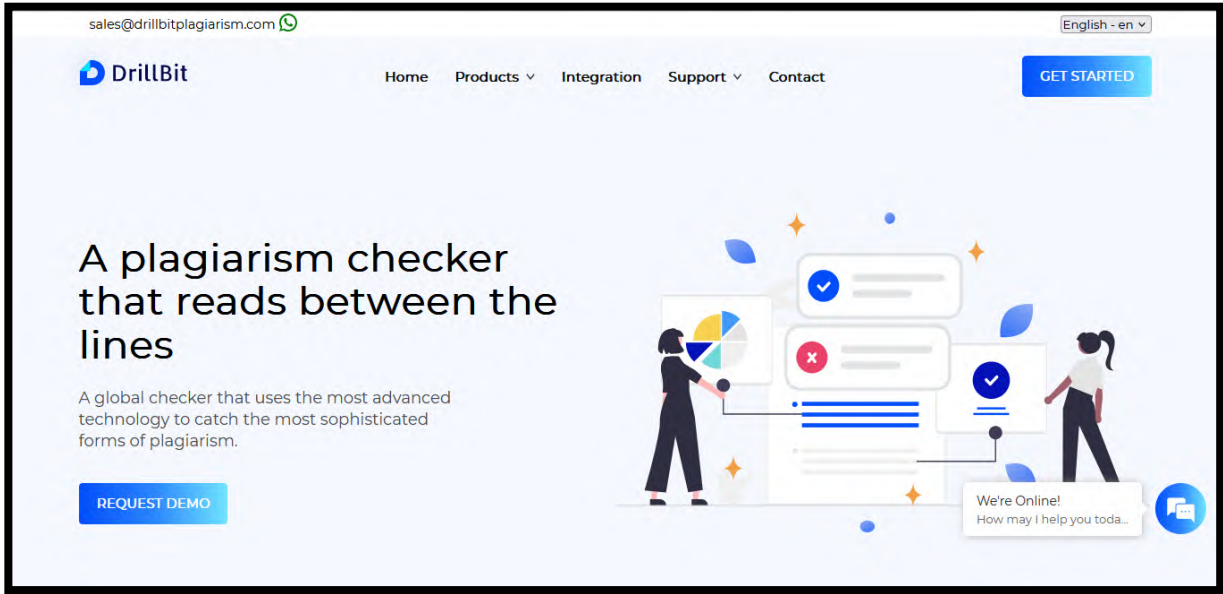




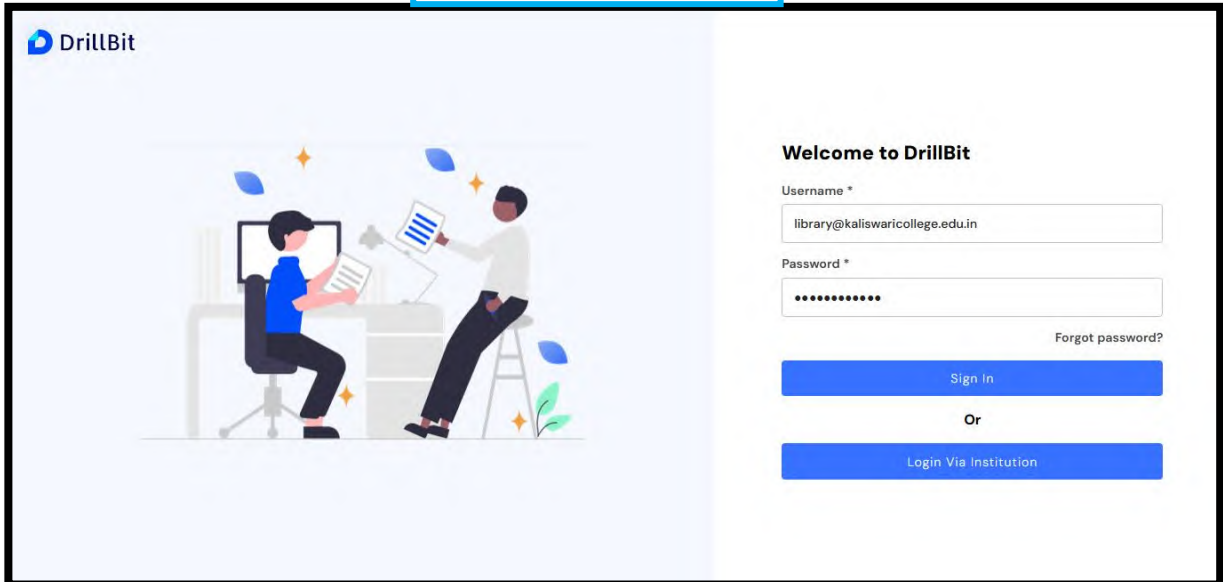
### 4.3.1 IT facilities are Frequently Updated and provides Sufficient Bandwidth for Internet Connection

#### Drill Bit Plagiarism Detection Software

##### Home Page



##### Login Page





**Admin Panel**

**Account Information**

The screenshot shows the 'Account Information' page in the DrillBit admin panel. The page includes a sidebar with navigation options like Dashboard, Users, Reports, Repository, Integrations, and Settings. The main content area displays account details for 'Sri Kaliswari College'.

Field	Value
Institution Name	Sri Kaliswari College
Username	Dr.S.Sridhar
User ID	38349
User Email Address	library@kaliswaricollege.edu.in
Date Of Activation	2023-09-14 00:00:00
Total Documents Alloted	500
Total Documents Submitted	14
Total User Accounts	6
Files Saved to Repository	2
Account Expires on	2024-09-13 00:00:00
Account Type	License

**Users List**

The screenshot shows the 'Users List' page in the DrillBit admin panel. It features a table with columns for Name, Email, Designation, Department, Creation Date, Allocated, Submitted, Status, and Actions. A search bar and pagination controls are also visible.

Name	Email	Designat...	Departm...	Creation Da...	Allocated	Submissi...	Status	Statis...	Actions
<input type="checkbox"/>	Dr.S.Sridhar	library@kaliswar...	Chief Librar...	--	21-08-2023 0...	50	14	Active	[Icons]



**Report Generation**

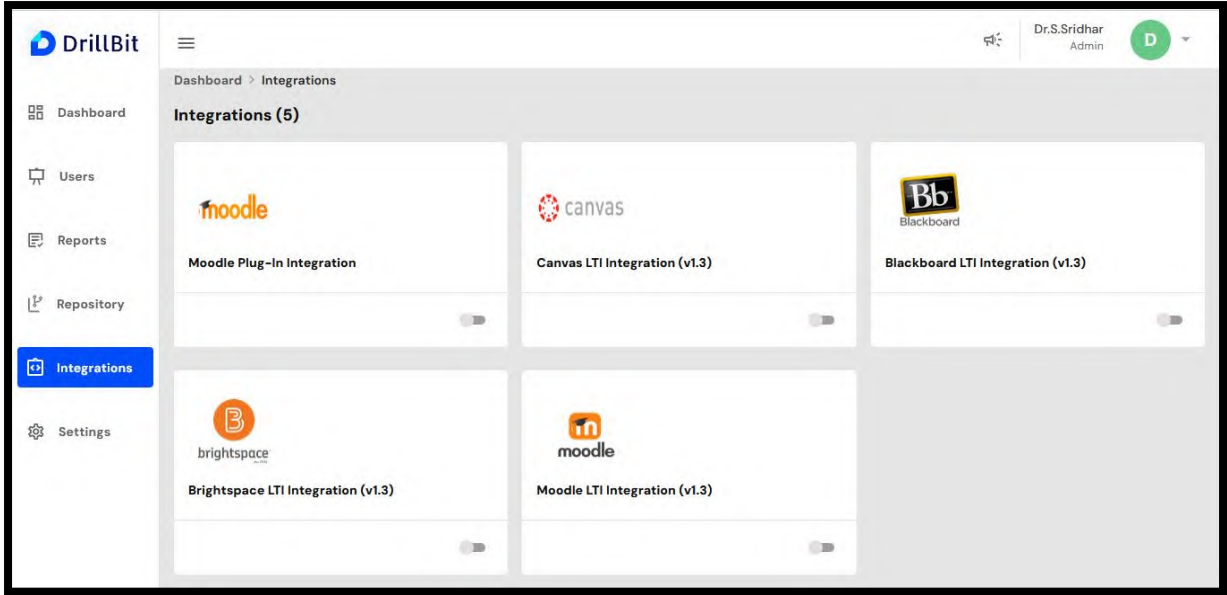
The screenshot shows the DrillBit Reports generation interface. On the left is a navigation menu with options: Dashboard, Users, Reports (highlighted), Repository, Integrations, and Settings. The main content area is titled 'Reports' and includes a 'Users list (1)' section with a download icon. Below this are four filter fields: 'Choose Reports \*' (set to 'submissions'), 'Choose Users \*' (set to 'library@kaliswaricollege.edu.in'), 'Choose From Date \*' (set to '12/04/2022'), and 'Choose To Date \*' (set to '30/11/2023'). A blue 'View & Download' button is positioned at the bottom of the filter section.

**Reports (9)**

Author Name	Title	Submission Date	Email	Paper ID	Similarity
R.Vanthana1,S.Ashwinipriya2	Dynamical Analysis on a within...	03-11-2023 11:49:21	library@kaliswaricollege.edu.in	1076690	20%
Mohamed Nasar Nazeer	Virtual and biological assessmen...	20-11-2023 11:59:09	library@kaliswaricollege.edu.in	1116275	DREP
Mohamed Nasar Nazeer	Virtual and biological assessmen...	20-11-2023 12:03:19	library@kaliswaricollege.edu.in	1116301	DREP
Mohamed Nasar Nazeer	Virtual and biological assessmen...	20-11-2023 12:16:22	library@kaliswaricollege.edu.in	1116360	DREP
Mohamed Nasar Nazeer	Virtual and biological assessmen...	20-11-2023 12:19:16	library@kaliswaricollege.edu.in	1116373	DREP
Mohamed Nasar Nazeer	Virtual and biological assessmen...	20-11-2023 12:20:48	library@kaliswaricollege.edu.in	1116380	21%
Mohamed Nasar Nazeer	Theoretical and experimental inv...	20-11-2023 12:29:50	library@kaliswaricollege.edu.in	1116429	46%
S.VISWANATHAN	POWE AWARE DATACENTER USIN...	21-11-2023 15:53:15	library@kaliswaricollege.edu.in	1120350	DREP
S.VISWANATHAN	POWE AWARE DATACENTER USIN...	21-11-2023 15:55:45	library@kaliswaricollege.edu.in	1120365	25%



**Integration Page**





**User Panel**

**Dashboard**

User	Folder Name	ID	Date	Progress	Status	Action
Dr.S.santhi	4 INDIA'S PAST, PRESENT AND ...	1482622	01-03-2024 14:25:45	7%	Active	Review
Dr.S.santhi	3 INDIA'S PAST, PRESENT AND ...	1481543	01-03-2024 11:33:26	24%	Active	Review
Dr.S.Santhi	INDIA'S PAST, PRESENT AND FU...	1478553	29-02-2024 15:27:17	25%	Active	Review
Mrs.J.Santha Christina,	2.RESHAPING CULTURAL MEM...	1478252	29-02-2024 14:41:42	11%	Active	Review
Dr.S.Santhi	UNVEILING THE MULTIFACETE...	1478002	29-02-2024 13:48:14	17%	Active	Review

**My Folders**





DrillBit interface showing 'My Folders(7)' table with columns: Folder ID, Folder name, Created date, Submissions, and Actions.

Folder ID ↑	Folder name ↑	Created date ↑	Submissions	Actions
361837	English	29-02-2024 09:45:47	7	[Edit] [Delete] [Share]
354549	BioTECHNOLOGY	12-02-2024 09:46:28	3	[Edit] [Delete] [Share]
323395	BCA	21-11-2023 15:47:59	1	[Edit] [Delete] [Share]
322732	chemistry	20-11-2023 11:53:23	2	[Edit] [Delete] [Share]
305964	B.COM C A	05-10-2023 11:23:51	0	[Edit] [Delete] [Share]
303012	computer science	14-09-2023 13:18:19	0	[Edit] [Delete] [Share]
303010	library	14-09-2023 13:12:19	1	[Edit] [Delete] [Share]

**File Uploading Page**

DrillBit interface showing 'Upload files for plagiarism check' page. It includes a file upload area with a plus sign icon and lists supported file formats and upload limits.

**File formats:** pdf, doc, docx, txt, dotx, dot, pptx, xlsx, wpd, rtf, html, odt, ppt, xls, ps, tex, xml, tiff

**Multiple files - upto 15 files at a time**  
**Document length - upto 800 pages**  
**Document size - upto 100 MB**

[Browse your file here](#)



**Settings Page**

The screenshot shows the DrillBit interface with the 'Settings' page selected. The 'Multi-Factor Authentication' section is visible, with a toggle switch set to 'Off'. A note below the toggle reads: '\* Check your email address for the verification code'.

**Download Report Page**

The screenshot shows the 'Submissions (7)' page in DrillBit. It features a table with columns for Name, Title, File, Language, Grammar, Similarity, Paper ID, Submission date, and Actions. The 'Actions' column contains download and delete icons for each submission.

Name	Title	File	Language	Grammar	Similarity	Paper ID	Submission	Actions
Dr.S.santhi	4 INDIA'S PAS...	INDIA'S PAST, ...	English	NA	7%	1482622	01-03-2024 1...	[Download] [Delete]
Dr.S.santhi	3 INDIA'S PAS...	INDIA'S PAST, ...	English	NA	24%	1481543	01-03-2024 1...	[Download] [Delete]
Dr.S.Santhi	INDIA'S PAST, ...	INDIA'S PAST, ...	English	NA	25%	1478553	29-02-2024 1...	[Download] [Delete]
Mrs.J.Santha ...	2.RESHAPING ...	RESHAPING C...	English	NA	11%	1478252	29-02-2024 1...	[Download] [Delete]
Dr.S.Santhi	UNVEILING TH...	UNVEILING TH...	English	NA	17%	1478002	29-02-2024 1...	[Download] [Delete]
Dr.S.Santhi	INDIA'S PAST, ...	INDIA'S PASTP...	English	NA	32%	1477920	29-02-2024 1...	[Download] [Delete]
Mrs.J.Santha ...	RESHAPING C...	RESHAPING C...	English	NA	14%	1477037	29-02-2024 1...	[Download] [Delete]



**Final Plagiarism Report**



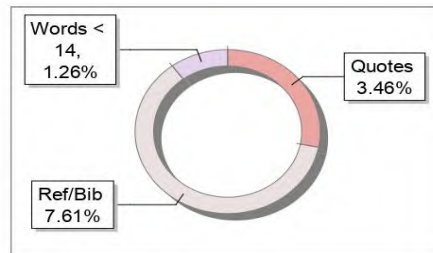
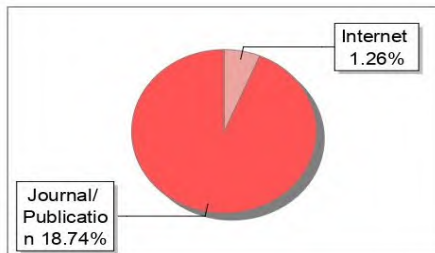
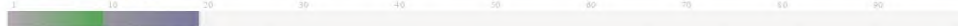
The Report is Generated by DrillBit Plagiarism Detection Software

**Submission Information**

Author Name	R.Vanthana1,S.Ashwinipriya2
Title	Dynamical Analysis on a within-host mathematical model of COVID-19
Paper/Submission ID	1076690
Submitted by	library@kaliswaricollege.edu.in
Submission Date	2023-11-03 11:49:21
Total Pages	13
Document type	Article

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References/Bibliography	Excluded
Sources: Less than 14 Words %	Not Excluded
Excluded Source	<b>0 %</b>
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Journals & publishers	Yes
Internet or Web	Yes
Institution Repository	Yes

A Unique QR Code use to View/Download/Share Pdf File







**DrillBit Similarity Report**

**20**

SIMILARITY %

**6**

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**B**

GRADE

A-Satisfactory (0-10%)  
 B-Upgrade (11-40%)  
 C-Poor (41-60%)  
 D-Unacceptable (61-100%)

LOCATION	MATCHED DOMAIN	%	SOURCE TYPE
1	Within-host mathematical modeling on crucial inflammatory mediators and drug int by Chhetri-2020	14	Publication
2	Control Intervention Strategies for Within-Host, Between-Host and their Efficacy by Prakash-2020	3	Publication
3	www.scirp.org	2	Publication
5	www.biorxiv.org	<1	Internet Data
6	docobook.com	<1	Internet Data
7	scientific.net	<1	Internet Data



## Dynamical Analysis on a within-host mathematical model of COVID-19

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<sup>1,2</sup>Assistant Professor, Department of Mathematics, Sri Kaliswari College (Autonomous),  
Sivakasi-626130, India.

### Abstract

A within-host mathematical model on the inflammatory mediators in COVID-19 is presented. Homotopy Perturbation Method (HPM) is discussed which is used to compute an approximate analytical expression for the concentrations of healthy type II Pneumocytes, infected type II Pneumocytes and viral load. The validity of HPM is analyzed using the function  $pde4$ , a function used to solve boundary value problems in MATLAB software. Graphical results confirm that (HPM) is in good agreement with the numerical solution adding to the accuracy and efficiency of (HPM) in finding the solution of the proposed model. The achieved results are applicable to the entire domain.

**Keywords:** *Mathematical Modeling, COVID-19, Nonlinear initial value problem, Homotopy Perturbation Method.*

### 1. Introduction

The outbreak of novel coronavirus in Wuhan, China marked the introduction of a virulent coronavirus into human society. The World Health Organization (WHO) named this novel corona viral pneumonia induced disease as Coronavirus disease (COVID-19) on Feb. 11, 2020. The causative agent of this disease is identified as Severe Acute Respiratory Syndrome coronavirus-2 (SARS-CoV-2). [1]. The transmission of SARS-CoV-2 from a person to another occurs either through droplet infection or by a direct contact with an infected host. Also, transmissions from asymptomatic carriers have also been reported. In spite of several researches being carried around the world, we are still lacking effective treatment approaches and epidemiological control measures. So, in order to break the natural history of the disease, it is inevitable to identify the possible interventions that help in reducing the severity of the virus and the growth of infected cells. Therefore, it is crucial to determine the coaction of viral growth along with the host immune response in the form of inflammatory mediators. In this paper, an analytical expression is derived for the ratio of healthy type II Pneumocytes  $S(t)$ , infected type II Pneumocytes  $I(t)$ , viral load  $V(t)$  against time  $t$  by applying the method of Homotopy Perturbation. These analytical expressions can be useful in predicting the course of the disease over time and the simulation of novel therapies under various mechanisms.

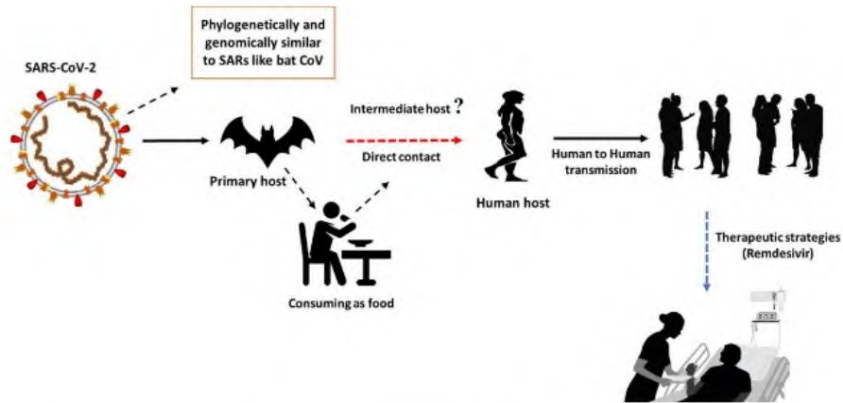


Fig. 1. Transmission of COVID-19

**2. Mathematical Formulation of the Problem**

Recently *D.K.K. Vamsi et al.* [2] formulated a mathematical model with reference to the pathogens that deals with the natural history of covid-19. This is a first of its kind. Up to our knowledge there is no analytical solution for this system of nonlinear equations. The model is denoted as

$$\frac{dS}{dt} = \omega - \mu S - \beta SV \tag{1}$$

$$\frac{dI}{dt} = \beta SV - (d_1 + d_2 + d_3 + d_4 + d_5 + d_6)I - \mu I$$

$$\frac{dI}{dt} = \beta SV - DI - \mu I \tag{2}$$

where  $D = \frac{dI}{dt} = d_1 + d_2 + d_3 + d_4 + d_5 + d_6$

$$\frac{dV}{dt} = \alpha I - (b_1 + b_2 + b_3 + b_4 + b_5 + b_6)V - \mu_1 V$$

$$\frac{dV}{dt} = \alpha I - BV - \mu_1 V \tag{3}$$

where  $B = b_1 + b_2 + b_3 + b_4 + b_5 + b_6$





Where  $S(t)$  represents the healthy type II Pneumocytes,  $I(t)$  represent the infected type II Pneumocytes, and  $V(t)$  represent the viral load. Let  $\omega$  be the natural birth rate of type II Pneumocytes. Let the natural birth rate of the virus  $V(t)$  be  $\alpha$  and the natural death rate be  $\mu_1$ . We suppose that infected type II Pneumocytes  $I(t)$  secrete virus  $V(t)$  that attacks the healthy type II Pneumocytes  $S(t)$  at rate  $\beta$  and the natural death rate of type II Pneumocytes be  $\mu$ . With the release of cytokines and chemokines IL-6, TNF- $\alpha$ , INF- $\alpha$ , CCL5, CXCL8, CXCL10, the infected Pneumocytes and the virus are removed at the rate  $B$  and  $D$  die at rate  $\mu_1$  respectively. The parameters  $\omega, \beta, \mu, \alpha, \mu_1, B, D$  are positive constants. The initial conditions for the above equations as  $t=0$  are  $S = S_i, I = I_i, V = V_i$  where  $S(t)$  represent the healthy type II Pneumocytes,  $I(t)$  represent the infected type II Pneumocytes, and  $V(t)$  represent the viral load.

**Table 1**

Nomenclature

Parameters	Biological meaning
S	Healthy type II Pneumocytes
I	Infected Type II Pneumocytes
$\omega$	Natural birth rate of Type II Pneumocytes
V	Viral load
$\beta$	Rate at which healthy Pneumocytes are infected
$\alpha$	Burst rate of virus particles (rate at which infected cells release the virus particles)
$\mu$	Natural death rate of Type II Pneumocytes
$\mu_1$	Natural death rate of virus
$d_1, d_2, d_3, d_4, d_5, d_6$	Rates at which Infected Pneumocytes are removed because



	the release of cytokines and chemokines IL-6 TNF- $\alpha$ , INF- $\alpha$ , CCL5, CXCL8 , CXCL10 respectively
$b_1, b_2, b_3, b_4, b_5, b_6$	Rates at which Virus is removed because of the release of cytokines and chemokines IL-6 TNF- $\alpha$ , INF- $\alpha$ , CCL5, CXCL8 , CXCL10 respectively

**3. Analytical Solution for the within-host mathematical model on the inflammatory mediators**

Homotopy Perturbation <sup>3</sup> method is a combination of topology and classic perturbation techniques. It is implemented to compute an approximate solution to a system of nonlinear differential equations pertaining to the problem. The efficiency of the Homotopy perturbation method for handling and solving various non-linear structures problems can be found in [3-6]. Ji Huan He employed the Homotopy perturbation method to solve the Lighthill equation [7], the Duffing equation [8] and the Blasius equation [9]. The homotopy perturbation method makes use of a small imbedding parameter  $p$  due to which very few iterations are required to achieve accurate result. The procedure for solving the non-linear differential equations, eqn. (1) -eqn. (3), by employing the method of homotopy perturbation is illustrated in Appendix A. The obtained results are as follows

$$S(t) = \frac{\omega}{\mu} + e^{-\mu t} (S_i - \frac{\omega}{\mu}) + \frac{\beta V_i \omega}{\mu B} (e^{-t(\mu+B)} - 1) + \frac{\beta V_i}{\mu + B} (e^{-t(2\mu+B)} - 1) (S_i - \frac{\omega}{\mu}) \quad (4)$$

$$I(t) = I_i e^{-t(D+\mu)} + \frac{\beta S_i V_i}{\mu + B - D} (1 - e^{-t(2\mu+B)}) \quad (5)$$

$$V(t) = V_i e^{-t(B+\mu)} + \frac{\alpha I_i}{D - B} (1 - e^{-t(D-B)}) \quad (6)$$

Where  $S(t)$  represents the healthy type II Pneumocytes,  $I(t)$  represent the infected type II Pneumocytes, and  $V(t)$  represent the viral load.

**4. Numerical Simulation**





By implementing the Homotopy Perturbation Method, the non-linear differential equations governing the model (1)-(3) for the predetermined initial condition are established. These equations are illustrated numerically by making use of Matlab pde4 software which is presented in Appendix B. The obtained solutions in comparison with the analytical solutions admit a remarkable accuracy.

### 5. Result and Discussion

Fig. 2 illustrates the ratio of healthy type II Pneumocytes  $S(t)$ , infected type II Pneumocytes  $I(t)$ , viral load  $V(t)$  against time  $t$ . Fig. 3-5 presents plot of the ratio of healthy type II Pneumocytes  $S(t)$  against time  $t$  by varying parameters  $R_1, R_2, R_3$  respectively. From Fig 3, it can be noted that the ratio of healthy type II Pneumocytes  $S(t)$  increases steadily due to the increase in natural birth rate of type II Pneumocytes. From Fig. 4, it can be seen that there is an deterioration in the ratio of healthy type II Pneumocytes  $S(t)$ . This is due to the increase in rate at which healthy Pneumocytes are infected. Fig. 5 depicts that there is a decline in the ratio of healthy type II Pneumocytes  $S(t)$  which is a consequence of the natural death rate of these cells. Fig. 6-7 presents plot of the ratio of infected type II Pneumocytes  $I(t)$  against time  $t$  by varying parameters  $R_3, R_4$  respectively. From Fig. 6, it can be observed that the ratio of infected type II Pneumocytes  $I(t)$  decreases steadily due to the increase in natural death rate of type II Pneumocytes. From Fig. 7, it can be noted that when the infected type II Pneumocytes are removed from the host the ratio of infected type II Pneumocytes  $I(t)$  decreases. From this it can be inferred that the immunization drugs play a pivot role in stopping the spread of the infected cells. Fig. 8- 10 represents plot of the ratio of viral load  $V(t)$  against time  $t$  by varying parameters  $R_5, R_6, R_7$  respectively. From Fig. 8, it can be noted that when the rate of removal of the virus from the host is high the ratio of the viral load decreases. From Fig. 9, it can be seen that ratio of the viral load  $V(t)$  decreases as the death rate of the virus increases. From Fig. 10, it can be observed that ratio of the viral load  $V(t)$  increases when the rate of release of the virus from the infected cells is maximum. The higher the infected cells, the higher the viral load. Therapeutic agents which acts to improve the response of the host immune system in reducing the number of infected cells and viral load can be administered.

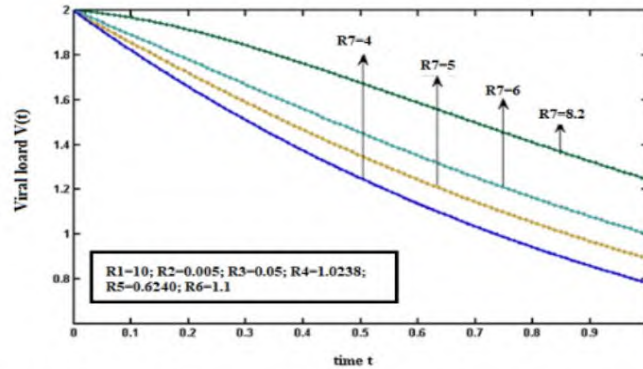


Fig. 10. Plot of viral load  $V(t)$  versus time. The correlation is assessed for Eq. (3) with distinct values of the parameter  $R_7$  and the allotted values of other parameters  $R_1 = 10$ ;  $R_2 = 0.005$ ;  $R_3 = 0.05$ ;  $R_4 = 1.0238$ ;  $R_5 = 0.6240$ ;  $R_6 = 1.1$ . The annotation to the graph: solid line constitutes the Eq. (3) and dotted line constitutes the numerical solution.

**6. Conclusion**

In this paper, HPM is employed to attempt the solution of the model. Numerical simulations were performed to compare the analytical results obtained by HPM with numerical results. The results of the simulations were illustrated graphically. The results show that the analytical solution is in good agreement with the numerical results and produced accurately the same behavior. A clear conclusion can be drawn that HPM is highly reliable in finding the solution of a nonlinear differential Equation.

**Author Contributions**

S. Ashwinipriya: <sup>5</sup> Data curation, Software, Formal analysis, Visualization, Writing - original draft.

R.Vanthana: Methodology, Resources, Conceptualization, Investigation, Writing - review & editing, Project administration, Supervision, Validation.

**Conflict of interest**

The authors declare that they have no conflict of interest.



$$p^1 : \frac{dy_1}{dt} + ay_1 - bx_0v_0 = 0 \quad (\text{A.11})$$

$$p^1 : \frac{dv_1}{dt} + kv_1 - cy_0 + dx_0v_0 = 0 \quad (\text{A.12})$$

**Appendix B: Matlab/Scilab program to find the numerical solution of the eqns. (1)-(3):**

```
function main1
options= odeset('RelTol',1e-6,'Stats','on');
Xo = [0.5;0.4;2];
tspan = [0,1];
tic
[t,X] = ode45(@TestFunction,tspan,Xo,options);
toc
figure
hold on
%plot(t, X(:,1),'g')
%plot(t, X(:,2),'r')
%plot(t, X(:,3))
return

function [dx_dt]=TestFunction(t,x)
R1=10;R2=0.005;R3=0.05;R4=1.0238;R5=0.6240;R6=1.1;R7=8.2;
dx_dt(1)=(R1-(R2*x(1)*x(3))-(R3*x(1)));
dx_dt(2)=(R2*x(1)*x(3))-((R4+R3)*x(2));
dx_dt(3)=(R7*x(2))-(R5*x(3))-(R6*x(3));
dx_dt = dx_dt';
return
```