.2826371428571428t} \\ & (-1.e^{0.13978t} + 1.e^{0.14285714285714285t}) + 5.662453222217899 \times 10^{10} e^{-0.6599849688571426t} \\ & (0.011902199285953595e^{0.0030771428571427784t} + 322.9765687516541e^{0.5171278259999998t} \\ & - 322.98847095094004e^{0.5202049688571426t} + 1.e^{0.5202049688571426t} t). \end{aligned} \tag{77}$$

$$\begin{aligned} S_q(t) =& 739e^{-t/14} - 1502.535510389303e^{-0.7252592545714286t} \\ & (-0.107173312618706e^{0.06835142857142862t} - 0.8928266873812939e^{0.5854792545714286t} \\ & + 1.e^{0.6538306831428572t}) + 7273848.199122141e^{-3.7691534157142805t} \\ & (0.013652061810143121e^{2.4553377637142813t} + 0.1296348087598582e^{2.972465589714281t} \\ & - 1.31589041905024 \times 10^{-9} e^{3.0408170182857095t} - 0.16139961665976396e^{3.1122455897142807t} \\ & + 0.3622514177293506e^{3.489593415714281t} - 6.014447218305942 \times 10^{-9} e^{3.55794484428571t} \\ & - 0.0019395261323268999e^{3.626296272857138t} - 1.3421991381769234e^{3.629373415714281t} \\ & + 1.e^{3.697724844285709t}). \end{aligned} \tag{78}$$

$$\begin{aligned} E_q(t) =& 1.1642e^{-0.1259t} + 12944.586834398624e^{-0.670787826t} (-0.02617301509751275e^{0.013880000000000003t} \\ & - 0.9738269849024873e^{0.531007826t} + 1.e^{0.544887826t}) \\ & - 8.536953685846727 \times 10^{7} e^{-3.387853415714281t} (0.002321404574788029 2e^{2.0740377637142817t} \\ & + 0.022788251647984353e^{2.5911655897142816t} - 2.33288980952792 \times 10^{-10} e^{2.65951701828571t} \\ & - 0.028933059256547822e^{2.730945589714281t} + 0.07977525448342258e^{3.1082934157142814t} \\ & - 1.602246578630015 \times 10^{-9} e^{3.1766448442857103t} - 0.001328300050019394 1e^{3.2449962728571387t} \\ & - 1.0746235495640923e^{3.2480734157142814t} + 1.e^{3.261953415714281t}). \end{aligned} \tag{79}$$

$$\begin{aligned} H(t) =& 1.e^{-0.116257826t} + 31.921759750033623e^{-0.66655t} (-0.5237976480945624e^{0.009642174000000003t} \\ & - 0.4762023519054375e^{0.54065t} + 1.e^{0.550292174t}) + 101766.35565315833e^{-0.7166714908571429t} \\ & (0.0009258109972406025e^{0.059763664857142906t} - 0.003060060534075873 7e^{0.5738143480000001t} \\ & + 0.6630007924132848e^{0.5768914908571429t} - 1.6608665428764495e^{0.5907714908571428t} \\ & + 1.e^{0.6004136648571429t}). \end{aligned} \tag{80}$$

$$\begin{aligned} R(t) =& 2 + 68.75571072170078e^{-0.9129456520000001t}(-0.20241030028246748e^{0.256037826t} \\ & - 0.7830476833832982e^{0.7731656520000001t} - 0.014542016334234376e^{0.7966878260000001t} \\ & + 1.e^{0.9129456520000001t}) + 74.64711217749436e^{-1.181702794857143t} \\ & (0.21046681774653264e^{0.5247949688571429t} + 7.635017935997784e^{1.038845652t} \\ & - 8.605930940314238e^{1.041922794857143t} + 0.18801617828273953e^{1.0558027948571431t} \\ & - 0.42756999171281834e^{1.065444968857143t} + 1.e^{1.181702794857143t}). \end{aligned} \tag{81}$$

$$\begin{aligned} I(t) =& 27.679e^{-0.656907826t} - 2.070405815456379 \times 10^{25} e^{-0.656907826t} \\ & (-1. + 1.e^{1.110223024625156} \times 10^{-16} t + 3.487368493187135 \times 10^{-14} e^{0.5140506831428572t} \\ & - 3.488086109177916 \times 10^{-14} e^{0.5171278260000001t}) + 25.3622945843254e^{-0.7997649688571429t} \\ & (-1.e^{0.1428571428571429t} + 1.e^{0.656907826t}). \end{aligned} \tag{82}$$

Figs. 2–9 shows the responses of the model. Which the behavior between the related parameters and time also, shows the efficiency of the proposed style is highly amended.

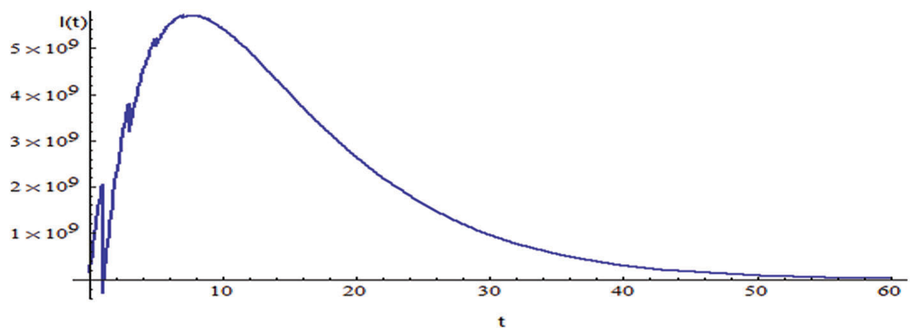

Figure 2: The relation of variable I and t

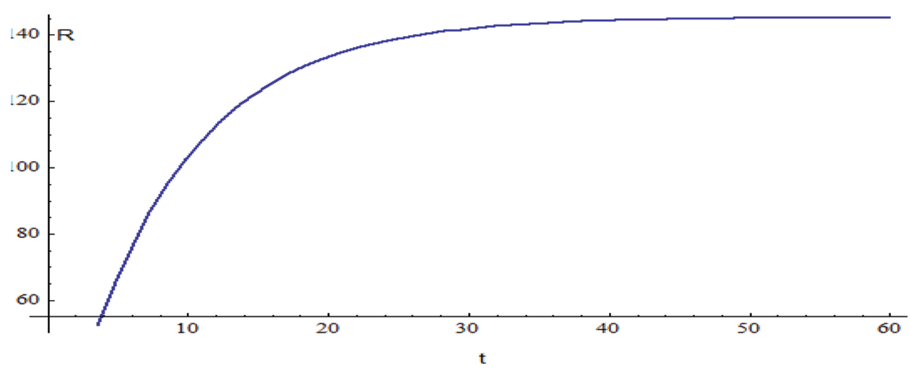

Figure 3: The relation of variable R and t

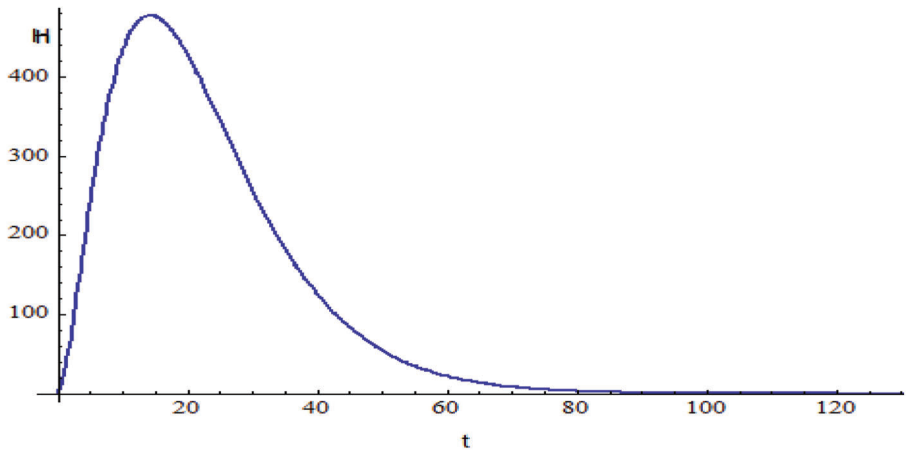

Figure 4: The relation of variable IH and t

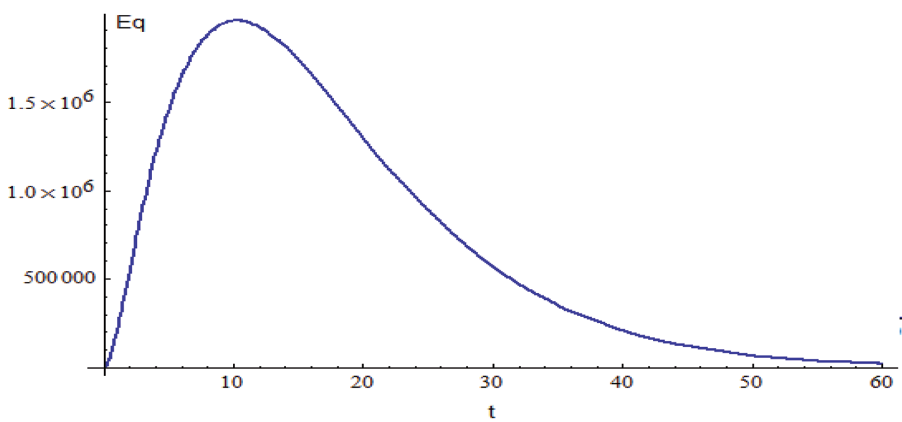

Figure 5: The relation of variable Eq and t

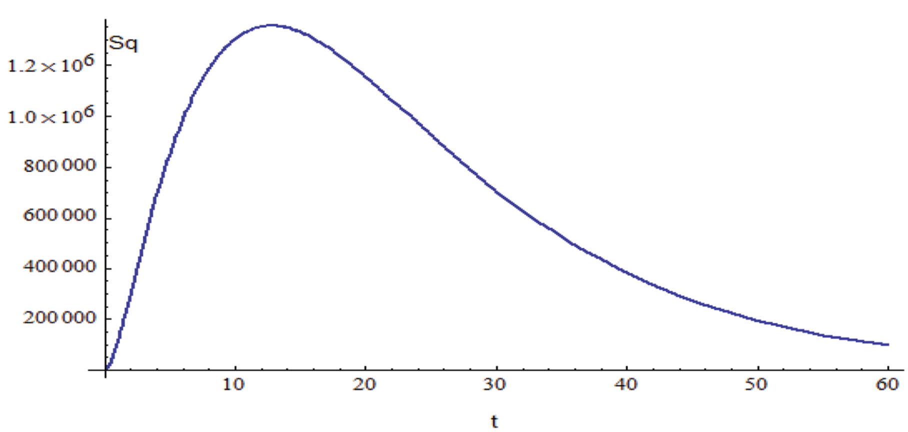

Figure 6: The relation of variable Sq and t

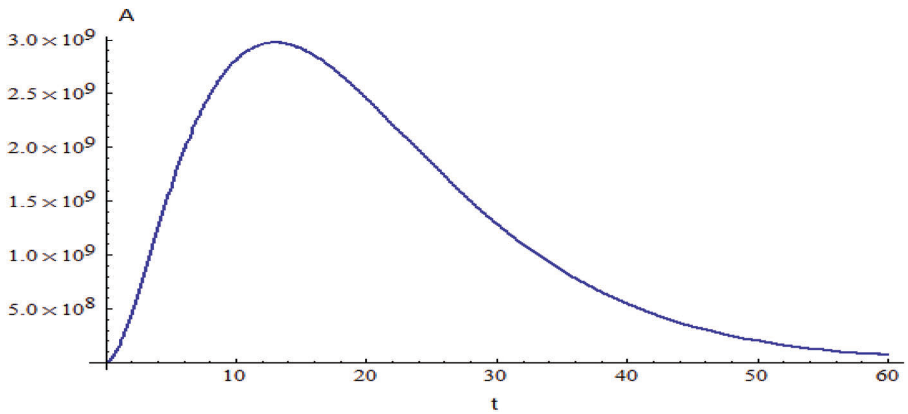

Figure 7: The relation of variable A and t

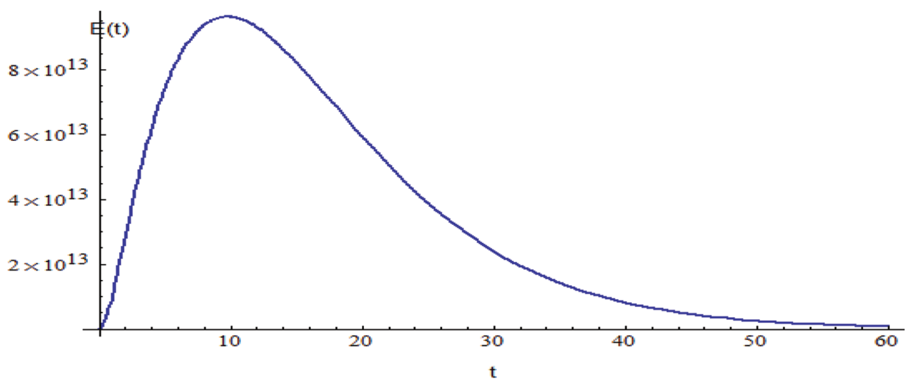

Figure 8: The relation of variable E and t

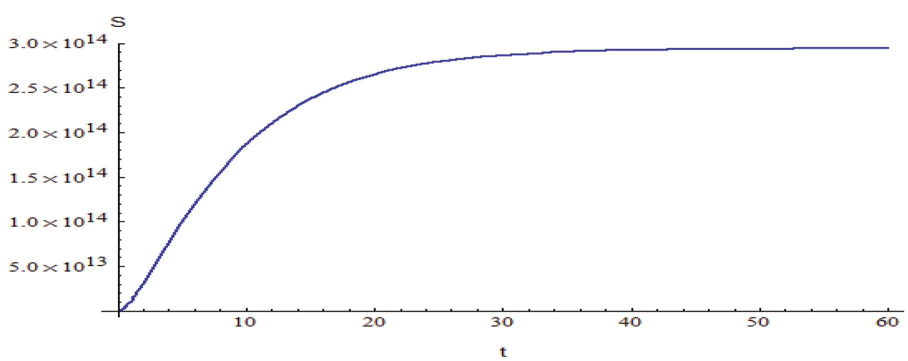

Figure 9: The relation of variable S and t

6 Conclusion

This article investigates the conduct of the Coronavirus model by utilizing the homotopy annoyance and decreased differential change techniques. The free infection balance and soundness point for the Coronavirus model are addressed. The model is portrayed by a novel sign stream graph where the signal stream chart is a scheme agent that is applied to display the interrelation among the system states and becomes possible to utilize scheme-theoretic stuff to find novel brow of the system. Through our numerical investigations, the seriousness of the infection is explained, which shows more impact by expanding the contact number. The mathematical recreations show that the nearby association among helpless and irresistible people is a significant danger factor for spreading the infection while keeping up actual distance is fundamental to decrease the danger of spreading the infection.

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Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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