DAFTAR PUSTAKA

Alydrus, M.R. (2015). *Analisis Dinamik Model Predator Prey Leslie-Gower dengan Fungsi Respon Sokol-Howell*. Tugas Akhir Jurusan Matematika FMIPA ITS.

Altwegg, R, Bradley A., & Margaret L.E. (2006). Functional Response and Prey Defence Level in an Experimental Predator-Prey System. *Evolutionary Ecology Research*, 8:115-128.

Anton, H.(1987).*Aljabar Linear Elementer, Edisi Kelima.* Jakarta: Erlangga.

Balram, D., & Ankit K. (2019). Dynamics of Prey-Predator Model with Stage Structure in Prey Including Maturation and Gestation Delays. *Nonlinear Dynamic*, vol. 96, Issue 4, pp 2653-2679.

Cain, J.W & Reynolds, A. (2010). *Ordinary and Partial Differential Equations*. Math. Department: Virginia Commonwealth University.

Causon, D.M & Mingham, C.G. (2010). *Introductory Finite Difference Methods for PDEs.* Ventus Publishing.

Capone, F., M.F. Carfora, R.D.Luca, & I. Torcicollo. (2018). On the Dynamics of an Intraguild Predator-Prey Model. *Math. Comput. Simulation*, vol. 149, page 17-31.

Collera, J.A. (2014). Bifurcations in Delayed Lotka-Volterra Intraguild Predation Model. *Matimyas Matematika*, 37(1-2), pp. 11-22.

Collera, J.A. (2016). Harvesting in Delayed Food Web Model with Omnivory. *AIP Conf. Proc*, 1705.

Collera.J.A & Magpantay.M.G. (2018). Dynamics of a Stage Structured Intraguild Predation Model. *Springer Nature Switzerland*.

Crank, J. (1956). *The Mathematic of Diffusion*. Oxford: Clarendon Press.

Durmin & Lukman. (2013). *Studi perbandingan perpindahan panas menggunakan metode beda hingga dan Crank-Nicolson*. Surabaya : tidak diterbitkan.

Fitriyah, Lailatul. (2014). *Penyelesaian Numerik Solusi Gelombang Berjalan pada Model Difusi Predator-Prey*. Skripsi. Fakultas Sains dan Teknologi UIN Maulana Malik Ibrahim Malang : Malang.

Garain, K., Kumar, U., & Mandal, P.S. (2019). Global Dynamics in a Beddington-DeAngelis Prey-Predator Model with Density Dependent Death Rate of Predator. *Differential Equations and Dynamical Systems,* 29,265-283

Hale, J. K & Husyen K. (1991). *Dynamics and Bifurcations*. New York : Springer-Verlag.

Han, R., Binxiang D., & Lin W. (2018). Delay Induced Spatiotemporal Patterns in a Diffusive Intraguild Predation Model with Beddington-DeAngelis Functional Response, M*athematical Bioscience and engineering*, vol. 15, No. 3.

Han, R., Binxiang D., & Yuming C. (2019). Pattern Formation in a Diffusive Intraguild Predation Model with Nonlocal Interaction Effects. *AIP Advances,* Vol.9, Issue 3.

Hoffman, J.D. (1992). *Numerical Method for Engineers and Scientists*. New York: McGraw-Hill Inc.

Holt, R.D. & G.A. Polis. (1997). A Theoretical Framework for Intraguild Predation. *The American Naturalist*, Vol.149,No.4 (Apr.,1997), pp. 745-764.

Iswanto, R.J. (2012). *Pemodelan Matematika: Aplikasi dan Terapannya*. Yogyakarta: Graha Ilmu.

Kang Y & Wedekin L. (2013). Dynamics of Intraguild Predation model with Generalist or Specialist Predator. *J.Math Biol*, 67(5):1227-59.

Li, Z & Dai, B. (2018). Global Dynamics of Delayed Intraguild Predation Model with Intraspecific Competition. *International Journal of Biomathematics*, Vol.11 No.8.

Pastor, J. (2008). *Mathematical Ecology of Populastions and Ecosystems*. USA: Wiley-Blackwell.S.

Polis, G.A., R.D. Holt, & C.A Myers. 1989. The Ecology and Evolution of Intraguild Predation: Potential Competitors That Eat Each Other. *Annu.Rev.Ecol.Syst*., Vol. 20:297-330.

Polis, G.A. & R.D. Holt. (1992). Intraguild Predation: The Dynamics of Complex Trophic Interactions. *Trends Ecol. Evol*.,7(5):151-4.

Robbie, W., Chanin U., & Hannah L.B. (2015). Density-Dependent Allometric Functional Response Model. *Ecological Modelling*, 12-18.

Strogatz, S.H. (1994). *Nonlinear Dynamic and Chaos with Application to Physics, Biology, Chemistry and Engineering*. Massachusets (US): Addison-Wesley Publishing Company.

Sugiyarto. (2014). *Persamaan Diferensial*. Binafsi Publisher: Yogyakarta.

Supriyono. (2014). *Diktat Kuliah Sistem Dinamik*. Semarang: Jurusan Matematika UNNES.

Tsai, C.H. & H.C. Pao. (2004). Global Stability for the Leslie-Gower Predator-Prey System with Time-Delay and Holling's Type Functional Response. *Tunghai Science*, Vol. 6:43 72.

Waldhani, G.E. (2015). *Bifurkasi Hopf pada Modifikasi Model Predator-Prey Leslie Gower dengan Fungsi Respon Holling tipe II.* Tugas Akhir Jurusan Matematika Universitas Negeri Semarang.

Wang. X, Guohong Z., & Ju L. (2018). Dynamics of an Intraguild Predation Model with an Adaptive IGpredator. *Mathematical Biosciences*, Vol. 302, page 19-26.

Wei. H.C.,Yuh-Yih C., Jenn-Tsan L., & Shin_Feng, Hwang. (2018). The Dynamics of an Intraguild Predation Model with Prey Switching. *American Institute of Physics*.

Wei, C.X., (2010). *Differential Equations for Engineers*. New York: Cambridge University Press.

Zhang, D. & Dai, B. (2019). Spreading and Vanishing in a Diffusive Intraguild Predation Model with Intraspecific Competition and Free Boundary. *Math. Meth. Appl. Sci*, Vol. 42, 1-27.

Zauderer, E. (2006). *Partial Differential Equation of Applied Mathematics Third Edition*. New York: John Wiley & Sons.Inc.

Lampiran 1. Koefisien persamaan karakteristik (4.25)

$$e_0 = 1$$

$$e_1 = -\Big(\big((D_3 + D_4)D_2 + D_3D_4\big)D_1 + D_2D_3D_4\Big)\frac{c}{D_1D_2D_3D_4}$$

$$e_2 = \frac{1}{D_1D_2D_3D_4}\Big(\big((D_1 + D_3 + D_4)D_2 + (D_1 + D_4)D_3 + D_1D_4\big)c^2 - \big((D_1\Omega_6 + D_4\Omega_1)D_3 + D_1D_4\Omega_3\big)D_2 + D_1D_3D_4\Omega_2\Big)$$

$$e_3 = \frac{1}{D_1D_2D_3D_4}\Big(\big((\Omega_3 + \Omega_6)D_2 + (\Omega_2 + \Omega_6)D_3 + (\Omega_2 + \Omega_3)D_4 - c^2\big)cD_1 + \big((\Omega_1 + \Omega_6)D_3 + (\Omega_1 + \Omega_3)D_4 - c^2\big)cD_2 + \big((\Omega_1 + \Omega_2)D_4 - c^2\big)cD_3 - c^3D_4\Big)$$

$$e_4 = \frac{1}{D_1D_2D_3D_4}\big(c^4 - \big((\Omega_1 + \Omega_3 + \Omega_6)D_2 - (\Omega_1 + \Omega_2 + \Omega_6)D_3 - (\Omega_2 + \Omega_3 + \Omega_6)D_1 - (\Omega_1 + \Omega_2 + \Omega_3)D_4\big)c^2 + \big((\alpha\alpha_1w^*z^* + \Omega_2\Omega_6)D_1 - D_4(r_1r_2 - \Omega_1\Omega_2)\big)D_3 + D_1D_4\Omega_2\Omega_3\big)$$

$$e_5 = \frac{1}{D_1D_2D_3D_4}\Big(c\Big(\big(c^2 - (D_3 + D_4)\Omega_2 - (D_2 + D_4)\Omega_3 - (D_2 + D_3)\Omega_6\big)\Omega_1 + c^2\Omega_6 - \big((D_1 + D_4)\Omega_3 + (D_1 + D_3)\Omega_6 - c^2\big)\Omega_2 - \big((D_1 + D_2)\Omega_6 - c^2\big)\Omega_3 + c^2\Omega_6 + (\Omega_4\Omega_5 - (\delta\delta_1z^* + \rho\rho_1y^*)u^*)D_2 + (r_1r_2 - \alpha\alpha_1w^*z^* - \delta\delta_1u^*z^*)D_3 + (\Omega_4\Omega_5 - \alpha\alpha_1w^*z^*)D_1 + D_4(r_1r_2 - \rho\rho_1u^*y^*)\Big)\Big)$$

$$e_6 = \frac{1}{D_1D_2D_3D_4}\Big(\big((\Omega_1 + \Omega_3 + \Omega_6)\Omega_2 + (\Omega_1 + \Omega_6)\Omega_3 + \Omega_6\Omega_1 + (\delta\delta_1z^* + \rho\rho_1y^*)u^* + \alpha\alpha_1w^*z^* - r_1r_2 - \Omega_4\Omega_5\big)c^2 + (D_1\Omega_4\Omega_5 - (D_1\Omega_6 + D_4\Omega_1)\Omega_3 - (D_3\delta\delta_1z^* + D_4\rho\rho_1y^*)u^* - D_3\Omega_1\Omega_6)\Omega_2 + (D_4r_1r_2 - D_1\alpha\alpha_1w^*z^* - D_2\delta\delta_1u^*z^* - D_2\Omega_1\Omega_6)\Omega_3 + \big((D_2\Omega_4\delta_1\rho - D_3\alpha_1\delta r_2)z^* - \rho_1D_2y^*(\Omega_6\rho - \Omega_5\delta)\big)u^* - \alpha D_3w^*(\Omega_1\alpha_1 + \delta_1r_1)z^* + D_3\Omega_6r_1r_2 + D_2\Omega_1\Omega_4\Omega_5\Big)$$

$$e_7 = \frac{1}{D_1D_2D_3D_4}\Big(c\big(\alpha w^*(\Lambda_1\alpha_1 + \Lambda_3\alpha_1 + \delta_1r_1)z^* + \big((\Lambda_1 + \Lambda_6)\Lambda_3 + \Lambda_1\Lambda_6 - \Lambda_4\Lambda_5\big)\Lambda_2 - \big((\Lambda_4\delta_1\rho - \Lambda_2\delta\delta_1 - \Lambda_3\delta\delta_1 - \alpha_1\delta r_2)z^* - \rho_1y^*(\Lambda_2\rho - \Lambda_5\delta + \Lambda_6\rho)\big)u^* - (r_1r_2 - \Lambda_1\Lambda_6)\Lambda_3 - r_1r_2\Lambda_6 - \Lambda_1\Lambda_4\Lambda_5\big)\Big)$$

$$e_8 = \frac{1}{D_1 D_2 D_3 D_4}\Big(\Big(\big(\delta_1(\Lambda_3\delta - \Lambda_4\rho)\Lambda_2 + \big(r_2\delta\Lambda_3 - \rho(\Lambda_4 r_2 - \alpha\rho_1 w^* y^*)\big)\alpha_1\big)z^* + \rho_1\Lambda_2 y^*(\Lambda_6\rho - \Lambda_5\delta)\Big)u^* + \alpha\Lambda_3 w^*(\Lambda_1\alpha_1 + \delta_1 r_1)z^* + \Lambda_1\Lambda_2(\Lambda_3\Lambda_6 - \Lambda_4\Lambda_5) - \big(r_2\Lambda_3\Lambda_6 - \Lambda_5(\Lambda_4 r_2 - \alpha\rho_1 w^* y^*)\big)r_1\Big)$$

Lampiran 2. Simulasi numerik titik kesetimbangan sistem persamaan (4.21) dengan *Maple 2016.*

```
> restart : with(linalg) : with(DEtools) :
> r1 := 3 : r2 := 4.5 : rho := 0.05 : delta := 0.0001 : r3 := 4 : k := 100 : alpha := 0.03 : rho1
    := 0.02 : beta := 0.035 : h1 := 0.03 : g := 0.04 : d1 := 0.6 : alpha1 := 0.009 : beta1
    := 0.025 : delta1 := 0.00005 : d2 := 1.3 : c := 0.5 :

> du := 1/c·( r1·w − r2·u − rho·u·y − delta·u·z) :
> dw := 1/c·( r3·w·(1 − w/k) + r2·u − alpha·w·z) :
> dy := 1/c·( rho1·u·y − beta·y·z/(1 + h1·y + g·z) − d1·y) :
> dz := 1/c·( alpha1·w·z + beta1·y·z/(1 + h1·y + g·z) + delta1·u·z − d2·z) :
>
> T := solve({du, dw, dy, dz}, {u, w, y, z}) :
> Efix1 := T[1];
      Efix1 := {u = 49.06619104, w = 113.2413240, y = 48.38111098, z = 47.33821294}
> Efix2 := T[2];
  Efix2 := {u = 118.4994594 + 21.07055841 I, w = 200.1926987 − 17.46127088 I, y
      = 6.827055947 − 26.13476298 I, z = -46.83824463 + 46.63611412 I}

> Efix3 := T[3];
     Efix3 := {u = 13.77606576, w = -16.01523757, y = -159.8037624, z = 25.65924617}
> Efix4 := T[4];
     Efix4 := {u = 2.530444792, w = -17.14152701, y = -496.7150621, z = 134.0455927}
> Efix5 := T[5];
  Efix5 := {u = 118.4994594 − 21.07055841 I, w = 200.1926987 + 17.46127088 I, y
      = 6.827055947 + 26.13476298 I, z = -46.83824463 − 46.63611412 I}

> Efix6 := T[6];
                Efix6 := {u = 0., w = 0., y = 413.6363636, z = -136.3636364}
> Efix7 := T[7];
              Efix7 := {u = 30.00000000, w = 126.6485486, y = 163.2970972, z = 0.}
> Efix8 := T[8];
            Efix8 := {u = 30.00000000, w = -26.64854858, y = -143.2970972, z = 0.}
> Efix9 := T[9];
                          Efix9 := {u = 0., w = 0., y = 0., z = 0.}
> Efix10 := T[10];
                       Efix10 := {u = 116.6666667, w = 175., y = 0., z = 0.}
> Efix11 := T[11];
```

$$Efix11 := \{u = 95.85318702,\ w = 143.9119267,\ y = 0.,\ z = 41.35893999\}$$

> $Efix12 := T[12];$

$$Efix12 := \{u = 63919.11898,\ w = -210.6617721,\ y = 0.,\ z = -45098.87266\}$$

> $Efix13 := T[13];$

$$Efix13 := \{u = -2.482514972\,10^{6},\ w = 13936.19429,\ y = 0.,\ z = -45168.41221\}$$

> $jac := jacobian([du, dw, dy, dz], [u, w, y, z])$:

> $jac1 := subs(Efix1, evalm(jac));$

$$jac1 := \begin{bmatrix} -13.84757874 & 6.000000000 & -4.906619104 & -0.009813238208 \\ 9.000000000 & -12.95890462 & 0 & -6.794479440 \\ 1.935244439 & 0 & 0.254762238 & -0.4397663841 \\ 0.004733821294 & 0.8520878329 & 0.3627752881 & -0.242630703 \end{bmatrix}$$

> $eigenvals(jac1);$

$$-20.3857657912328,\ -4.38568975587105,\ -1.189600188816 91,\ -0.833296089079273$$

> $jac2 := subs(Efix2, evalm(jac));$

$$jac2 := [[-9.673337946 + 2.604149075\,I,\ 6.000000000,\ -11.84994594 - 2.107055841\,I,\ -0.02369989188 - 0.0042141116 82\,I],\ [9.000000000,\ -21.22053711 - 0.004363506\,I,\ 0,\ -12.01156192 + 1.047676253\,I],\ [0.2730822379 - 1.045390519\,I,\ 0,\ -2.314398731 + 0.1496599918\,I,\ -1.664419047 - 0.2375274910\,I],\ [-0.004683824463 + 0.004663611412\,I,\ -0.8430884033 + 0.8394500542\,I,\ 4.181697933 + 0.4951159604\,I,\ 2.204189271 - 0.1425333263\,I]]$$

> $eigenvals(jac2);$

$$-24.98082284 + 0.6585324901\,I,\ -5.675637942 + 0.5425298589\,I,\ -1.717264681 + 2.956291257\,I,\ 1.369641036 - 1.550441376\,I$$

> $jac3 := subs(Efix3, evalm(jac));$

$$jac3 := \begin{bmatrix} 6.975244390 & 6.000000000 & -1.377606576 & -0.002755213152 \\ 9.000000000 & 9.022883240 & 0 & 0.9609142542 \\ -6.392150496 & 0 & -1.124083720 & -5.540433631 \\ 0.002565924617 & 0.4618664311 & 0.3393759652 & 1.070555924 \end{bmatrix}$$

> $eigenvals(jac3);$

$$15.6692662410300,\ -2.52917793354797,\ 1.40225576325899 + 0.565865052491988\,I,\ 1.40225576325899 - 0.565865052491988\,I$$

> $jac4 := subs(Efix4, evalm(jac));$

$$jac4 := \begin{bmatrix} 40.64469709 & 6.000000000 & -0.2530444792 & -0.0005060889584 \\ 9.000000000 & 2.699908758 & 0 & 1.028491621 \\ -19.86860248 & 0 & -1.917349315 & -6.628077977 \\ 0.01340455927 & 2.412820669 & 0.5846907905 & 1.826046970 \end{bmatrix}$$

> $eigenvals(jac4);$

$$42.1298041651814,\ 2.80084319118259,\ -0.838671926682009 + 1.142941788339 87\,I,\ -0.838671926682009 - 1.142941788339 87\,I$$

> $jac5 := subs(Efix5, evalm(jac));$

$$jac5 := [[-9.673337946 - 2.604149075\,I,\ 6.000000000,\ -11.84994594 + 2.107055841\,I,\ -0.02369989188 + 0.004214111682\,I],\ [9.000000000,\ -21.22053711 + 0.004363506\,I,\ 0,\ -12.01156192 - 1.047676253\,I],\ [0.2730822379 + 1.045390519\,I,\ 0,\ -2.314398731 - 0.1496599918\,I,\ -1.664419047 + 0.2375274910\,I],\ [-0.004683824463 - 0.004663611412\,I,\ -0.8430884033 - 0.8394500542\,I,\ 4.181697933 - 0.4951159604\,I,\ 2.204189271 + 0.1425333263\,I]]$$

> $eigenvals(jac5);$

$$-24.98082284 - 0.6585324901\,I,\ -5.675637942 - 0.5425298589\,I,\ -1.717264681 - 2.956291257\,I,\ 1.369641036 + 1.550441376\,I$$

> $jac6 := subs(Efix6, evalm(jac));$

$$jac6 := \begin{bmatrix} -50.33636363 & 6.000000000 & -0. & -0. \\ 9.000000000 & 16.18181818 & 0 & -0. \\ 16.54545454 & 0 & -1.872000001 & -6.136000001 \\ -0.01363636364 & -2.454545455 & 0.4800000005 & 1.782857143 \end{bmatrix}$$

> $eigenvals(jac6);$

$$-51.1384988894682,\ 16.9839534394682,\ -0.672437005548007,\ 0.583294147548007$$

> $jac7 := subs(Efix7, evalm(jac));$

$$jac7 := \begin{bmatrix} -25.32970972 & 6.000000000 & -3.000000000 & -0.006000000000 \\ 9.000000000 & -12.26376778 & 0 & -7.598912916 \\ 6.531883888 & 0 & 0. & -1.937780226 \\ 0. & 0. & 0. & 1.066802608 \end{bmatrix}$$

> $eigenvals(jac7);$

$$-28.0515227495230,\ -8.53863663107278,\ -1.00331811940423,\ 1.06680260800000$$

> $jac8 := subs(Efix8, evalm(jac));$

$$jac8 := \begin{bmatrix} 5.329709720 & 6.000000000 & -3.000000000 & -0.006000000000 \\ 9.000000000 & 12.26376777 & 0 & 1.598912915 \\ -5.731883888 & 0 & 0. & -3.040637040 \\ 0. & 0. & 0. & -0.904790274 \end{bmatrix}$$

> $eigenvals(jac8);$

$$17.2211269109131,\ -3.31814878118001,\ 3.69049936026687,\ -0.904790274000000$$

> $jac9 := subs(Efix9, evalm(jac));$

$$jac9 := \begin{bmatrix} -9.000000000 & 6.000000000 & -0. & -0. \\ 9.000000000 & 8.000000000 & 0 & -0. \\ 0. & 0 & -1.200000000 & 0. \\ 0. & 0. & 0. & -2.600000000 \end{bmatrix}$$

> $eigenvals(jac9);$

$$-11.7361025271221,\ 10.7361025271221,\ -1.20000000000000,\ -2.60000000000000$$

> $jac10 := subs(Efix10, evalm(jac));$

$$jac10 := \begin{bmatrix} -9.000000000 & 6.000000000 & -11.66666667 & -0.02333333334 \\ 9.000000000 & -20.00000000 & 0 & -10.50000000 \\ 0. & 0 & 3.466666668 & 0. \\ 0. & 0. & 0. & 0.561666667 \end{bmatrix}$$

```
> eigenvals(jac10);
```

$$-5.32122012465709, -23.6787798753429, 3.46666666800000, 0.561666667000000$$

```
> jac11 := subs(Efix11, evalm(jac));
```

$$jac11 := \begin{bmatrix} -9.008271788 & 6.000000000 & -9.585318702 & -0.01917063740 \\ 9.000000000 & -17.50744467 & 0 & -8.634715602 \\ 0. & 0 & 1.543420713 & 0. \\ 0.004135893999 & 0.7444609198 & 0.7790762630 & 0. \end{bmatrix}$$

```
> eigenvals(jac11);
```

$$-21.5244761882719, -4.37227798474319, -0.618962284984929, 1.54342071300000$$

```
> jac12 := subs(Efix12, evalm(jac));
```

$$jac12 := \begin{bmatrix} 0.019774532 & 6.000000000 & -6391.911898 & -12.78382380 \\ 9.000000000 & 2747.638244 & 0 & 12.63970633 \\ 0. & 0 & 2553.813788 & 0. \\ -4.509887266 & -811.7797079 & 1.250693306 & 0. \end{bmatrix}$$

```
> eigenvals(jac12);
```

$$-3.35339079593085, 7.08055491888413, 2743.93085440905, 2553.81378800000$$

```
> jac13 := subs(Efix13, evalm(jac));
```

$$jac13 := \begin{bmatrix} 0.033682442 & 6.000000000 & 2.482514972\,10^{5} & 496.5029944 \\ 9.000000000 & 488.313647 & 0 & -836.1716574 \\ 0. & 0 & -99303.54985 & 0. \\ -4.516841221 & -813.0314198 & 1.250692238 & 0. \end{bmatrix}$$

```
> eigenvals(jac13);
```

$$3.73570724694794, 1101.46309021789, -616.851468022841, -99303.5498500000$$

Lampiran 3. Simulasi numerik titik kesetimbangan sistem persamaan (4.20) *dengan Maple 2016*.

```
> restart : with(linalg) : with(DEtools) :
> D1 := 0.00001 : D2 := 0.00001 : D3 := 0.00001 : D4 := 0.00001 : r1 := 3 : r2 := 4.5 : rho
  := 0.05 : delta := 0.0001 : r3 := 4 : k := 100 : alpha := 0.03 : rho1 := 0.02 : beta
  := 0.035 : h1 := 0.03 : g := 0.04 : d1 := 0.6 : alpha1 := 0.009 : beta1 := 0.025 : delta1
  := 0.00005 : d2 := 1.3 : c := 0.5 :
> du := u1 :
> du1 := c/D1 · u1 − 1/D1 · (r1 · w − r2 · u − rho · u · y − delta · u · z) :
> dw := w1 :
> dw1 := c/D2 · w1 − 1/D2 · (r3 · w · (1 − w/k) + r2 · u − alpha · w · z) :
> dy := y1 :
```

> $dy1 := \frac{c}{D3} \cdot y1 - \frac{1}{D3} \cdot \left(rho1 \cdot u \cdot y - \frac{\text{beta} \cdot y \cdot z}{1 + h1 \cdot y + g \cdot z} - d1 \cdot y \right)$:

> $dz := z1$:

> $dz1 := \frac{c}{D4} \cdot z1 - \frac{1}{D4} \cdot \left(alpha1 \cdot w \cdot z + \frac{beta1 \cdot y \cdot z}{1 + h1 \cdot y + g \cdot z} + delta1 \cdot u \cdot z - d2 \cdot z \right)$:

> $T := solve(\{du, du1, dw, dw1, dy, dy1, dz, dz1\}, \{u, u1, w, w1, y, y1, z, z1\})$:

> $Efix1 := T[1];$

$$Efix1 := \{u = 95.85318702, u1 = 0., w = 143.9119267, w1 = 0., y = 0., y1 = 0., z = 41.35893999, z1 = 0.\}$$

> $Efix2 := T[2];$

$$Efix2 := \{u = 63919.11898, u1 = 0., w = -210.6617721, w1 = 0., y = 0., y1 = 0., z = -45098.87266, z1 = 0.\}$$

> $Efix3 := T[3];$

$$Efix3 := \{u = -2.482514972\,10^{6}, u1 = 0., w = 13936.19429, w1 = 0., y = 0., y1 = 0., z = -45168.41221, z1 = 0.\}$$

> $Efix4 := T[4];$

$$Efix4 := \{u = 30.00000000, u1 = 0., w = 126.6485486, w1 = 0., y = 163.2970972, y1 = 0., z = 0., z1 = 0.\}$$

> $Efix5 := T[5];$

$$Efix5 := \{u = 30.00000000, u1 = 0., w = -26.64854858, w1 = 0., y = -143.2970972, y1 = 0., z = 0., z1 = 0.\}$$

> $Efix6 := T[6];$

$$Efix6 := \{u = 49.06619104, u1 = 0., w = 113.2413240, w1 = 0., y = 48.38111098, y1 = 0., z = 47.33821294, z1 = 0.\}$$

> $Efix7 := T[7];$

$$Efix7 := \{u = 118.4994594 + 21.07055841\,I, u1 = 0., w = 200.1926987 - 17.46127088\,I, w1 = 0., y = 6.827055947 - 26.13476298\,I, y1 = 0., z = -46.83824463 + 46.63611412\,I, z1 = 0.\}$$

> $Efix8 := T[8];$

$$Efix8 := \{u = 13.77606576, u1 = 0., w = -16.01523757, w1 = 0., y = -159.8037624, y1 = 0., z = 25.65924617, z1 = 0.\}$$

> $Efix9 := T[9];$

$$Efix9 := \{u = 2.530444792, u1 = 0., w = -17.14152701, w1 = 0., y = -496.7150621, y1 = 0., z = 134.0455927, z1 = 0.\}$$

> $Efix10 := T[10];$

$$Efix10 := \{u = 118.4994594 - 21.07055841\,I, u1 = 0., w = 200.1926987 + 17.46127088\,I, w1 = 0., y = 6.827055947 + 26.13476298\,I, y1 = 0., z = -46.83824463 - 46.63611412\,I, z1 = 0.\}$$

> $Efix11 := T[11];$

$$Efix11 := \{u = 0., u1 = 0., w = 0., w1 = 0., y = 0., y1 = 0., z = 0., z1 = 0.\}$$

> $Efix12 := T[12];$

$$Efix12 := \{u = 116.6666667,\ u1 = 0.,\ w = 175.,\ w1 = 0.,\ y = 0.,\ y1 = 0.,\ z = 0.,\ z1 = 0.\}$$

> $Efix13 := T[13];$

$$Efix13 := \{u = 0.,\ u1 = 0.,\ w = 0.,\ w1 = 0.,\ y = 413.6363636,\ y1 = 0.,\ z = -136.3636364,\ z1 = 0.\}$$

> $jac := jacobian([du, du1, dw, dw1, dy, dy1, dz, dz1], [u, u1, w, w1, y, y1, z, z1]);$

$$jac := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$

$$\left[5000.\,y + 10.\,z + 4.5\,10^5,\ 50000.00000,\ -3.\,10^5,\ 0,\ 5000.\,u,\ 0,\ 10.\,u,\ 0\right],$$

$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$

$$\left[-4.5\,10^5,\ 0,\ -4.\,10^5 + 8000.000000\,w + 3000.\,z,\ 50000.00000,\ 0,\ 0,\ 3000.\,w,\ 0\right],$$

$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$

$$\left[-2000.\,y,\ 0,\ 0,\ 0,\ -2000.\,u + \frac{3500.\,z}{0.03\,y + 0.04\,z + 1} - \frac{105.\,yz}{(0.03\,y + 0.04\,z + 1)^2} + 60000.,\right.$$

$$\left.50000.00000,\ \frac{3500.\,y}{0.03\,y + 0.04\,z + 1} - \frac{140.\,yz}{(0.03\,y + 0.04\,z + 1)^2},\ 0\right],$$

$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$

$$\left[-5.\,z,\ 0,\ -900.\,z,\ 0,\ -\frac{2500.\,z}{0.03\,y + 0.04\,z + 1} + \frac{75.\,yz}{(0.03\,y + 0.04\,z + 1)^2},\ 0,\ -900.\,w\right.$$

$$\left.\left. - \frac{2500.\,y}{0.03\,y + 0.04\,z + 1} + \frac{100.\,yz}{(0.03\,y + 0.04\,z + 1)^2} - 5.\,u + 1.3\,10^5,\ 50000.00000\right]\right]$$

> $jac1 := subs(Efix1, evalm(jac));$

$$jac1 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$

$$\left[4.504135894\,10^5,\ 50000.00000,\ -3.\,10^5,\ 0,\ 4.792659351\,10^5,\ 0,\ 958.5318702,\ 0\right],$$

$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$

$$\left[-4.5\,10^5,\ 0,\ 8.753722340\,10^5,\ 50000.00000,\ 0,\ 0,\ 4.317357801\,10^5,\ 0\right],$$

$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$

$$\left[-0.,\ 0,\ 0,\ 0,\ -77171.0356,\ 50000.00000,\ 0.,\ 0\right],$$

$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$

$$\left.\left[-206.7947000,\ 0,\ -37223.04599,\ 0,\ -38953.81315,\ 0,\ 0.0001,\ 50000.00000\right]\right]$$

> $eigenvals(jac1);$

$$-21.5152181035592,\ 50021.5152181035,\ -4.37189571822819,\ 50004.3718957183,$$
$$-0.618954624456819,\ 50000.6189546245,\ 1.54346835789329,\ 49998.4565316421$$

> $jac2 := subs(Efix2, evalm(jac));$

$$jac2 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[-988.7266, 50000.00000, -3.\,10^{5}, 0, 3.195955949\,10^{8}, 0, 6.391911898\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, -1.373819122\,10^{8}, 50000.00000, 0, 0, -6.319853163\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-0., 0, 0, 0, -1.276906895\,10^{8}, 50000.00000, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[2.254943633\,10^{5}, 0, 4.058898539\,10^{7}, 0, -62534.66532, 0, 0., 50000.00000\right]\right]$$

> $eigenvals(jac2);$

$$2913.72694908745, 47086.2730509125, 7.08155788670410, 49992.9184421133,$$
$$-3.35316592171876, 50003.3531659217, 2699.56703335112, 47300.4329666489$$

> $jac3 := subs(Efix3, evalm(jac));$

$$jac3 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[-1684.1221, 50000.00000, -3.\,10^{5}, 0, -1.241257486\,10^{10}, 0, -2.482514972\,10^{7}, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, -2.44156823\,10^{7}, 50000.00000, 0, 0, 4.180858287\,10^{7}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-0., 0, 0, 0, 4.965177492\,10^{9}, 50000.00000, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[2.258420610\,10^{5}, 0, 4.065157099\,10^{7}, 0, -62534.61192, 0, 0., 50000.00000\right]\right]$$

> $eigenvals(jac3);$

$$1126.85932849815, 48873.1406715019, -609.423527660976, 50609.4235276610,$$
$$3.73598640250566, 49996.2640135975, -49767.4895392376, 99767.4895392376$$

> $jac4 := subs(Efix4, evalm(jac));$

$$jac4 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[1.266485486\,10^{6}, 50000.00000, -3.\,10^{5}, 0, 1.500000000\,10^{5}, 0, 300.0000000, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, 6.13188389\,10^{5}, 50000.00000, 0, 0, 3.799456458\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-3.265941944\,10^{5}, 0, 0, 0, 0., 50000.00000, 96889.01131, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[-0., 0, -0., 0, 0., 0, -53340.1304, 50000.00000\right]\right]$$

> $eigenvals(jac4);$

$$-28.0358026249451,\ 50028.0358026249,\ -8.53717896257876,\ 50008.5371789626,$$
$$-1.00329798727034,\ 50001.0032979873,\ 1.06682537032611,\ 49998.9331746297$$

> $jac5 := subs(Efix5, evalm(jac));$

$$jac5 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[-2.664854860\,10^{5}, 50000.00000, -3.\,10^{5}, 0, 1.500000000\,10^{5}, 0, 300.0000000, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, -6.131883886\,10^{5}, 50000.00000, 0, 0, -79945.64574, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[2.865941944\,10^{5}, 0, 0, 0, 0., 50000.00000, 1.520318520\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[-0., 0, -0., 0, 0., 0, 45239.51372, 50000.00000\right]\right]$$

> $eigenvals(jac5);$

$$17.2270623458026,\ 49982.7729376542,\ -3.31792860801943,\ 50003.3179286080,$$
$$3.69077179668238,\ 49996.3092282033,\ -0.904773902089801,\ 50000.9047739021$$

> $jac6 := subs(Efix6, evalm(jac));$

$$jac6 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[6.923789370\,10^{5}, 50000.00000, -3.\,10^{5}, 0, 2.453309552\,10^{5}, 0, 490.6619104, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, 6.479452308\,10^{5}, 50000.00000, 0, 0, 3.397239720\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-96762.22196, 0, 0, 0, -12738.11192, 50000.00000, 21988.31921, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[-236.6910647, 0, -42604.39165, 0, -18138.76441, 0, 12131.5352, 50000.00000\right]\right]$$

> $eigenvals(jac6);$

$$-20.3774609709435,\ 50020.3774609710,\ -4.38530513430305,\ 50004.3853051343,$$
$$-1.18957188987406,\ 50001.1895718899,\ -0.833282201339898,\ 50000.8332822013$$

> $jac7 := subs(Efix7, evalm(jac));$

$$jac7 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[4.836668973\,10^{5} - 1.302074538\,10^{5}\,I, 50000.00000, -3.\,10^{5}, 0, 5.924972970\,10^{5}\right.$$
$$\left. + 1.053527920\,10^{5}\,I, 0, 1184.994594 + 210.7055841\,I, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, 1.061026856\,10^{6} + 218.1754\,I, 50000.00000, 0, 0, 6.005780961\,10^{5}\right.$$
$$\left. - 52383.81264\,I, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-13654.11189 + 52269.52596\,I, 0, 0, 0, 1.157199366\,10^{5} - 7482.999591\,I, 50000.00000,\right.$$
$$\left. 83220.95236 + 11876.37455\,I, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left[234.1912232 - 233.1805706\,I, 0, 42154.42017 - 41972.50271\,I, 0, -2.090848966\,10^{5}\right.$$
$$\left. - 24755.79802\,I, 0, -1.102094635\,10^{5} + 7126.666314\,I, 50000.00000\right]\left.\right]$$

> $eigenvals(jac7);$

$$-24.96836883 + 0.6578692031\,I, -5.674990924 + 0.5424087169\,I, -1.717389440$$
$$+ 2.956087689\,I, 1.369599188 - 1.550535872\,I, 50024.96828 - 0.6578703453\,I,$$
$$50005.67483 - 0.5423833907\,I, 50001.71735 - 2.956136370\,I, 49998.63038$$
$$+ 1.550546284\,I$$

> $jac8 := subs(Efix8, evalm(jac));$

$$jac8 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[-3.487622195\,10^{5}, 50000.00000, -3.\,10^{5}, 0, 68880.32880, 0, 137.7606576, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^{5}, 0, -4.511441621\,10^{5}, 50000.00000, 0, 0, -48045.71271, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[3.196075248\,10^{5}, 0, 0, 0, 56204.18604, 50000.00000, 2.770216815\,10^{5}, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left[-128.2962308, 0, -23093.32155, 0, -16968.79826, 0, -53527.7961, 50000.00000\right]\left.\right]$$

> $eigenvals(jac8);$

$$15.6741798403600, -2.52905001184990, 49984.3258201597, 1.40228868591657$$
$$+ 0.565896792501020\,I, 1.40228868591657 - 0.565896792501020\,I,$$
$$50002.5290500119, 49998.5977113141 + 0.565896792499129\,I, 49998.5977113141$$
$$- 0.565896792499129\,I$$

> $jac9 := subs(Efix9, evalm(jac));$

```
jac9 := [[0, 1, 0, 0, 0, 0, 0, 0],
    [-2.032234854 10^6, 50000.00000, -3. 10^5, 0, 12652.22396, 0, 25.30444792, 0],
    [0, 0, 0, 1, 0, 0, 0, 0],
    [-4.5 10^5, 0, -1.349954380 10^5, 50000.00000, 0, 0, -51424.58103, 0],
    [0, 0, 0, 0, 0, 1, 0, 0],
    [9.934301242 10^5, 0, 0, 0, 95867.46578, 50000.00000, 3.314038988 10^5, 0],
    [0, 0, 0, 0, 0, 0, 0, 1],
    [-670.2279635, 0, -1.206410334 10^5, 0, -29234.53954, 0, -91302.3485, 50000.00000]]

> eigenvals(jac9);
  42.1653625115941, 49957.8346374885, 2.80100010343449, -0.838683983092778
    + 1.142903446975071, -0.838683983092778 - 1.142903446975071,
    49997.1989998965, 50000.8386839831 + 1.142903447002731, 50000.8386839831
    - 1.142903447002731

> jac10 := subs(Efix10, evalm(jac));
  jac10 := [[0, 1, 0, 0, 0, 0, 0, 0],
    [4.836668973 10^5 + 1.302074538 10^5 I, 50000.00000, -3. 10^5, 0, 5.924972970 10^5
    - 1.053527920 10^5 I, 0, 1184.994594 - 210.7055841 I, 0],
    [0, 0, 0, 1, 0, 0, 0, 0],
    [-4.5 10^5, 0, 1.061026856 10^6 - 218.1754 I, 50000.00000, 0, 0, 6.005780961 10^5
    + 52383.81264 I, 0],
    [0, 0, 0, 0, 0, 1, 0, 0],
    [-13654.11189 - 52269.52596 I, 0, 0, 0, 1.157199366 10^5 + 7482.999591 I, 50000.00000,
    83220.95236 - 11876.37455 I, 0],
    [0, 0, 0, 0, 0, 0, 0, 1],
    [234.1912232 + 233.1805706 I, 0, 42154.42017 + 41972.50271 I, 0, -2.090848966 10^5
    + 24755.79802 I, 0, -1.102094635 10^5 - 7126.666314 I, 50000.00000]]


> eigenvals(jac10);
  -24.96836883 - 0.6578692031 I, -5.674990924 - 0.5424087169 I, -1.717389440
    - 2.956087689 I, 1.369599188 + 1.550535872 I, 50024.96828 + 0.6578703453 I,
    50005.67483 + 0.5423833907 I, 50001.71735 + 2.956136370 I, 49998.63038
    - 1.550546284 I

> jac11 := subs(Efix11, evalm(jac));
```

$$jac11 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[4.5\,10^5, 50000.00000, -3.\,10^5, 0, 0., 0, 0., 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^5, 0, -4.\,10^5, 50000.00000, 0, 0, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-0., 0, 0, 0, 60000., 50000.00000, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[-0., 0, -0., 0, 0., 0, 1.3\,10^5, 50000.00000\right]\right]$$

```
> eigenvals(jac11);
```

$$-11.7333490975070, 50011.7333490975, 10.7384087955943, 49989.2615912044,$$
$$-1.19997120137850, 50001.1999712014, -2.59986481405940, 50002.5998648141$$

```
> jac12 := subs(Efix12, evalm(jac));
```

$$jac12 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[4.5\,10^5, 50000.00000, -3.\,10^5, 0, 5.833333335\,10^5, 0, 1166.666667, 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^5, 0, 1.000000000\,10^6, 50000.00000, 0, 0, 5.25\,10^5, 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-0., 0, 0, 0, -1.733333334\,10^5, 50000.00000, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[-0., 0, -0., 0, 0., 0, -28083.3333, 50000.00000\right]\right]$$

```
> eigenvals(jac12);
```

$$-23.6675767915149, 50023.6675767916, -5.32065393748780, 50005.3206539375,$$
$$3.46690705689252, 49996.5330929431, 0.561672975527472, 49999.4383270245$$

```
> jac13 := subs(Efix13, evalm(jac));
```

$$jac13 := \left[\left[0, 1, 0, 0, 0, 0, 0, 0\right],\right.$$
$$\left[2.516818182\,10^6, 50000.00000, -3.\,10^5, 0, 0., 0, 0., 0\right],$$
$$\left[0, 0, 0, 1, 0, 0, 0, 0\right],$$
$$\left[-4.5\,10^5, 0, -8.090909092\,10^5, 50000.00000, 0, 0, 0., 0\right],$$
$$\left[0, 0, 0, 0, 0, 1, 0, 0\right],$$
$$\left[-8.272727272\,10^5, 0, 0, 0, 93600.00001, 50000.00000, 3.068000000\,10^5, 0\right],$$
$$\left[0, 0, 0, 0, 0, 0, 0, 1\right],$$
$$\left.\left[681.8181820, 0, 1.227272728\,10^5, 0, -24000.00000, 0, -89142.8572, 50000.00000\right]\right]$$

```
> eigenvals(jac13);
```

$$-51.0863026928419,\ 50051.0863026928,\ 16.9897264594038,\ 49983.0102735406,$$
$$-0.672427964578674,\ 50000.6724279646,\ 0.583300956364837,\ 49999.4166990437$$

Lampiran 4. Simulasi numerik Gambar 4.2 dan Gambar 4.3

```
> restart : with(DEtools) :
> du := 1/c·( r1·w − r2·u − rho·u·y − delta·u·z) :
> dw := 1/c·( r3·w·(1 − w/k) + r2·u − alpha·w·z) :
> dy := 1/c·( rho1·u·y − beta·y·z/(1 + h1·y + g·z) − d1·y) :
> dz := 1/c·( alpha1·w·z + beta1·y·z/(1 + h1·y + g·z) + delta1·u·z − d2·z) :
> data := {r1 = 3, r2 = 4.5, rho = 0.05, delta = 0.0001 , r3 = 4, k = 100, alpha = 0.03, rho1 = 0.02,
    beta = 0.035, h1 = 0.03, g = 0.04, d1 = 0.6, alpha1 = 0.009, beta1 = 0.025, delta1 = 0.00005,
    d2 = 1.3, u = u(s), w = w(s), y = y(s), z = z(s)} :
> sys := diff(u(s), s) = subs(data, du), diff(w(s), s) = subs(data, dw), diff(y(s), s) = subs(data,
    dy), diff(z(s), s) = subs(data, dz);
```

$$sys := \frac{d}{ds}u(s) = \frac{-0.0001\,u(s)\,z(s) - 0.05\,u(s)\,y(s) + 3\,w(s) - 4.5\,u(s)}{c},\ \frac{d}{ds}w(s)$$
$$= \frac{4\,w(s)\left(1 - \frac{1}{100}\,w(s)\right) + 4.5\,u(s) - 0.03\,w(s)\,z(s)}{c},\ \frac{d}{ds}y(s)$$
$$= \frac{0.02\,u(s)\,y(s) - \frac{0.035\,y(s)\,z(s)}{0.04\,z(s) + 0.03\,y(s) + 1} - 0.6\,y(s)}{c},\ \frac{d}{ds}z(s)$$
$$= \frac{0.009\,w(s)\,z(s) + \frac{0.025\,y(s)\,z(s)}{0.04\,z(s) + 0.03\,y(s) + 1} + 0.00005\,u(s)\,z(s) - 1.3\,z(s)}{c}$$

```
> ivs1 := [u(0) = 49.06, w(0) = 113.24, y(0) = 48.38, z(0) = 47.33] :
> ivs2 := [u(0) = 59.06, w(0) = 123.24, y(0) = 38.38, z(0) = 37.33] :
> c := 0.5 :
> U11 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, u(s)], linecolour
    = blue) :
> c := 1.0 :
> U12 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, u(s)], linecolour
    = green) :
> c := 1.5 :
> U13 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, u(s)], linecolour
    = yellow) :
> c := 2.0 :
> U14 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, u(s)], linecolour
    = red) :
> c := 0.5 :
```

```
> U21 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, u(s)], linecolour
      = blue) :
> c := 1.0 :
> U22 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, u(s)], linecolour
      = green) :
> c := 1.5 :
> U23 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, u(s)], linecolour
      = yellow) :
> c := 2.0 :
> U24 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, u(s)], linecolour
      = red) :
> c := 0.5 :
> W11 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, w(s)], linecolour
      = blue) :
> c := 1.0 :
> W12 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, w(s)], linecolour
      = green) :
> c := 1.5 :
> W13 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, w(s)], linecolour
      = yellow) :
> c := 2.0 :
> W14 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs1], scene = [s, w(s)], linecolour
      = red) :
> c := 0.5 :
> W21 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, w(s)], linecolour
      = blue) :
> c := 1.0 :
> W22 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, w(s)], linecolour
      = green) :
> c := 1.5 :
> W23 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, w(s)], linecolour
      = yellow) :
> c := 2.0 :
> W24 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..10, [ivs2], scene = [s, w(s)], linecolour
      = red) :
> c := 0.5 :
> Y11 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs1], scene = [s, y(s)], linecolour
      = blue) :
> c := 1.0 :
> Y12 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs1], scene = [s, y(s)], linecolour
      = green) :
> c := 1.5 :
```

```
> Y13 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs1], scene = [s, y(s)], linecolour
      = yellow) :
> c := 2.0 :
> Y14 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs1], scene = [s, y(s)], linecolour
      = red) :
> c := 0.5 :
> Y21 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs2], scene = [s, y(s)], linecolour
      = blue) :
> c := 1.0 :
> Y22 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs2], scene = [s, y(s)], linecolour
      = green) :
> c := 1.5 :
> Y23 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs2], scene = [s, y(s)], linecolour
      = yellow) :
> c := 2.0 :
> Y24 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..25, [ivs2], scene = [s, y(s)], linecolour
      = red) :
> c := 0.5 :
> Z11 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs1], scene = [s, z(s)], linecolour
      = blue) :
> c := 1.0 :
> Z12 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs1], scene = [s, z(s)], linecolour
      = green) :
> c := 1.5 :
> Z13 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs1], scene = [s, z(s)], linecolour
      = yellow) :
> c := 2.0 :
> Z14 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs1], scene = [s, z(s)], linecolour
      = red) :
> c := 0.5 :
> Z21 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs2], scene = [s, z(s)], linecolour
      = blue) :
> c := 1.0 :
> Z22 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs2], scene = [s, z(s)], linecolour
      = green) :
> c := 1.5 :
> Z23 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs2], scene = [s, z(s)], linecolour
      = yellow) :
> c := 2.0 :
> Z24 := DEplot([sys], [u(s), w(s), y(s), z(s)], s = 0..15, [ivs2], scene = [s, z(s)], linecolour
      = red) :
> with(plots) :
> display([U11, U12, U13, U14])
> display([U21, U22, U23, U24])
```

> $display([W11, W12, W13, W14])$
> $display([W21, W22, W23, W24])$
> $display([Y11, Y12, Y13, Y14])$
> $display([Y21, Y22, Y23, Y24])$
> $display([Z11, Z12, Z13, Z14])$
> $display([Z21, Z22, Z23, Z24])$

Lampiran 5. Simulasi numerik Gambar (4.4)-(4.9) dengan Matlab R2016a

```
clear;
%parameter yang dapat diubah
D1=input('masukkan koefisien difusi prey kecil=');%0.00001-0.01
D2=input('masukkan koefisien difusi prey dewasa=');%0.00001-0.01
D3=input('masukkan koefisien difusi prey intraguild=');%0.00001-
0.01
D4=input('masukkan koefisien difusi predator
intraguild=');%0.00001-0.01
%parameter tetap
r1=3;
r2=4.5;
rho=0.05;
delta=0.0001;
r3=4;
K=100;
alpha=0.03;
rho1=0.02;
beta=0.035;
h=0.03;
g=0.04;
d1=0.6;
alpha1=0.009;
beta1=0.025;
delta1=0.00005;
d2=1.3;
a=1;
%interval
L=1;
T=1;
Nt=1000;
dt=T/Nt;
Nx=100;
dx=L/Nx;
lambda1=D1*dt/(dx^2);
lambda2=D2*dt/(dx^2);
lambda3=D3*dt/(dx^2);
lambda4=D4*dt/(dx^2);
disp(lambda1);
disp(lambda2);
disp(lambda3);
disp(lambda4);
%kondisi awal
for j=1:Nx+1
    x(j)=(j-1)*dx;
    u(j,1)=49.06+sin(pi*x(j));
    w(j,1)=113.24+sin(pi*x(j));
    y(j,1)=48.38+sin(pi*x(j));
```

```
    z(j,1)=56.33+sin(pi*x(j));%z(j,1)=47.33+sin(pi*x(j))untuk
Gambar (4.9)
end
%kondisi batas
for n=1:Nt+1
    t(n)=(n-1)*dt;
end
for n=1:Nt
    j=1;
    u(j,n+1)=lambda1.*(u(j,n)+u(j+1,n)-2.*u(j,n))+dt*r1.*(w(j,n))-
dt*u(j,n).*(r2+rho.*(y(j,n))+delta.*(z(j,n)))+u(j,n);
    w(j,n+1)=lambda2.*(w(j,n)+w(j+1,n)-
2.*w(j,n))+dt*r2.*(u(j,n))+dt*w(j,n).*(r3.*(1-(w(j,n))/K)-
alpha.*z(j,n))+w(j,n);
    y(j,n+1)=lambda3.*(y(j,n)+y(j+1,n)-
2.*y(j,n))+dt*(y(j,n)).*(rho1.*u(j,n)-
((beta.*z(j,n))/(a+h.*y(j,n)+g.*z(j,n)))-d1)+y(j,n);
    z(j,n+1)=lambda4.*(z(j,n)+z(j+1,n)-
2.*z(j,n))+dt*(z(j,n)).*(alpha1.*w(j,n)+((beta.*y(j,n))/(a+h.*y(j,
n)+g.*z(j,n)))+delta1.*u(j,n)-d2)+z(j,n);
    for j=2:Nx;
       u(j,n+1)=lambda1.*(u(j-1,n)+u(j+1,n)-
2.*u(j,n))+dt*r1.*(w(j,n))-
dt*u(j,n).*(r2+rho.*(y(j,n))+delta.*(z(j,n)))+u(j,n);
       w(j,n+1)=lambda2.*(w(j-1,n)+w(j+1,n)-
2.*w(j,n))+dt*r2.*(u(j,n))+dt*w(j,n).*(r3.*(1-(w(j,n))/K)-
alpha.*z(j,n))+w(j,n);
       y(j,n+1)=lambda3.*(y(j-1,n)+y(j+1,n)-
2.*y(j,n))+dt*(y(j,n)).*(rho1.*u(j,n)-
((beta.*z(j,n))/(a+h.*y(j,n)+g.*z(j,n)))-d1)+y(j,n);
       z(j,n+1)=lambda4.*(z(j-1,n)+z(j+1,n)-
2.*z(j,n))+dt*(z(j,n)).*(alpha1.*w(j,n)+((beta.*y(j,n))/(a+h.*y(j,
n)+g.*z(j,n)))+delta1.*u(j,n)-d2)+z(j,n);
    end
   j=Nx+1;
   u(j,n+1)=lambda1.*(u(j-1,n)+u(j,n)-2.*u(j,n))+dt*r1.*(w(j,n))-
dt*u(j,n).*(r2+rho.*(y(j,n))+delta.*(z(j,n)))+u(j,n);
   w(j,n+1)=lambda2.*(w(j-1,n)+w(j,n)-
2.*w(j,n))+dt*r2.*(u(j,n))+dt*w(j,n).*(r3.*(1-(w(j,n))/K)-
alpha.*z(j,n))+w(j,n);
   y(j,n+1)=lambda3.*(y(j-1,n)+y(j,n)-
2.*y(j,n))+dt*(y(j,n)).*(rho1.*u(j,n)-
((beta.*z(j,n))/(a+h.*y(j,n)+g.*z(j,n)))-d1)+y(j,n);
   z(j,n+1)=lambda4.*(z(j-1,n)+z(j,n)-
2.*z(j,n))+dt*(z(j,n)).*(alpha1.*w(j,n)+((beta.*y(j,n))/(a+h.*y(j,
n)+g.*z(j,n)))+delta1.*u(j,n)-d2)+z(j,n);
end
figure(1)
contourf(t,x,u)%Gambar (4.4)
colormap(jet)
title('D1=D2=D3=D4=0.00001')%disesuaikan dengan koefisien D yang
diinput
xlabel('t Tahun')
ylabel('x Jarak')
colorbar
figure(2)%Gambar (4.5)-(4.8)
```

```
plot(x,u(:,1),'-b',x,u(:,(Nt/100)),'--
g',x,u(:,(Nt/10)),':b',x,u(:,(Nt)),'-.r');
title('D1=D2=D3=D4=0.00001')
xlabel('x Jarak')
ylabel('Kepadatan Populasi u')
figure(3)%Gambar untuk perubahan terhadap waktu
plot(t,u(j,:)),'-b';
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('Kepadatan Populasi u')
figure(4)%Gambar (4.9)
mesh(t,x,u)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
zlabel('u(x,t)')
colorbar
figure(5)
contourf(t,x,w)%Gambar (4.4)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
colorbar
figure(6)%Gambar (4.5)-(4.8)
plot(x,w(:,1),'-b',x,w(:,round(Nt/100)),'--
g',x,w(:,round(Nt/10)),':b',x,w(:,Nt),'-.r');
title('D1=D2=D3=D4=0.00001')
xlabel('x Jarak')
ylabel('Kepadatan Populasi w')
figure(7)%Gambar untuk perubahan terhadap waktu
plot(t,w(j,:)),'-b';
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('Kepadatan Populasi w')
figure(8)%Gambar (4.9)
mesh(t,x,w)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
zlabel('w(x,t)')
colorbar
figure(9)
contourf(t,x,y)%Gambar (4.4)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
colorbar
figure(10)%Gambar (4.5)-(4.8)
plot(x,y(:,1),'-b',x,y(:,round(Nt/100)),'--
g',x,y(:,round(Nt/10)),':b',x,y(:,Nt),'-.r');
title('D1=D2=D3=D4=0.00001')
xlabel('x Jarak')
```

```
ylabel('Kepadatan Populasi y')
figure(11)%Gambar untuk perubahan terhadap waktu
plot(t,y(j,:)),'-b';
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('Kepadatan Populasi y')
figure(12)%Gambar (4.9)
mesh(t,x,y)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
zlabel('y(x,t)')
colorbar
figure(13)%Gambar (4.4)
contourf(t,x,z)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
colorbar
figure(14)%Gambar (4.5)-(4.8)
plot(x,z(:,1),'-b',x,z(:,round(Nt/100)),'--
g',x,z(:,round(Nt/10)),':b',x,z(:,Nt),'-.r');
title('D1=D2=D3=D4=0.00001')
xlabel('x Jarak')
ylabel('Kepadatan Populasi z')
figure(15)%Gambar untuk perubahan terhadap waktu
plot(t,z(j,:)),'-b';
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('Kepadatan Populasi z')
figure(16)%Gambar (4.9)
mesh(t,x,z)
colormap(jet)
title('D1=D2=D3=D4=0.00001')
xlabel('t Tahun')
ylabel('x Jarak')
zlabel('z(x,t)')
colorbar
```

Lampiran 6. Nilai kepadatan populasi untuk setiap kordinat jarak x dan waktu t.

Untuk Populasi Mangsa kecil u dengan $D_1 = D_2 = D_3 = D_4 = 0.01$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
49.0600000000000	49.0799954138818	49.1030090935114	48.1800111443633	$x = 1$
49.0914107590781	49.0957325909985	49.1055901722868	48.1790670199576	$x = 2$
49.1227905195293	49.1207751964905	49.1106215716877	48.1771854775160	$x = 3$
49.1541083133185	49.1492554721082	49.1178604576683	48.1743798359874	⋮
49.1853332335643	49.1785186678098	49.1269848355920	48.1706698416017	
49.2164344650402	49.2078131513536	49.1376332718394	48.1660813955550	
49.2473813145857	49.2369788204590	49.1494433404108	48.1606462012139	
49.2781432413965	49.2659707804788	49.1620823090348	48.1544013392037	
49.3086898871649	49.2947591015602	49.1752665694195	48.1473887802833	
49.3389911060392	49.3233153200783	49.1887695236439	48.1396548471222	

49.3690169943750	49.3516112729248	49.2024200781810	48.1312496369463	
49.3987379202453	49.3796190582076	49.2160950929463	48.1222264174841	
49.4281245526847	49.4073110605148	49.2297091466602	48.1126410087420	
49.4571478906348	49.4346599780392	49.2432042189615	48.1025511628529	
49.4857792915651	49.4616388494151	49.2565408470387	48.0920159536308	
49.5139904997396	49.4882210802127	49.2696913716615	48.0810951865437	
49.5417536741017	49.5143804690636	49.2826352362263	48.0698488386467	
49.5690414157504	49.5400912333917	49.2953559668001	48.0583365366540	
49.5958267949790	49.5653280347249	49.3078393676172	48.0466170798197	
49.6220833778521	49.5900660035630	49.3200725135682	48.0347480127211	
49.6477852522925	49.6142807637785	49.3320432236763	48.0227852514336	
49.6729070536530	49.6379484565255	49.3437398042031	48.0107827650286	
49.6974239897487	49.6610457636350	49.3551509330114	47.9987923128437	
49.7213118653237	49.6835499304732	49.3662656133612	47.9868632366261	
49.7445471059287	49.7054387882411	49.3770731597878	47.9750423054566	
49.7671067811866	49.7266907756945	49.3875631978924	47.9633736103522	
49.7889686274214	49.7472849602627	49.3977256697362	47.9518985046306	
49.8101110696305	49.7672010585462	49.4075508412568	47.9406555855085	
49.8305132427758	49.7864194561741	49.4170293102426	47.9296807119903	
49.8501550123757	49.8049212270016	49.4261520142994	47.9190070538792	
49.8690169943750	49.8226881516297	49.4349102385983	47.9086651666875	
49.8870805742746	49.8397027352288	49.4432956233292	47.8986830873216	
49.9043279255020	49.8559482246510	49.4513001708347	47.8890864456453	
49.9207420270039	49.8714086248120	49.4589162524113	47.8798985873517	
49.9363066800439	49.8860687143298	49.4661366147763	47.8711407039851	
49.9510065241884	49.8999140604035	49.4729543861946	47.8628319664126	
49.9648270524660	49.9129310329190	49.4793630822652	47.8549896585370	
49.9777546256840	49.9251068177677	49.4853566113648	47.8476293085398	
49.9897764858883	49.9364294293662	49.4909292797462	47.8407648154359	
50.0008807689542	49.9468877223642	49.4960757962916	47.8344085691829	
50.0110565162952	49.9564714025306	49.5007912769175	47.8285715630196	
50.0202936856770	49.9651710368068	49.5050712486317	47.8232634970915	
50.0285831611286	49.9729780625177	49.5089116532403	47.8184928727519	
50.0359167619388	49.9798847957322	49.5123088507043	47.8142670772095	
50.0422872507287	49.9858844387646	49.5152596221451	47.8105924584143	
50.0476883405951	49.9909710868107	49.5177611724974	47.8074743902465	
50.0521147013145	49.9951397337113	49.5198111328098	47.8049173281924	
50.0555619646031	49.9983862768386	49.5214075621925	47.8029248557645	
50.0580267284283	50.0007075211001	49.5225489494109	47.8014997219583	
50.0595065603657	50.0021011820571	49.5232342141257	47.8006438700295	⋮
50.0600000000000	50.0025658881541	49.5234627077790	47.8003584578485	$x = 51$
50.0595065603657	50.0021011820571	49.5232342141257	47.8006438700295	⋮
50.0580267284283	50.0007075211001	49.5225489494109	47.8014997219583	
50.0555619646031	49.9983862768386	49.5214075621925	47.8029248557645	
50.0521147013145	49.9951397337113	49.5198111328098	47.8049173281924	
50.0476883405951	49.9909710868107	49.5177611724974	47.8074743902465	
50.0422872507287	49.9858844387646	49.5152596221451	47.8105924584143	
50.0359167619388	49.9798847957322	49.5123088507043	47.8142670772095	
50.0285831611286	49.9729780625177	49.5089116532403	47.8184928727519	
50.0202936856770	49.9651710368068	49.5050712486317	47.8232634970915	
50.0110565162952	49.9564714025306	49.5007912769175	47.8285715630196	
50.0008807689542	49.9468877223642	49.4960757962916	47.8344085691829	
49.9897764858883	49.9364294293662	49.4909292797462	47.8407648154359	
49.9777546256840	49.9251068177677	49.4853566113648	47.8476293085398	
49.9648270524660	49.9129310329190	49.4793630822652	47.8549896585370	
49.9510065241884	49.8999140604035	49.4729543861946	47.8628319664126	
49.9363066800439	49.8860687143298	49.4661366147763	47.8711407039851	
49.9207420270039	49.8714086248120	49.4589162524113	47.8798985873517	
49.9043279255020	49.8559482246510	49.4513001708347	47.8890864456453	
49.8870805742746	49.8397027352288	49.4432956233292	47.8986830873216	
49.8690169943750	49.8226881516297	49.4349102385983	47.9086651666875	
49.8501550123757	49.8049212270016	49.4261520142994	47.9190070538792	

49.8305132427758	49.7864194561741	49.4170293102426	47.9296807119903	
49.8101110696305	49.7672010585462	49.4075508412568	47.9406555855085	
49.7889686274214	49.7472849602627	49.3977256697362	47.9518985046306	
49.7671067811866	49.7266907756945	49.3875631978924	47.9633736103522	
49.7445471059287	49.7054387882411	49.3770731597878	47.9750423054566	
49.7213118653237	49.6835499304732	49.3662656133612	47.9868632366261	
49.6974239897487	49.6610457636350	49.3551509330114	47.9987923128437	
49.6729070536530	49.6379484565255	49.3437398042031	48.0107827650286	
49.6477852522925	49.6142807637785	49.3320432236763	48.0227852514336	
49.6220833778521	49.5900660035630	49.3200725135682	48.0347480127211	
49.5958267949790	49.5653280347249	49.3078393676172	48.0466170798197	
49.5690414157504	49.5400912333917	49.2953559668001	48.0583365366540	
49.5417536741017	49.5143804690636	49.2826352362263	48.0698488386467	
49.5139904997396	49.4882210802127	49.2696913716615	48.0810951865437	
49.4857792915651	49.4616388494151	49.2565408470387	48.0920159536308	
49.4571478906348	49.4346599780392	49.2432042189615	48.1025511628529	
49.4281245526847	49.4073110605148	49.2297091466602	48.1126410087420	
49.3987379202453	49.3796190582076	49.2160950929463	48.1222264174841	
49.3690169943750	49.3516112729248	49.2024200781810	48.1312496369463	
49.3389911060392	49.3233153200783	49.1887695236439	48.1396548471222	
49.3086898871649	49.2947591015602	49.1752665694195	48.1473887802833	
49.2781432413965	49.2659707804788	49.1620823090348	48.1544013392037	
49.2473813145857	49.2369788204590	49.1494433404108	48.1606462012139	
49.2164344650402	49.2078131513536	49.1376332718394	48.1660813955550	
49.1853332335643	49.1785186678098	49.1269848355920	48.1706698416017	
49.1541083133185	49.1492554721082	49.1178604576683	48.1743798359874	⋮
49.1227905195293	49.1207751964905	49.1106215716877	48.1771854775160	$x = 99$
49.0914107590781	49.0957325909985	49.1055901722868	48.1790670199576	$x = 100$
49.0600000000000	49.0799954138818	49.1030090935114	48.1800111443633	$x = 101$

Untuk Populasi mangsa dewasa w dengan $\mathrm{D}_1 = \mathrm{D}_2 = \mathrm{D}_3 = \mathrm{D}_4 = 0.01$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
113.240000000000	113.259239878802	113.217776089326	110.493740309189	$x = 1$
113.271410759078	113.275121030833	113.220487183138	110.492348108879	$x = 2$
113.302790519529	113.300387988250	113.225771986891	110.489573550867	$x = 3$
113.334108313319	113.329119373591	113.233375360985	110.485436183641	⋮
113.365333233564	113.358638646328	113.242958992259	110.479964991412	
113.396434465040	113.388188748373	113.254143127852	110.473197997033	
113.427381314586	113.417608534912	113.266546970528	110.465181747456	
113.458143241397	113.446852786651	113.279820921441	110.455970693833	
113.488689887165	113.475891325906	113.293666997436	110.445626480616	
113.518991106039	113.504695448915	113.307847119605	110.434217159774	
113.549016994375	113.533236755732	113.322181532961	110.421816347489	
113.578737920245	113.561487110955	113.336540873867	110.408502341387	
113.608124552685	113.589418669189	113.350835416821	110.394357216520	
113.637147890635	113.617003902351	113.365004233026	110.379465917933	
113.665779291565	113.644215626700	113.379005897812	110.363915366759	
113.693990499740	113.671027029499	113.392811393251	110.347793595497	
113.721753674102	113.697411695318	113.406399167936	110.331188926441	
113.749041415750	113.723343631923	113.419751963155	110.314189205243	
113.775826794979	113.748797295747	113.432854916308	110.296881099445	
113.802083377852	113.773747616909	113.445694501874	110.279349469500	
113.827785252292	113.798170023757	113.458257977844	110.261676817494	
113.852907053653	113.822040466915	113.470533115515	110.243942816506	
113.877423989749	113.845335442811	113.482508077733	110.226223921366	
113.901311865324	113.868032016656	113.494171370103	110.208593059624	
113.924547105929	113.890107844870	113.505511825908	110.191119399770	
113.947106781187	113.911541196908	113.516518605658	110.173868192254	
113.968968627421	113.932310976489	113.527181202513	110.156900677687	
113.990111069630	113.952396742195	113.537489449842	110.140274055633	
114.010513242776	113.971778727424	113.547433529363	110.124041506845	

114.030155012376	113.990437859677	113.557003979282	110.108252261390	
114.049016994375	114.008355779163	113.566191702198	110.092951705070	
114.067080574275	114.025514856706	113.574987972711	110.078181516620	
114.084327925502	114.041898210926	113.583384444687	110.063979828528	
114.100742027004	114.057489724694	113.591373158192	110.050381404775	
114.116306680044	114.072274060838	113.598946546071	110.037417829365	
114.131006524188	114.086236677080	113.606097440178	110.025117700226	
114.144827052466	114.099363840197	113.612819077260	110.013506823732	
114.157754625684	114.111642639396	113.619105104485	110.002608405856	
114.169776485888	114.123060998878	113.624949584620	109.992443236654	
114.180880768954	114.133607689590	113.630347000848	109.983029865501	
114.191056516295	114.143272340155	113.635292261243	109.974384765082	
114.200293685677	114.152045446957	113.639780702872	109.966522482745	
114.208583161129	114.159918383388	113.643808095560	109.959455778295	
114.215916761939	114.166883408237	113.647370645282	109.953195747720	
114.222287250729	114.172933673217	113.650464997208	109.947751932685	
114.227688340595	114.178063229623	113.653088238389	109.943132415862	
114.232114701314	114.182267034119	113.655237900080	109.939343902366	
114.235561964603	114.185540953636	113.656911959715	109.936391787660	
114.238026728428	114.187881769392	113.658108842514	109.934280212354	
114.239506560366	114.189287180019	113.658827422739	109.933012104304	⋮
114.240000000000	114.189755803802	113.659067024590	109.932589208399	$x = 51$
114.239506560366	114.189287180019	113.658827422739	109.933012104304	⋮
114.238026728428	114.187881769392	113.658108842514	109.934280212354	
114.235561964603	114.185540953636	113.656911959715	109.936391787660	
114.232114701314	114.182267034119	113.655237900080	109.939343902366	
114.227688340595	114.178063229623	113.653088238389	109.943132415862	
114.222287250729	114.172933673217	113.650464997208	109.947751932685	
114.215916761939	114.166883408237	113.647370645282	109.953195747720	
114.208583161129	114.159918383388	113.643808095560	109.959455778295	
114.200293685677	114.152045446957	113.639780702872	109.966522482745	
114.191056516295	114.143272340155	113.635292261243	109.974384765082	
114.180880768954	114.133607689590	113.630347000848	109.983029865501	
114.169776485888	114.123060998878	113.624949584620	109.992443236654	
114.157754625684	114.111642639396	113.619105104485	110.002608405856	
114.144827052466	114.099363840197	113.612819077260	110.013506823732	
114.131006524188	114.086236677080	113.606097440178	110.025117700226	
114.116306680044	114.072274060838	113.598946546071	110.037417829365	
114.100742027004	114.057489724694	113.591373158192	110.050381404775	
114.084327925502	114.041898210926	113.583384444687	110.063979828528	
114.067080574275	114.025514856706	113.574987972711	110.078181516620	
114.049016994375	114.008355779163	113.566191702198	110.092951705070	
114.030155012376	113.990437859677	113.557003979282	110.108252261390	
114.010513242776	113.971778727424	113.547433529363	110.124041506845	
113.990111069630	113.952396742195	113.537489449842	110.140274055633	
113.968968627421	113.932310976489	113.527181202513	110.156900677687	
113.947106781187	113.911541196908	113.516518605658	110.173868192254	
113.924547105929	113.890107844870	113.505511825908	110.191119399770	
113.901311865324	113.868032016656	113.494171370103	110.208593059624	
113.877423989749	113.845335442811	113.482508077733	110.226223921366	
113.852907053653	113.822040466915	113.470533115515	110.243942816506	
113.827785252292	113.798170023757	113.458257977844	110.261676817494	
113.802083377852	113.773747616909	113.445694501874	110.279349469500	
113.775826794979	113.748797295747	113.432854916308	110.296881099445	
113.749041415750	113.723343631923	113.419751963155	110.314189205243	
113.721753674102	113.697411695318	113.406399167936	110.331188926441	
113.693990499740	113.671027029499	113.392811393251	110.347793595497	
113.665779291565	113.644215626700	113.379005897812	110.363915366759	
113.637147890635	113.617003902351	113.365004233026	110.379465917933	
113.608124552685	113.589418669189	113.350835416821	110.394357216520	
113.578737920245	113.561487110955	113.336540873867	110.408502341387	
113.549016994375	113.533236755732	113.322181532961	110.421816347489	

113.518991106039	113.504695448915	113.307847119605	110.434217159774	
113.488689887165	113.475891325906	113.293666997436	110.445626480616	
113.458143241397	113.446852786651	113.279820921441	110.455970693833	
113.427381314586	113.417608534912	113.266546970528	110.465181747456	
113.396434465040	113.388188748373	113.254143127852	110.473197997033	
113.365333233564	113.358638646328	113.242958992259	110.479964991412	
113.334108313319	113.329119373591	113.233375360985	110.485436183641	⋮
113.302790519529	113.300387988250	113.225771986891	110.489573550867	$x = 99$
113.271410759078	113.275121030833	113.220487183138	110.492348108879	$x = 100$
113.240000000000	113.259239878802	113.217776089326	110.493740309189	$x = 101$

Untuk Populasi mangsa IG y dengan $D_1 = D_2 = D_3 = D_4 = 0.01$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
48.3800000000000	48.4007741414708	48.4758054866465	47.7615809298869	$x = 1$
48.4114107590781	48.4176342529158	48.4816180122990	47.7624694065056	$x = 2$
48.4427905195293	48.4444253038488	48.4929468921731	47.7642400698675	$x = 3$
48.4741083133185	48.4748631711333	48.5092424619216	47.7668804277693	⋮
48.5053332335643	48.5061252937265	48.5297766709304	47.7703719586520	
48.5364344650402	48.5374185661357	48.5537335347284	47.7746903658304	
48.5673813145857	48.5685748941033	48.5802964033606	47.7798059069043	
48.5981432413965	48.5995468076361	48.6087172617448	47.7856837905811	
48.6286898871649	48.6303023637516	48.6383602071013	47.7922846317026	
48.6589911060392	48.6608111304748	48.6687186224697	47.7995649541405	
48.6890169943750	48.6910429890264	48.6994111157127	47.8074777304273	
48.7187379202453	48.7209680952954	48.7301639514346	47.8159729465469	
48.7481245526847	48.7505569071253	48.7607876474544	47.8249981802166	
48.7771478906348	48.7797802134757	48.7911536033285	47.8344991812423	
48.8057792915651	48.8086091632907	48.8211742189140	47.8444204430928	
48.8339904997396	48.8370152940164	48.8507878149938	47.8547057556835	
48.8617536741017	48.8649705597359	48.8799482088335	47.8652987304435	
48.8890414157504	48.8924473588974	48.9086180637408	47.8761432900020	
48.9158267949790	48.9194185616043	48.9367649441003	47.8871841162263	
48.9420833778521	48.9458575364439	48.9643591301701	47.8983670518131	
48.9677852522925	48.9717381768240	48.9913724865564	47.9096394521223	
48.9929070536530	48.9970349267951	49.0177779167469	47.9209504853990	
49.0174239897487	49.0217228063291	49.0435491222684	47.9322513809099	
49.0413118653237	49.0457774360319	49.0686605104007	47.9434956257815	
49.0645471059287	49.0691750612640	49.0930871699806	47.9546391124477	
49.0871067811866	49.0918925756446	49.1168048764827	47.9656402395604	
49.1089686274214	49.1139075439175	49.1397901087778	47.9764599699862	
49.1301110696305	49.1351982241544	49.1620200700348	47.9870618500884	
49.1505132427758	49.1557435892734	49.1834727097078	47.9974119948934	
49.1701550123757	49.1755233478532	49.2041267454232	48.0074790439541	
49.1890169943750	49.1945179642194	49.2239616843200	48.0172340927862	
49.2070805742746	49.2127086777850	49.2429578436755	48.0266506046635	
49.2243279255020	49.2300775216250	49.2610963707460	48.0357043073585	
49.2407420270040	49.2466073402660	49.2783592617851	48.0443730791059	
49.2563066800439	49.2622818066742	49.2947293802169	48.0526368276943	
49.2710065241884	49.2770854384240	49.3101904739405	48.0604773661618	
49.2848270524660	49.2910036130305	49.3247271917493	48.0678782881149	
49.2977546256840	49.3040225824327	49.3383250988458	48.0748248452261	
49.3097764858883	49.3161294866095	49.3509706914358	48.0813038290064	
49.3208807689542	49.3273123663189	49.3626514103859	48.0873034585148	
49.3310565162952	49.3375601749437	49.3733556539299	48.0928132752638	
49.3402936856770	49.3468627894351	49.3830727894098	48.0978240462214	
49.3485831611286	49.3552110203407	49.3917931640397	48.1023276754945	
49.3559167619388	49.3625966209089	49.3995081146791	48.1063171250188	
49.3622872507287	49.3690122952593	49.4062099766071	48.1097863443655	
49.3676883405951	49.3744517056109	49.4118920912866	48.1127302096170	
49.3721147013145	49.3789094785617	49.4165488131107	48.1151444711456	
49.3755619646031	49.3823812104128	49.4201755151229	48.1170257100627	

49.3780267284283	49.3848634715319	49.4227685937070	48.1183713030701	
49.3795065603657	49.3863538097513	49.4243254722389	48.1191793954507	⋮
49.3800000000000	49.3868507527977	49.4248446036987	48.1194488819621	$x = 51$
49.3795065603657	49.3863538097513	49.4243254722389	48.1191793954507	⋮
49.3780267284283	49.3848634715319	49.4227685937070	48.1183713030701	
49.3755619646031	49.3823812104128	49.4201755151229	48.1170257100627	
49.3721147013145	49.3789094785617	49.4165488131107	48.1151444711456	
49.3676883405951	49.3744517056109	49.4118920912866	48.1127302096170	
49.3622872507287	49.3690122952593	49.4062099766071	48.1097863443655	
49.3559167619388	49.3625966209089	49.3995081146791	48.1063171250188	
49.3485831611286	49.3552110203407	49.3917931640397	48.1023276754945	
49.3402936856770	49.3468627894351	49.3830727894098	48.0978240462214	
49.3310565162952	49.3375601749437	49.3733556539299	48.0928132752638	
49.3208807689542	49.3273123663189	49.3626514103859	48.0873034585148	
49.3097764858883	49.3161294866095	49.3509706914358	48.0813038290064	
49.2977546256840	49.3040225824327	49.3383250988458	48.0748248452261	
49.2848270524660	49.2910036130305	49.3247271917493	48.0678782881149	
49.2710065241884	49.2770854384240	49.3101904739405	48.0604773661618	
49.2563066800439	49.2622818066742	49.2947293802169	48.0526368276943	
49.2407420270040	49.2466073402660	49.2783592617851	48.0443730791059	
49.2243279255020	49.2300775216250	49.2610963707460	48.0357043073585	
49.2070805742746	49.2127086777850	49.2429578436755	48.0266506046635	
49.1890169943750	49.1945179642194	49.2239616843200	48.0172340927862	
49.1701550123757	49.1755233478532	49.2041267454232	48.0074790439541	
49.1505132427758	49.1557435892734	49.1834727097078	47.9974119948934	
49.1301110696305	49.1351982241544	49.1620200700348	47.9870618500884	
49.1089686274214	49.1139075439175	49.1397901087778	47.9764599699862	
49.0871067811866	49.0918925756446	49.1168048764827	47.9656402395604	
49.0645471059287	49.0691750612640	49.0930871699806	47.9546391124477	
49.0413118653237	49.0457774360319	49.0686605104007	47.9434956257815	
49.0174239897487	49.0217228063291	49.0435491222684	47.9322513809099	
48.9929070536530	48.9970349267951	49.0177779167469	47.9209504853990	
48.9677852522925	48.9717381768240	48.9913724865564	47.9096394521223	
48.9420833778521	48.9458575364439	48.9643591301701	47.8983670518131	
48.9158267949790	48.9194185616043	48.9367649441003	47.8871841162263	
48.8890414157504	48.8924473588974	48.9086180637408	47.8761432900020	
48.8617536741017	48.8649705597359	48.8799482088335	47.8652987304435	
48.8339904997396	48.8370152940164	48.8507878149938	47.8547057556835	
48.8057792915651	48.8086091632907	48.8211742189140	47.8444204430928	
48.7771478906348	48.7797802134757	48.7911536033285	47.8344991812423	
48.7481245526847	48.7505569071253	48.7607876474544	47.8249981802166	
48.7187379202453	48.7209680952954	48.7301639514346	47.8159729465469	
48.6890169943750	48.6910429890264	48.6994111157127	47.8074777304273	
48.6589911060392	48.6608111304748	48.6687186224697	47.7995649541405	
48.6286898871649	48.6303023637516	48.6383602071013	47.7922846317026	
48.5981432413965	48.5995468076361	48.6087172617448	47.7856837905811	
48.5673813145857	48.5685748941033	48.5802964033606	47.7798059069043	
48.5364344650402	48.5374185661357	48.5537335347284	47.7746903658304	
48.5053332335643	48.5061252937265	48.5297766709304	47.7703719586520	
48.4741083133185	48.4748631711333	48.5092424619216	47.7668804277693	⋮
48.4427905195293	48.4444253038488	48.4929468921731	47.7642400698675	$x = 99$
48.4114107590781	48.4176342529158	48.4816180122990	47.7624694065056	$x = 100$
48.3800000000000	48.4007741414708	48.4758054866465	47.7615809298869	$x = 101$

Untuk Populasi Pemangsa IG z dengan $\mathrm{D}_1 = \mathrm{D}_2 = \mathrm{D}_3 = \mathrm{D}_4 = 0.01$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
47.3300000000000	47.3982378620809	47.9502614338724	52.1865500226729	$x = 1$
47.3614107590781	47.4150609850993	47.9560285022238	52.1879355870936	$x = 2$
47.3927905195293	47.4417943003224	47.9672686975399	52.1906969149595	$x = 3$
47.4241083133185	47.4721673632137	47.9834365001506	52.1948145406039	⋮
47.4553332335643	47.5033631674806	48.0038093622433	52.2002596029382	

47.4864344650402	47.5345899922369	48.0275774870705	52.2069942412208	
47.5173813145857	47.5656800130094	48.0539304434588	52.2149721078811	
47.5481432413965	47.5965858480504	48.0821259417098	52.2241389863088	
47.5786898871649	47.6272756240589	48.1115329763242	52.2344334992903	
47.6089911060392	47.6577189776983	48.1416488608826	52.2457878920109	
47.6390169943750	47.6878858588704	48.1720951891338	52.2581288723028	
47.6687379202453	47.7177464921477	48.2026003933988	52.2713784901278	
47.6981245526847	47.7472714039746	48.2329765147239	52.2854550381346	
47.7271478906348	47.7764314517414	48.2630960075762	52.3002739555197	
47.7557792915651	47.8051978525644	48.2928720099996	52.3157487182927	
47.7839904997395	47.8335422117134	48.3222433803178	52.3317917003637	
47.8117536741017	47.8614365506558	48.3511643536027	52.3483149915458	
47.8390414157504	47.8888533346924	48.3795979432130	52.3652311605349	
47.8658267949790	47.9157655001559	48.4075120268192	52.3824539530992	
47.8920833778521	47.9421464811455	48.4348771783935	52.3998989179939	
47.9177852522925	47.9679702357714	48.4616655455352	52.4174839554347	
47.9429070536530	47.9932112718824	48.4878503081702	52.4351297852309	
47.9674239897487	48.0178446722525	48.5134054394180	52.4527603338270	
47.9913118653237	48.0418461192000	48.5383056138037	52.4703030414688	
48.0145471059287	48.0651919186157	48.5625261829984	52.4876890924541	
48.0371067811865	48.0878590233762	48.5860431805928	52.5048535729033	
48.0589686274214	48.1098250561181	48.6088333384485	52.5217355616846	
48.0801110696305	48.1310683313529	48.6308741071561	52.5382781610306	
48.1005132427758	48.1515678768973	48.6521436775695	52.5544284740013	
48.1201550123757	48.1713034546008	48.6726210022413	52.5701375362908	
48.1390169943750	48.1902555803481	48.6922858163181	52.5853602099666	
48.1570805742746	48.2084055433166	48.7111186577291	52.6000550466000	
48.1743279255020	48.2257354244713	48.7291008866010	52.6141841269264	
48.1907420270039	48.2422281142769	48.7462147038618	52.6277128837036	
48.2063066800439	48.2578673296103	48.7624431690124	52.6406099138492	
48.2210065241884	48.2726376298573	48.7777702170450	52.6528467852716	
48.2348270524660	48.2865244321764	48.7921806744900	52.6643978431006	
48.2477546256840	48.2995140259153	48.8056602745760	52.6752400192950	
48.2597764858883	48.3115935861654	48.8181956714867	52.6853526488951	
48.2708807689542	48.3227511864413	48.8297744536997	52.6947172955065	
48.2810565162952	48.3329758104718	48.8403851563931	52.7033175879764	
48.2902936856769	48.3422573630918	48.8500172729083	52.7111390696623	
48.2985831611286	48.3505866802233	48.8586612652557	52.7181690612036	
48.3059167619388	48.3579555379364	48.8663085736533	52.7243965372989	
48.3122872507287	48.3643566605804	48.8729516250881	52.7298120176604	
48.3176883405951	48.3697837279780	48.8785838408910	52.7344074720665	
48.3221147013145	48.3742313816741	48.8831996433179	52.7381762392535	
48.3255619646031	48.3776952302346	48.8867944611301	52.7411129592804	
48.3280267284283	48.3801718535881	48.8893647341675	52.7432135189485	
48.3295065603657	48.3816588064083	48.8909079169112	52.7444750098622	⋮
48.3300000000000	48.3821546205315	48.8914224810304	52.7448956987652	$x = 51$
48.3295065603657	48.3816588064083	48.8909079169112	52.7444750098622	⋮
48.3280267284283	48.3801718535881	48.8893647341675	52.7432135189485	
48.3255619646031	48.3776952302346	48.8867944611301	52.7411129592804	
48.3221147013145	48.3742313816741	48.8831996433179	52.7381762392535	
48.3176883405951	48.3697837279780	48.8785838408910	52.7344074720665	
48.3122872507287	48.3643566605804	48.8729516250881	52.7298120176604	
48.3059167619388	48.3579555379364	48.8663085736533	52.7243965372989	
48.2985831611286	48.3505866802233	48.8586612652557	52.7181690612036	
48.2902936856769	48.3422573630918	48.8500172729083	52.7111390696623	
48.2810565162952	48.3329758104718	48.8403851563931	52.7033175879764	
48.2708807689542	48.3227511864413	48.8297744536997	52.6947172955065	
48.2597764858883	48.3115935861654	48.8181956714867	52.6853526488951	
48.2477546256840	48.2995140259153	48.8056602745760	52.6752400192950	
48.2348270524660	48.2865244321764	48.7921806744900	52.6643978431006	
48.2210065241884	48.2726376298573	48.7777702170450	52.6528467852716	
48.2063066800439	48.2578673296103	48.7624431690124	52.6406099138492	

48.1907420270039	48.2422281142769	48.7462147038618	52.6277128837036	
48.1743279255020	48.2257354244713	48.7291008866010	52.6141841269264	
48.1570805742746	48.2084055433166	48.7111186577291	52.6000550466000	
48.1390169943750	48.1902555803481	48.6922858163181	52.5853602099666	
48.1201550123757	48.1713034546008	48.6726210022413	52.5701375362908	
48.1005132427758	48.1515678768973	48.6521436775695	52.5544284740013	
48.0801110696305	48.1310683313529	48.6308741071561	52.5382781610306	
48.0589686274214	48.1098250561181	48.6088333384485	52.5217355616846	
48.0371067811865	48.0878590233762	48.5860431805928	52.5048535729033	
48.0145471059287	48.0651919186157	48.5625261829984	52.4876890924541	
47.9913118653237	48.0418461192000	48.5383056138037	52.4703030414688	
47.9674239897487	48.0178446722525	48.5134054394180	52.4527603338270	
47.9429070536530	47.9932112718824	48.4878503081702	52.4351297852309	
47.9177852522925	47.9679702357714	48.4616655455352	52.4174839554347	
47.8920833778521	47.9421464811455	48.4348771783935	52.3998989179939	
47.8658267949790	47.9157655001559	48.4075120268192	52.3824539530992	
47.8390414157504	47.8888533346924	48.3795979432130	52.3652311605349	
47.8117536741017	47.8614365506558	48.3511643536027	52.3483149915458	
47.7839904997395	47.8335422117134	48.3222433803178	52.3317917003637	
47.7557792915651	47.8051978525644	48.2928720099996	52.3157487182927	
47.7271478906348	47.7764314517414	48.2630960075762	52.3002739555197	
47.6981245526847	47.7472714039746	48.2329765147239	52.2854550381346	
47.6687379202453	47.7177464921477	48.2026003933988	52.2713784901278	
47.6390169943750	47.6878858588704	48.1720951891338	52.2581288723028	
47.6089911060392	47.6577189776983	48.1416488608826	52.2457878920109	
47.5786898871649	47.6272756240589	48.1115329763242	52.2344334992903	
47.5481432413965	47.5965858480504	48.0821259417098	52.2241389863088	
47.5173813145857	47.5656800130094	48.0539304434588	52.2149721078811	
47.4864344650402	47.5345899922369	48.0275774870705	52.2069942412208	
47.4553332335643	47.5033631674806	48.0038093622433	52.2002596029382	
47.4241083133185	47.4721673632137	47.9834365001506	52.1948145406039	⋮
47.3927905195293	47.4417943003224	47.9672686975399	52.1906969149595	$x = 99$
47.3614107590781	47.4150609850993	47.9560285022238	52.1879355870936	$x = 100$
47.3300000000000	47.3982378620809	47.9502614338724	52.1865500226729	$x = 101$

Untuk Populasi Mangsa kecil u dengan $D_1 = D_2 = D_3 = D_4 = 0.00001$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
49.0600000000000	49.0603877635831	49.0574078277185	48.3849785495127	$x = 1$
49.0914107590781	49.0899960644918	49.0721480275461	48.3663543701330	$x = 2$
49.1227905195293	49.1196010709837	49.0870136823214	48.3459904905066	$x = 3$
49.1541083133185	49.1491467666647	49.1018442532094	48.3255910436031	⋮
49.1853332335643	49.1786039890835	49.1166244319019	48.3052601221649	
49.2164344650402	49.2079436764037	49.1313396978203	48.2850204634113	
49.2473813145857	49.2371368852601	49.1459756153370	48.2648919582277	
49.2781432413965	49.2661548192753	49.1605178453308	48.2448942889019	
49.3086898871649	49.2949688574240	49.1749521589119	48.2250469773397	
49.3389911060392	49.3235505822139	49.1892644509750	48.2053693680169	
49.3690169943750	49.3518718076581	49.2034407535623	48.1858806098995	
49.3987379202453	49.3799046070089	49.2174672490248	48.1665996386427	
49.4281245526847	49.4076213402281	49.2313302829734	48.1475451591034	
49.4571478906348	49.4349946811656	49.2450163770077	48.1287356281783	
49.4857792915651	49.4619976444213	49.2585122412141	48.1101892379807	
49.5139904997396	49.4886036118620	49.2718047864239	48.0919238993647	
49.5417536741017	49.5147863587705	49.2848811362225	48.0739572258089	
49.5690414157504	49.5405200795991	49.2977286387009	48.0563065176683	
49.5958267949790	49.5657794133032	49.3103348779437	48.0389887468049	
49.6220833778521	49.5905394682323	49.3226876852436	48.0220205416027	
49.6477852522925	49.6147758465509	49.3347751500367	48.0054181723773	
49.6729070536530	49.6384646681698	49.3465856305530	47.9891975371872	
49.6974239897487	49.6615825941609	49.3581077641739	47.9733741480515	
49.7213118653237	49.6841068496364	49.3693304774924	47.9579631175831	

49.7445471059287	49.7060152460677	49.3802429960702	47.9429791460402	
49.7671067811866	49.7272862030243	49.3908348538865	47.9284365088037	
49.7889686274214	49.7478987693114	49.4010959024735	47.9143490442835	
49.8101110696305	49.7678326434855	49.4110163197359	47.9007301422590	
49.8305132427758	49.7870681937292	49.4205866184479	47.8875927326575	
49.8501550123757	49.8055864770655	49.4297976544259	47.8749492747732	
49.8690169943750	49.8233692578937	49.4386406343726	47.8628117469313	
49.8870805742746	49.8403990258289	49.4471071233899	47.8511916365990	
49.9043279255020	49.8566590128288	49.4551890521569	47.8400999309460	
49.9207420270039	49.8721332095904	49.4628787237716	47.8295471078567	
49.9363066800439	49.8868063812021	49.4701688202525	47.8195431273967	
49.9510065241884	49.9006640820358	49.4770524086992	47.8100974237342	
49.9648270524660	49.9136926698644	49.4835229471090	47.8012188975180	
49.9777546256840	49.9258793191928	49.4895742898489	47.7929159087143	
49.9897764858883	49.9372120337879	49.4952006927802	47.7851962699015	
50.0008807689542	49.9476796583975	49.5003968180350	47.7780672400263	
50.0110565162952	49.9572718896449	49.5051577384435	47.7715355186190	
50.0202936856770	49.9659792860920	49.5094789416102	47.7656072404709	
50.0285831611286	49.9737932774575	49.5133563336387	47.7602879707736	
50.0359167619388	49.9807061729851	49.5167862425046	47.7555827007202	
50.0422872507287	49.9867111689517	49.5197654210744	47.7514958435685	
50.0476883405951	49.9918023553086	49.5222910497709	47.7480312311676	
50.0521147013145	49.9959747214505	49.5243607388845	47.7451921109472	
50.0555619646031	49.9992241611061	49.5259725305292	47.7429811433697	
50.0580267284283	50.0015474763455	49.5271249002441	47.7414003998455	
50.0595065603657	50.0029423807013	49.5278167582385	47.7404513611118	⋮
50.0600000000000	50.0034075014000	49.5280474502820	47.7401349160742	$x = 51$
50.0595065603657	50.0029423807013	49.5278167582385	47.7404513611118	⋮
50.0580267284283	50.0015474763455	49.5271249002441	47.7414003998455	
50.0555619646031	49.9992241611061	49.5259725305292	47.7429811433697	
50.0521147013145	49.9959747214505	49.5243607388845	47.7451921109472	
50.0476883405951	49.9918023553086	49.5222910497709	47.7480312311676	
50.0422872507287	49.9867111689517	49.5197654210744	47.7514958435685	
50.0359167619388	49.9807061729851	49.5167862425046	47.7555827007202	
50.0285831611286	49.9737932774575	49.5133563336387	47.7602879707736	
50.0202936856770	49.9659792860920	49.5094789416102	47.7656072404709	
50.0110565162952	49.9572718896449	49.5051577384435	47.7715355186190	
50.0008807689542	49.9476796583975	49.5003968180350	47.7780672400263	
49.9897764858883	49.9372120337879	49.4952006927802	47.7851962699015	
49.9777546256840	49.9258793191928	49.4895742898489	47.7929159087143	
49.9648270524660	49.9136926698644	49.4835229471090	47.8012188975180	
49.9510065241884	49.9006640820358	49.4770524086992	47.8100974237342	
49.9363066800439	49.8868063812021	49.4701688202525	47.8195431273967	
49.9207420270039	49.8721332095904	49.4628787237716	47.8295471078567	
49.9043279255020	49.8566590128288	49.4551890521569	47.8400999309460	
49.8870805742746	49.8403990258289	49.4471071233899	47.8511916365990	
49.8690169943750	49.8233692578937	49.4386406343726	47.8628117469313	
49.8501550123757	49.8055864770655	49.4297976544259	47.8749492747732	
49.8305132427758	49.7870681937292	49.4205866184479	47.8875927326575	
49.8101110696305	49.7678326434855	49.4110163197359	47.9007301422590	
49.7889686274214	49.7478987693114	49.4010959024735	47.9143490442835	
49.7671067811866	49.7272862030243	49.3908348538865	47.9284365088037	
49.7445471059287	49.7060152460677	49.3802429960702	47.9429791460402	
49.7213118653237	49.6841068496364	49.3693304774924	47.9579631175831	
49.6974239897487	49.6615825941609	49.3581077641739	47.9733741480515	
49.6729070536530	49.6384646681698	49.3465856305530	47.9891975371872	
49.6477852522925	49.6147758465509	49.3347751500367	48.0054181723773	
49.6220833778521	49.5905394682323	49.3226876852436	48.0220205416027	
49.5958267949790	49.5657794133032	49.3103348779437	48.0389887468049	
49.5690414157504	49.5405200795991	49.2977286387009	48.0563065176683	
49.5417536741017	49.5147863587705	49.2848811362225	48.0739572258089	
49.5139904997396	49.4886036118620	49.2718047864239	48.0919238993647	

49.4857792915651	49.4619976444213	49.2585122412141	48.1101892379807	
49.4571478906348	49.4349946811656	49.2450163770077	48.1287356281783	
49.4281245526847	49.4076213402281	49.2313302829734	48.1475451591034	
49.3987379202453	49.3799046070089	49.2174672490248	48.1665996386427	
49.3690169943750	49.3518718076581	49.2034407535623	48.1858806098995	
49.3389911060392	49.3235505822139	49.1892644509750	48.2053693680169	
49.3086898871649	49.2949688574240	49.1749521589119	48.2250469773397	
49.2781432413965	49.2661548192753	49.1605178453308	48.2448942889019	
49.2473813145857	49.2371368852601	49.1459756153370	48.2648919582277	
49.2164344650402	49.2079436764037	49.1313396978203	48.2850204634113	
49.1853332335643	49.1786039890835	49.1166244319019	48.3052601221649	
49.1541083133185	49.1491467666647	49.1018442532094	48.3255910436031	⋮
49.1227905195293	49.1196010709837	49.0870136823214	48.3459904905066	$x = 99$
49.0914107590781	49.0899960644918	49.0721480275461	48.3663543701330	$x = 100$
49.0600000000000	49.0603877635831	49.0574078277185	48.3849785495127	$x = 101$

Untuk Populasi mangsa dewasa w dengan $D_1 = D_2 = D_3 = D_4 = 0.00001$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1:100$
113.240000000000	113.239474298486	113.169864402856	110.795414627472	$x = 1$
113.271410759078	113.269342143391	113.185352182770	110.768037190681	$x = 2$
113.302790519529	113.299206322496	113.200970771984	110.738094612090	$x = 3$
113.334108313319	113.329010355065	113.216551474322	110.708091173440	⋮
113.365333233564	113.358724826061	113.232078216088	110.678179949819	
113.396434465040	113.388320423155	113.247535755384	110.648394487910	
113.427381314586	113.417767954745	113.262908943465	110.618764183714	
113.458143241397	113.447038378695	113.278182736795	110.589318158722	
113.488689887165	113.476102830928	113.293342211366	110.560085329975	
113.518991106039	113.504932653815	113.308372576829	110.531094384068	
113.549016994375	113.533499424364	113.323259190402	110.502373749525	
113.578737920245	113.561774982149	113.337987570564	110.473951569472	
113.608124552685	113.589731456983	113.352543410502	110.445855674661	
113.637147890635	113.617341296285	113.366912591330	110.418113556872	
113.665779291565	113.644577292123	113.381081195038	110.390752342717	
113.693990499740	113.671412607907	113.395035517187	110.363798767870	
113.721753674102	113.697820804713	113.408762079332	110.337279151732	
113.749041415750	113.723775867196	113.422247641165	110.311219372572	
113.775826794979	113.749252229081	113.435479212370	110.285644843142	
113.802083377852	113.774224798205	113.448444064191	110.260580486808	
113.827785252292	113.798668981082	113.461129740690	110.236050714192	
113.852907053653	113.822560706971	113.473524069709	110.212079400367	
113.877423989749	113.845876451425	113.485615173516	110.188689862605	
113.901311865324	113.868593259289	113.497391479137	110.165904838699	
113.924547105929	113.890688767146	113.508841728362	110.143746465882	
113.947106781187	113.912141225162	113.519954987430	110.122236260350	
113.968968627421	113.932929518333	113.530720656383	110.101395097407	
113.990111069630	113.953033187104	113.541128478090	110.081243192252	
114.010513242776	113.972432447338	113.551168546926	110.061800081408	
114.030155012376	113.991108209618	113.560831317120	110.043084604816	
114.049016994375	114.009042097873	113.570107610759	110.025114888612	
114.067080574275	114.026216467293	113.578988625442	110.007908328579	
114.084327925502	114.042614421532	113.587465941595	109.991481574310	
114.100742027004	114.058219829178	113.595531529431	109.975850514063	
114.116306680044	114.073017339463	113.603177755563	109.961030260356	
114.131006524188	114.086992397222	113.610397389266	109.947035136269	
114.144827052466	114.100131257066	113.617183608381	109.933878662496	
114.157754625684	114.112420996763	113.623530004870	109.921573545138	
114.169776485888	114.123849529815	113.629430590015	109.910131664248	
114.180880768954	114.134405617226	113.634879799254	109.899564063134	
114.191056516295	114.144078878431	113.639872496675	109.889880938434	
114.200293685677	114.152859801399	113.644403979134	109.881091630958	
114.208583161129	114.160739751884	113.648469980031	109.873204617308	

114.215916761939	114.167710981818	113.652066672720	109.866227502286	
114.222287250729	114.173766636853	113.655190673562	109.860167012081	
114.227688340595	114.178900763018	113.657839044621	109.855028988259	
114.232114701314	114.183108312511	113.660009295995	109.850818382535	
114.235561964603	114.186385148604	113.661699387799	109.847539252356	
114.238026728428	114.188728049666	113.662907731777	109.845194757272	
114.239506560366	114.190134712292	113.663633192563	109.843787156122	⋮
114.240000000000	114.190603753543	113.663875088575	109.843317805015	$x = 51$
114.239506560366	114.190134712292	113.663633192563	109.843787156122	⋮
114.238026728428	114.188728049666	113.662907731777	109.845194757272	
114.235561964603	114.186385148604	113.661699387799	109.847539252356	
114.232114701314	114.183108312511	113.660009295995	109.850818382535	
114.227688340595	114.178900763018	113.657839044621	109.855028988259	
114.222287250729	114.173766636853	113.655190673562	109.860167012081	
114.215916761939	114.167710981818	113.652066672720	109.866227502286	
114.208583161129	114.160739751884	113.648469980031	109.873204617308	
114.200293685677	114.152859801399	113.644403979134	109.881091630958	
114.191056516295	114.144078878431	113.639872496675	109.889880938434	
114.180880768954	114.134405617226	113.634879799254	109.899564063134	
114.169776485888	114.123849529815	113.629430590015	109.910131664248	
114.157754625684	114.112420996763	113.623530004870	109.921573545138	
114.144827052466	114.100131257066	113.617183608381	109.933878662496	
114.131006524188	114.086992397222	113.610397389266	109.947035136269	
114.116306680044	114.073017339463	113.603177755563	109.961030260356	
114.100742027004	114.058219829178	113.595531529431	109.975850514063	
114.084327925502	114.042614421532	113.587465941595	109.991481574310	
114.067080574275	114.026216467293	113.578988625442	110.007908328579	
114.049016994375	114.009042097873	113.570107610759	110.025114888612	
114.030155012376	113.991108209618	113.560831317120	110.043084604816	
114.010513242776	113.972432447338	113.551168546926	110.061800081408	
113.990111069630	113.953033187104	113.541128478090	110.081243192252	
113.968968627421	113.932929518333	113.530720656383	110.101395097407	
113.947106781187	113.912141225162	113.519954987430	110.122236260350	
113.924547105929	113.890688767146	113.508841728362	110.143746465882	
113.901311865324	113.868593259289	113.497391479137	110.165904838699	
113.877423989749	113.845876451425	113.485615173516	110.188689862605	
113.852907053653	113.822560706971	113.473524069709	110.212079400367	
113.827785252292	113.798668981082	113.461129740690	110.236050714192	
113.802083377852	113.774224798205	113.448444064191	110.260580486808	
113.775826794979	113.749252229081	113.435479212370	110.285644843142	
113.749041415750	113.723775867196	113.422247641165	110.311219372572	
113.721753674102	113.697820804713	113.408762079332	110.337279151732	
113.693990499740	113.671412607907	113.395035517187	110.363798767870	
113.665779291565	113.644577292123	113.381081195038	110.390752342717	
113.637147890635	113.617341296285	113.366912591330	110.418113556872	
113.608124552685	113.589731456983	113.352543410502	110.445855674661	
113.578737920245	113.561774982149	113.337987570564	110.473951569472	
113.549016994375	113.533499424364	113.323259190402	110.502373749525	
113.518991106039	113.504932653815	113.308372576829	110.531094384068	
113.488689887165	113.476102830928	113.293342211366	110.560085329975	
113.458143241397	113.447038378695	113.278182736795	110.589318158722	
113.427381314586	113.417767954745	113.262908943465	110.618764183714	
113.396434465040	113.388320423155	113.247535755384	110.648394487910	
113.365333233564	113.358724826061	113.232078216088	110.678179949819	
113.334108313319	113.329010355065	113.216551474322	110.708091173440	⋮
113.302790519529	113.299206322496	113.200970771984	110.738094612090	$x = 99$
113.271410759078	113.269342143391	113.185352182770	110.768037190681	$x = 100$
113.240000000000	113.239474298486	113.169864402856	110.795414627472	$x = 101$

Untuk Populasi mangsa IG y dengan $D_1 = D_2 = D_3 = D_4 = 0.00001$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$

48.3800000000000	48.3799491984092	48.3743022710149	47.5686533831774	$x = 1$
48.4114107590781	48.4115720636263	48.4072706634839	47.5861619253791	$x = 2$
48.4427905195293	48.4431924573415	48.4405333527764	47.6053104589836	$x = 3$
48.4741083133185	48.4747507553965	48.4737343969053	47.6244955942031	⋮
48.5053332335643	48.5062157997283	48.5068394288873	47.6436192830908	
48.5364344650402	48.5375565346830	48.5398157472141	47.6626600990561	
48.5673813145857	48.5687420263227	48.5726307754464	47.6815992879932	
48.5981432413965	48.5997414929685	48.6052520894012	47.7004182809017	
48.6286898871649	48.6305243355992	48.6376474492961	47.7190986485489	
48.6589911060392	48.6610601680740	48.6697848317515	47.7376221178004	
48.6890169943750	48.6913188471480	48.7016324616046	47.7559705889676	
48.7187379202453	48.7212705022517	48.7331588435035	47.7741261529338	
48.7481245526847	48.7508855650054	48.7643327932493	47.7920711080244	
48.7771478906348	48.7801347984369	48.7951234688545	47.8097879766084	
48.8057792915651	48.8089893258772	48.8255004012851	47.8272595214155	
48.8339904997396	48.8374206595018	48.8554335248556	47.8444687615611	
48.8617536741017	48.8654007284922	48.8848932072456	47.8613989882635	
48.8890414157504	48.8929019067872	48.9138502791063	47.8780337802434	
48.9158267949790	48.9198970403991	48.9422760632273	47.8943570187948	
48.9420833778521	48.9463594742644	48.9701424032324	47.9103529025172	
48.9677852522925	48.9722630786052	48.9974216917752	47.9260059616990	
48.9929070536530	48.9975822747739	49.0240868982045	47.9413010723419	
49.0174239897487	49.0222920605546	49.0501115956714	47.9562234698180	
49.0413118653237	49.0463680348977	49.0754699876489	47.9707587621523	
49.0645471059287	49.0697864220618	49.1001369338358	47.9848929429193	
49.0871067811866	49.0925240951391	49.1240879754190	47.9986124037491	
49.1089686274214	49.1145585989418	49.1472993596661	48.0119039464344	
49.1301110696305	49.1358681722244	49.1697480638228	48.0247547946303	
49.1505132427758	49.1564317692227	49.1914118182893	48.0371526051436	
49.1701550123757	49.1762290804853	49.2122691290524	48.0490854788017	
49.1890169943750	49.1952405529787	49.2322992993475	48.0605419708982	
49.2070805742746	49.2134474094449	49.2514824505282	48.0715111012078	
49.2243279255020	49.2308316669921	49.2697995421225	48.0819823635673	
49.2407420270040	49.2473761549012	49.2872323910504	48.0919457350163	
49.2563066800439	49.2630645316278	49.3037636899878	48.1013916844933	
49.2710065241884	49.2778813009861	49.3193770248510	48.1103111810844	
49.2848270524660	49.2918118274950	49.3340568913874	48.1186957018192	
49.2977546256840	49.3048423508736	49.3477887108522	48.1265372390113	
49.3097764858883	49.3169599996704	49.3605588447554	48.1338283071395	
49.3208807689542	49.3281528040129	49.3723546086621	48.1405619492675	
49.3310565162952	49.3384097074648	49.3831642850315	48.1467317429976	
49.3402936856770	49.3477205779786	49.3929771350817	48.1523318059585	
49.3485831611286	49.3560762179330	49.4017834096654	48.1573568008223	
49.3559167619388	49.3634683732454	49.4095743591467	48.1618019398498	
49.3622872507287	49.3698897415496	49.4163422422669	48.1656629889629	
49.3676883405951	49.3753339794303	49.4220803339903	48.1689362713414	
49.3721147013145	49.3797957087086	49.4267829323213	48.1716186705421	
49.3755619646031	49.3832705217708	49.4304453640853	48.1737076331418	
49.3780267284283	49.3857549859354	49.4330639896670	48.1752011708999	
49.3795065603657	49.3872466468546	49.4346362067016	48.1760978624415	⋮
49.3800000000000	49.3877440309465	49.4351604527135	48.1763968544606	$x = 51$
49.3795065603657	49.3872466468546	49.4346362067016	48.1760978624415	⋮
49.3780267284283	49.3857549859354	49.4330639896670	48.1752011708999	
49.3755619646031	49.3832705217708	49.4304453640853	48.1737076331418	
49.3721147013145	49.3797957087086	49.4267829323213	48.1716186705421	
49.3676883405951	49.3753339794303	49.4220803339903	48.1689362713414	
49.3622872507287	49.3698897415496	49.4163422422669	48.1656629889629	
49.3559167619388	49.3634683732454	49.4095743591467	48.1618019398498	
49.3485831611286	49.3560762179330	49.4017834096654	48.1573568008223	
49.3402936856770	49.3477205779786	49.3929771350817	48.1523318059585	
49.3310565162952	49.3384097074648	49.3831642850315	48.1467317429976	
49.3208807689542	49.3281528040129	49.3723546086621	48.1405619492675	

49.3097764858883	49.3169599996704	49.3605588447554	48.1338283071395	
49.2977546256840	49.3048423508736	49.3477887108522	48.1265372390113	
49.2848270524660	49.2918118274950	49.3340568913874	48.1186957018192	
49.2710065241884	49.2778813009861	49.3193770248510	48.1103111810844	
49.2563066800439	49.2630645316278	49.3037636899878	48.1013916844933	
49.2407420270040	49.2473761549012	49.2872323910504	48.0919457350163	
49.2243279255020	49.2308316669921	49.2697995421225	48.0819823635673	
49.2070805742746	49.2134474094449	49.2514824505282	48.0715111012078	
49.1890169943750	49.1952405529787	49.2322992993475	48.0605419708982	
49.1701550123757	49.1762290804853	49.2122691290524	48.0490854788017	
49.1505132427758	49.1564317692227	49.1914118182893	48.0371526051436	
49.1301110696305	49.1358681722244	49.1697480638228	48.0247547946303	
49.1089686274214	49.1145585989418	49.1472993596661	48.0119039464344	
49.0871067811866	49.0925240951391	49.1240879754190	47.9986124037491	
49.0645471059287	49.0697864220618	49.1001369338358	47.9848929429193	
49.0413118653237	49.0463680348977	49.0754699876489	47.9707587621523	
49.0174239897487	49.0222920605546	49.0501115956714	47.9562234698180	
48.9929070536530	48.9975822747739	49.0240868982045	47.9413010723419	
48.9677852522925	48.9722630786052	48.9974216917752	47.9260059616990	
48.9420833778521	48.9463594742644	48.9701424032324	47.9103529025172	
48.9158267949790	48.9198970403991	48.9422760632273	47.8943570187948	
48.8890414157504	48.8929019067872	48.9138502791063	47.8780337802434	
48.8617536741017	48.8654007284922	48.8848932072456	47.8613989882635	
48.8339904997396	48.8374206595018	48.8554335248556	47.8444687615611	
48.8057792915651	48.8089893258772	48.8255004012851	47.8272595214155	
48.7771478906348	48.7801347984369	48.7951234688545	47.8097879766084	
48.7481245526847	48.7508855650054	48.7643327932493	47.7920711080244	
48.7187379202453	48.7212705022517	48.7331588435035	47.7741261529338	
48.6890169943750	48.6913188471480	48.7016324616046	47.7559705889676	
48.6589911060392	48.6610601680740	48.6697848317515	47.7376221178004	
48.6286898871649	48.6305243355992	48.6376474492961	47.7190986485489	
48.5981432413965	48.5997414929685	48.6052520894012	47.7004182809017	
48.5673813145857	48.5687420263227	48.5726307754464	47.6815992879932	
48.5364344650402	48.5375565346830	48.5398157472141	47.6626600990561	
48.5053332335643	48.5062157997283	48.5068394288873	47.6436192830908	
48.4741083133185	48.4747507553965	48.4737343969053	47.6244955942031	
48.4427905195293	48.4431924573415	48.4405333527764	47.6053104589836	⋮
48.4114107590781	48.4115720636263	48.4072706634839	47.5861619253791	$x = 99$
48.3800000000000	48.3799491984092	48.3743022710149	47.5686533831774	$x = 100$
				$x = 101$

Untuk Populasi Pemangsa IG z dengan $D_1 = D_2 = D_3 = D_4 = 0.00001$

$t = 1$	$t = 10$	$t = 100$	$t = 1000$	$x = 1{:}100$
47.3300000000000	47.3774532618621	47.8495493983610	51.8861957036694	$x = 1$
47.3614107590781	47.4090096839648	47.8822635771152	51.9134528010768	$x = 2$
47.3927905195293	47.4405634738718	47.9152685944643	51.9432638012568	$x = 3$
47.4241083133185	47.4720551273664	47.9482112684282	51.9731346660149	⋮
47.4553332335643	47.5034535534288	47.9810575081429	52.0029129248023	
47.4864344650402	47.5347277639071	48.0137748798120	52.0325651836916	
47.5173813145857	47.5658468927696	48.0463310782641	52.0620621878744	
47.5481432413965	47.5967802265725	48.0786939538510	52.0913749590477	
47.5786898871649	47.6274972347801	48.1108315442466	52.1204747254855	
47.6089911060392	47.6579675999072	48.1427121060862	52.1493329478438	
47.6390169943750	47.6881612474526	48.1743041464037	52.1779213465821	
47.6687379202453	47.7180483755947	48.2055764538337	52.2062119290767	
47.6981245526847	47.7475994846194	48.2364981295488	52.2341770163692	
47.7271478906348	47.7767854060514	48.2670386178987	52.2617892695304	
47.7557792915651	47.8055773314600	48.2971677367234	52.2890217156124	
47.7839904997395	47.8339468409115	48.3268557073070	52.3158477731718	
47.8117536741017	47.8618659310385	48.3560731839434	52.3422412773405	
47.8390414157504	47.8893070427003	48.3847912830844	52.3681765044248	

47.8658267949790	47.9162430882056	48.4129816120392	52.3936281960143	
47.8920833778521	47.9426474780705	48.4406162971974	52.4185715825792	
47.9177852522925	47.9684941472866	48.4676680117467	52.4429824065414	
47.9429070536530	47.9937575810718	48.4941100028563	52.4668369448002	
47.9674239897487	48.0184128400788	48.5199161182997	52.4901120306945	
47.9913118653237	48.0424355850361	48.5450608324884	52.5127850753891	
48.0145471059287	48.0658021007981	48.5695192718911	52.5348340886666	
48.0371067811865	48.0884893197785	48.5932672398110	52.5562376991122	
48.0589686274214	48.1104748447457	48.6162812404975	52.5769751736769	
48.0801110696305	48.1317369709562	48.6385385025665	52.5970264366042	
48.1005132427758	48.1522547076052	48.6600170017054	52.6163720877109	
48.1201550123757	48.1720077985718	48.6806954826403	52.6349934200073	
48.1390169943750	48.1909767424392	48.7005534803412	52.6528724366464	
48.1570805742746	48.2091428117701	48.7195713404450	52.6699918671906	
48.1743279255020	48.2264880716173	48.7377302388750	52.6863351831865	
48.1907420270039	48.2429953972519	48.7550122006356	52.7018866130387	
48.2063066800439	48.2586484910907	48.7714001177635	52.7166311561711	
48.2210065241884	48.2734318988076	48.7868777664179	52.7305545964694	
48.2348270524660	48.2873310246105	48.8014298230898	52.7436435149975	
48.2477546256840	48.3003321456708	48.8150418799157	52.7558853019766	
48.2597764858883	48.3124224256905	48.8277004590787	52.7672681680246	
48.2708807689542	48.3235899275920	48.8393930262822	52.7777811546464	
48.2810565162952	48.3338236253204	48.8501080032836	52.7874141439707	
48.2902936856769	48.3431134147448	48.8598347794718	52.7961578677261	
48.2985831611286	48.3514501236484	48.8685637224806	52.8040039154553	
48.3059167619388	48.3588255207972	48.8762861878237	52.8109447419567	
48.3122872507287	48.3652323240785	48.8829945275430	52.8169736739571	
48.3176883405951	48.3706642077018	48.8886820978608	52.8220849160048	
48.3221147013145	48.3751158084528	48.8933432658275	52.8262735555849	
48.3255619646031	48.3785827309970	48.8969734149584	52.8295355674510	
48.3280267284283	48.3810615522255	48.8995689498543	52.8318678171736	
48.3295065603657	48.3825498246401	48.9011272997991	52.8332680639006	⋮
48.3300000000000	48.3830460787730	48.9016469213335	52.8337349623314	$x = 51$
48.3295065603657	48.3825498246401	48.9011272997991	52.8332680639006	⋮
48.3280267284283	48.3810615522255	48.8995689498543	52.8318678171736	
48.3255619646031	48.3785827309970	48.8969734149584	52.8295355674510	
48.3221147013145	48.3751158084528	48.8933432658275	52.8262735555849	
48.3176883405951	48.3706642077018	48.8886820978608	52.8220849160048	
48.3122872507287	48.3652323240785	48.8829945275430	52.8169736739571	
48.3059167619388	48.3588255207972	48.8762861878237	52.8109447419567	
48.2985831611286	48.3514501236484	48.8685637224806	52.8040039154553	
48.2902936856769	48.3431134147448	48.8598347794718	52.7961578677261	
48.2810565162952	48.3338236253204	48.8501080032836	52.7874141439707	
48.2708807689542	48.3235899275920	48.8393930262822	52.7777811546464	
48.2597764858883	48.3124224256905	48.8277004590787	52.7672681680246	
48.2477546256840	48.3003321456708	48.8150418799157	52.7558853019766	
48.2348270524660	48.2873310246105	48.8014298230898	52.7436435149975	
48.2210065241884	48.2734318988076	48.7868777664179	52.7305545964694	
48.2063066800439	48.2586484910907	48.7714001177635	52.7166311561711	
48.1907420270039	48.2429953972519	48.7550122006356	52.7018866130387	
48.1743279255020	48.2264880716173	48.7377302388750	52.6863351831865	
48.1570805742746	48.2091428117701	48.7195713404450	52.6699918671906	
48.1390169943750	48.1909767424392	48.7005534803412	52.6528724366464	
48.1201550123757	48.1720077985718	48.6806954826403	52.6349934200073	
48.1005132427758	48.1522547076052	48.6600170017054	52.6163720877109	
48.0801110696305	48.1317369709562	48.6385385025665	52.5970264366042	
48.0589686274214	48.1104748447457	48.6162812404975	52.5769751736769	
48.0371067811865	48.0884893197785	48.5932672398110	52.5562376991122	
48.0145471059287	48.0658021007981	48.5695192718911	52.5348340886666	
47.9913118653237	48.0424355850361	48.5450608324884	52.5127850753891	
47.9674239897487	48.0184128400788	48.5199161182997	52.4901120306945	
47.9429070536530	47.9937575810718	48.4941100028563	52.4668369448002	

47.9177852522925	47.9684941472866	48.4676680117467	52.4429824065414	
47.8920833778521	47.9426474780705	48.4406162971974	52.4185715825792	
47.8658267949790	47.9162430882056	48.4129816120392	52.3936281960143	
47.8390414157504	47.8893070427003	48.3847912830844	52.3681765044248	
47.8117536741017	47.8618659310385	48.3560731839434	52.3422412773405	
47.7839904997395	47.8339468409115	48.3268557073070	52.3158477731718	
47.7557792915651	47.8055773314600	48.2971677367234	52.2890217156124	
47.7271478906348	47.7767854060514	48.2670386178987	52.2617892695304	
47.6981245526847	47.7475994846194	48.2364981295488	52.2341770163692	
47.6687379202453	47.7180483755947	48.2055764538337	52.2062119290767	
47.6390169943750	47.6881612474526	48.1743041464037	52.1779213465821	
47.6089911060392	47.6579675999072	48.1427121060862	52.1493329478438	
47.5786898871649	47.6274972347801	48.1108315442466	52.1204747254855	
47.5481432413965	47.5967802265725	48.0786939538510	52.0913749590477	
47.5173813145857	47.5658468927696	48.0463310782641	52.0620621878744	
47.4864344650402	47.5347277639071	48.0137748798120	52.0325651836916	
47.4553332335643	47.5034535534288	47.9810575081429	52.0029129248023	
47.4241083133185	47.4720551273664	47.9482112684282	51.9731346660149	⋮
47.3927905195293	47.4405634738718	47.9152685944643	51.9432638012568	$x = 99$
47.3614107590781	47.4090096839648	47.8822635771152	51.9134528010768	$x = 100$
47.3300000000000	47.3774532618621	47.8495493983610	51.8861957036694	$x = 101$