Answer Template for Lab 1

ENGR 232 – Dynamic Engineering Systems

Lab #1:Bertalanffy Model **Lab Section: 62** **Name: Cole Bardin**

Summer 2022 *first* *last*

Question 1: The integral *Y* is: C + 25*atan(x) + 50*atanh(x)

```
clc, clear, close all
syms x C;
y = (75 + 25*x*x)/(1-x*x*x*x)
Y = int(y, x) + C
```

Question 2. The general solution is: 3*t + (C1*exp(-5*t))/5 + 2

```
clc, clear, close all
syms y(t);
DE = diff(y,t) + 5*y == 13 + 15*t

sol = dsolve(DE)
```

Question 3. The solution satisfying $y(0) = 0$ is: $y(t) =$ 3*t - 2*exp(-5*t) + 2

```
syms y(t);
DE = diff(y,t) + 5*y == 13 + 15*t
sol_spec = dsolve(DE, y(0)==0)
```

Question 4. The solution satisfying the initial condition $V(0) = 1$ is: $V(t) =$ -(exp(-t/6) - 2)^3

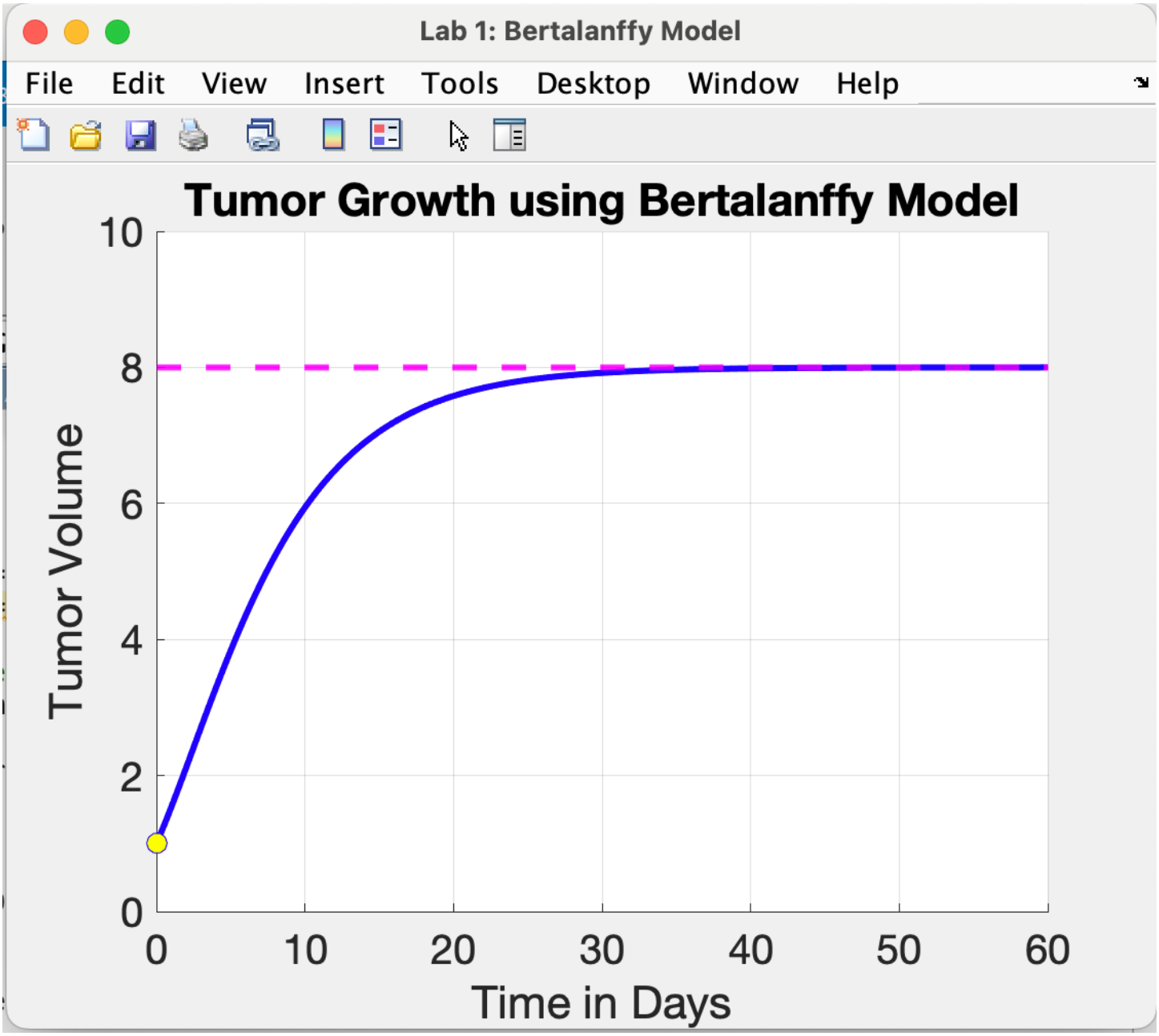
Paste your code here:

```
a = 1; b = a/2;
syms V(t)
% Now enter the Bertalanffy differential equation and name it DE.
DE = diff(V,t) == a*(V^(2/3)) - b*V;

% Take only the  real solution. Ignore the two imaginary solutions.

sol = dsolve(DE, V(0)==1);
sol = sol(1) % Parse out first real answer
```

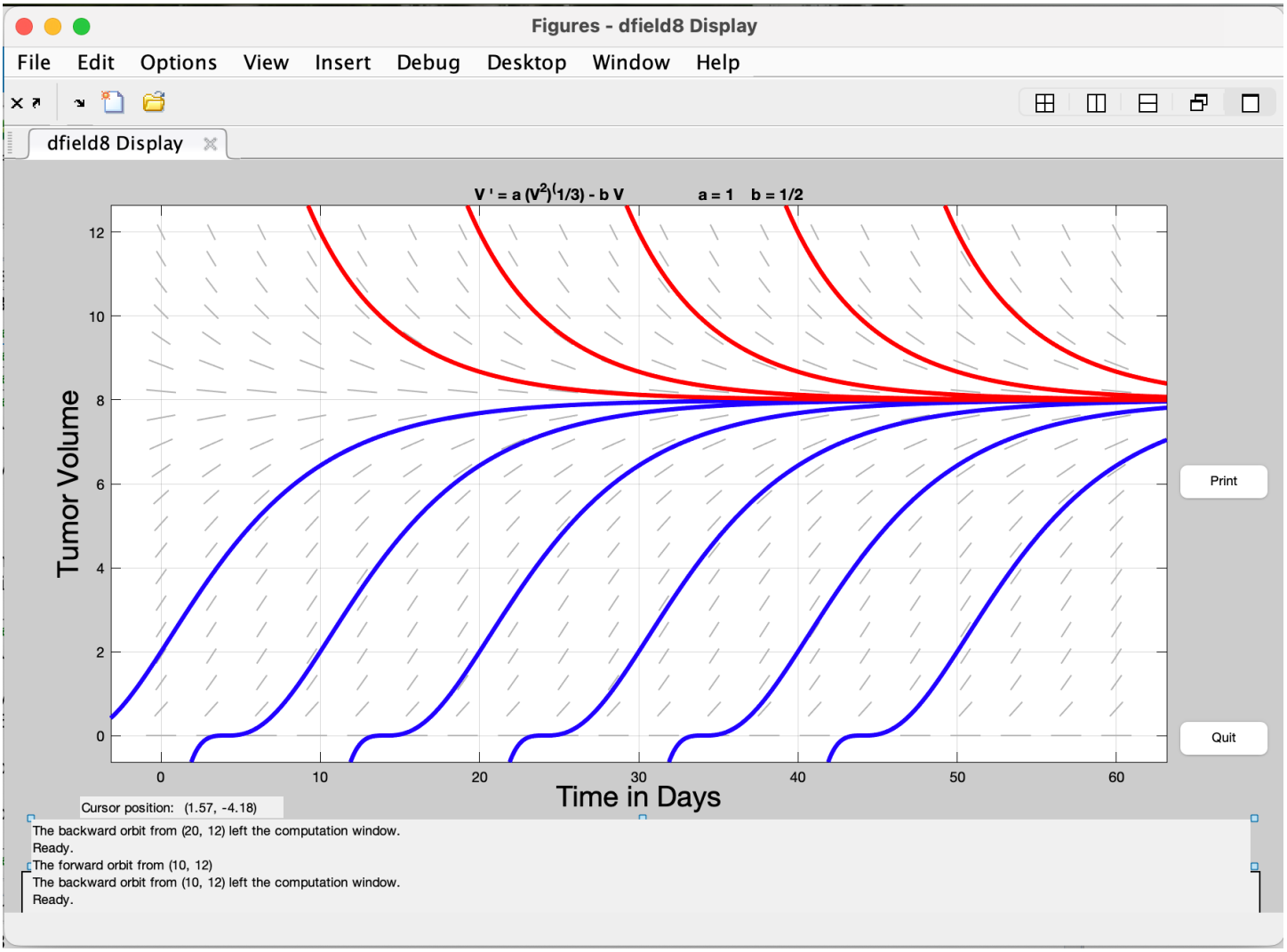
Question 5: Paste your completed image here, showing the solution with $V(0) = 1$ for the Bertalanffy Model.



Part B: Qualitative Analysis

Questions 6-7: Paste your completed image in the Answer Template.

Use the **View > Property Editor** so **all** the necrotic curves are shown in **red** and the growing tumors are shown in **blue**.



Question 8: Stability: Stable or Unstable?

The critical value $V = \left(\frac{a}{b}\right)^3 = 8$ is: Semi-stable

Question 9: Paste in the code you added to solve for the volume V at which the tumor grows the fastest.

Question 9: Paste your code here.

```
df = diff(f,V)

% Find the volume where the tumor grows the fastest using solve().
df = diff(f,V);
V_max_growth = solve(df, V)

% Paste in MATLAB's answer for V_max_growth.
(8*a^3)/(27*b^3)
```

Question 10: Paste your completed code in the answer template.

```
%% Question 10. Linearized Bertalanffy Differential Equation
clear, clc
a = 1, b = a/2
syms r(t) pi  % Be sure to make pi symbolic!
a1 = sym(a * (1/(36*pi))^(1/3)),  b1 = sym(b/3)

% Enter the linearized Bertalanffy DE here.
DE = diff(r,t) == a1 - b1*r;
% Use dsolve to find the solution with r(0)==(3/(4*pi))^ (1/3)
rt = dsolve(DE, r(0)==(3/(4*pi))^ (1/3) )
% Compute and simplify V(t) using the formula for the volume of a sphere of radius r.
Vt = simplify((4*pi/3)*(rt^3))
```

Ready to Submit?

Be sure all ten questions are answered. When your lab is complete, be sure to submit three files:

1. Your **completed Answer Template** as a PDF file
2. A copy of your **MATLAB Live Script**
3. An **PDF** copy of your **MATLAB Live Script** (Save-Export to PDF…)

The due date is the day after your lab section by **11:59pm** to receive full credit. You have one more day, to submit the lab (but with a small penalty), and then the window closes for good and your grade will be zero.