

```
disp("Independent Work 05.")
```

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```
disp("Question 01.")
```

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```
% Defining of system
```

```
f = @(t, z) [z(2); -z(1)^3 + 9*z(1)];
```

```
% Defining of grid
```

```
[x, y] = meshgrid(-5:0.2:5, -5:0.2:5);
```

```
% Defining of derivatives
```

```
dx = y;
```

```
dx(1,:)
```

```
ans = 1x51  
-5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 ...
```

```
dy = -x.^3 + 9*x;
```

```
dy(1,:)
```

```
ans = 1x51  
80.0000 67.3920 55.9360 45.5840 36.2880 28.0000 20.6720 14.2560 ...
```

```
% Normalizing of vectors
```

```
L = sqrt(dx.^2 + dy.^2);
```

```
L(1,:)
```

```
ans = 1x51  
80.1561 67.5772 56.1590 45.8574 36.6308 28.4429 21.2681 15.1074 ...
```

```
dx = dx ./ L;
```

```
dx(1,:)
```

```
ans = 1x51  
-0.0624 -0.0740 -0.0890 -0.1090 -0.1365 -0.1758 -0.2351 -0.3310 ...
```

```
dy = dy ./ L;
```

```
dy(1,:)
```

```
ans = 1x51  
0.9981 0.9973 0.9960 0.9940 0.9906 0.9844 0.9720 0.9436 ...
```

```
% Plotting of visualization
```

```
figure;
```

```
quiver(x, y, dx, dy, 'r', 'AutoScaleFactor', 0.5);
```

```
hold on;
```

```
% Setting of limits
```

```
axis([-5 5 -5 5]);
```

```

xlabel('x axis');
ylabel('y axis');
title('System Phase Portrait');

% Adding of critical points
cri_poi = [0, 0; 3, 0; -3, 0];
plot(cri_poi(:,1), cri_poi(:,2), 'bo', 'MarkerFaceColor', 'cyan');

% Solving of trajectories
tspan = [0 10];

% Plotting of a trajectory for (0, 0)
z0_1 = [0.1; 0];
[t1, z1] = ode45(f, tspan, z0_1);
plot(z1(:, 1), z1(:, 2), 'green', 'LineWidth', 2);

% Plotting of a trajectory for (3, 0)
z0_2 = [3.1; 0]; % Changed from 2.1 to 3.1
[t2, z2] = ode45(f, tspan, z0_2);
plot(z2(:, 1), z2(:, 2), 'magenta', 'LineWidth', 2);

% Plotting of a trajectory for (-3, 0)
z0_3 = [-3.1; 0]; % Changed from -2.1 to -3.1
[t3, z3] = ode45(f, tspan, z0_3);
plot(z3(:, 1), z3(:, 2), 'yellow', 'LineWidth', 2);

% Displaying of all critical points
text(0, 0, '(0, 0)', 'HorizontalAlignment', 'left');
text(3, 0, '(3, 0)', 'HorizontalAlignment', 'left');
text(-3, 0, '(-3, 0)', 'HorizontalAlignment', 'left');

% Adding of legend
legend('the field', 'a critical point', 'trajectory for (0,0)', ...
      'trajectory for (3,0)', 'trajectory for (-3,0)', 'Location', 'best');
grid on;
hold off;

```

