Question 01

In[352]:=
```
Clear
```

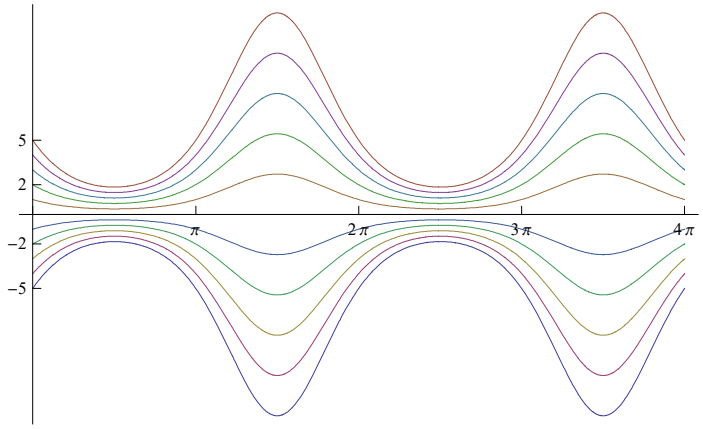
Out[352]=
```
Clear
```

In[1]:=
```
sol1 = DSolve[y'[x] + Cos[x] * y[x] == 0, y[x], x]
table1 = Table[sol1[[1, 1, 2]] /. C[1] → k, {k, -5, 5}];
```

Out[1]=
$$\left\{\left\{y[x] \to e^{-\text{Sin}[x]}\, C[1]\right\}\right\}$$

In[3]:=
```
Plot[table1, {x, 0, 4 * Pi}, Ticks → {{0, Pi, 2 * Pi, 3 * Pi, 4 * Pi}, {-2, 2, -5, 5}}]
```

Out[3]=



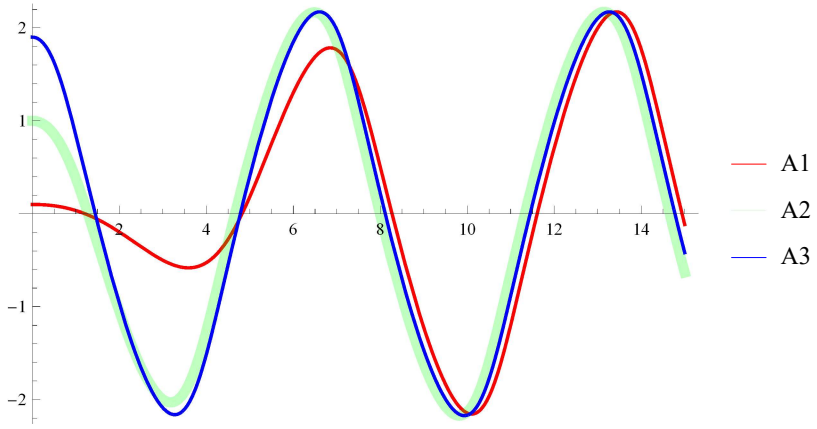
Question 02

In[4]:=
```
a1 = NDSolveValue[{x''[t] + (1 / 3 * x'[t]^2 - 1) * x'[t] + x[t] == 0,
    x[0] == .1, x'[0] == 0}, x[t], {t, 0, 15}];
a2 = NDSolveValue[{x''[t] + (1 / 3 * x'[t]^2 - 1) * x'[t] + x[t] == 0, x[0] == 1, x'[0] == 0},
  x[t], {t, 0, 15}]; a3 = NDSolveValue[{x''[t] + (1 / 3 * x'[t]^2 - 1) * x'[t] + x[t] == 0,
   x[0] == 1.9, x'[0] == 0}, x[t], {t, 0, 15}]
```

Out[5]=
```
InterpolatingFunction[{{0., 15.}}, <>][t]
```

In[6]:=
```
Plot[{a1, a2, a3}, {t, 0, 15}, PlotLegends → {"A1", "A2", "A3"},
 PlotStyle → {{RGBColor[1, 0, 0], Thickness[.005]}, {RGBColor[0, 1, 0],
    Thickness[.015], Opacity[.25]}, {RGBColor[0, 0, 1], Thickness[.005]}}]
```

Out[6]=

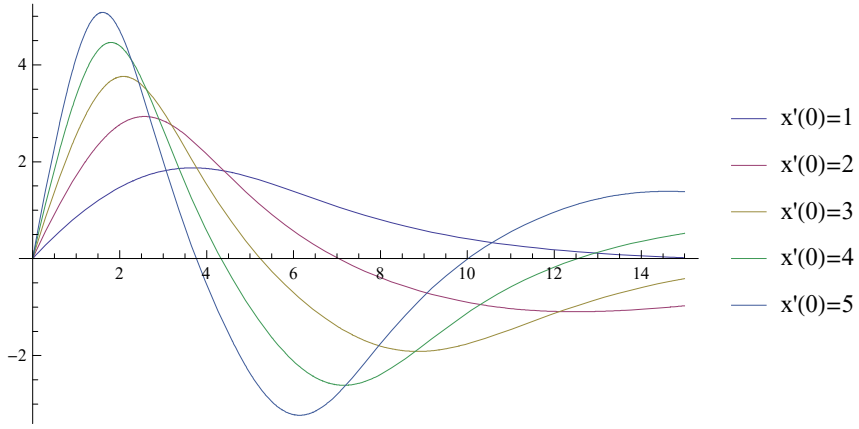


Question 03

```
m = 1; k = .3; a = .04;
table3 =
 Table[NDSolveValue[{m * x''[t] + k * x'[t] + a * x[t]^3 == 0, x[0] == 0, x'[0] == i},
   x[t], {t, 0, 15}], {i, 1, 5}]
```

```
{InterpolatingFunction[{{0., 15.}}, <>][t],
 InterpolatingFunction[{{0., 15.}}, <>][t],
 InterpolatingFunction[{{0., 15.}}, <>][t],
 InterpolatingFunction[{{0., 15.}}, <>][t],
 InterpolatingFunction[{{0., 15.}}, <>][t]}
```

```
Plot[table3, {t, 0, 15},
 PlotLegends → {"x'(0)=1", "x'(0)=2", "x'(0)=3", "x'(0)=4", "x'(0)=5"}]
```

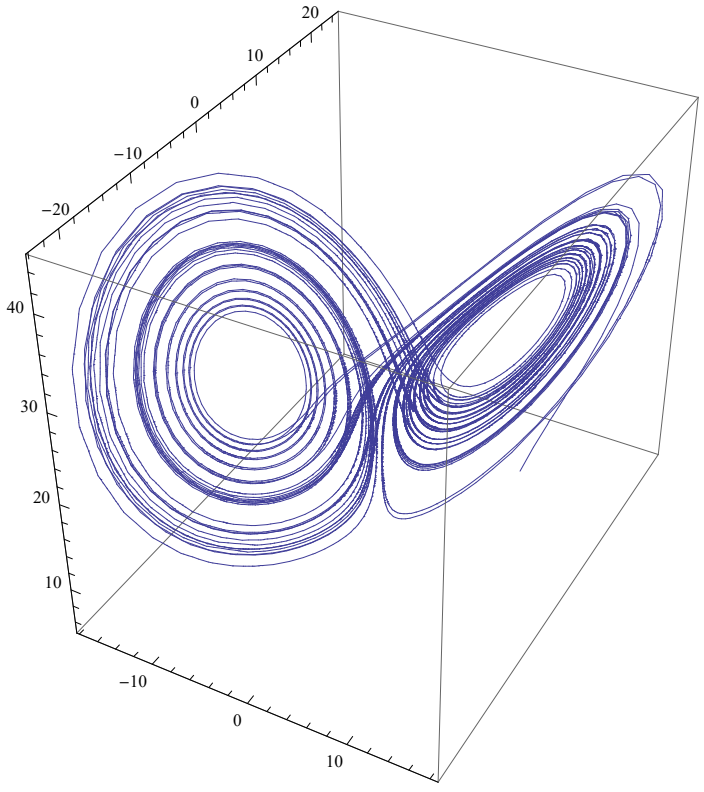


Question 04

```
σ = 10; β = 8 / 3; ρ = 28;
table4 = NDSolveValue[{x'[t] == σ * (y[t] - x[t]),
    y'[t] == ρ * x[t] - y[t] - x[t] * z[t], z'[t] == x[t] * y[t] - z[t] * β,
    x[0] == 10, y[0] == 10, z[0] == 10}, {x[t], y[t], z[t]}, {t, 0, 50}]
```

```
{InterpolatingFunction[{{0., 50.}}, <>][t],
 InterpolatingFunction[{{0., 50.}}, <>][t],
 InterpolatingFunction[{{0., 50.}}, <>][t]}
```

```
ParametricPlot3D[table4, {t, 0, 50}]
```

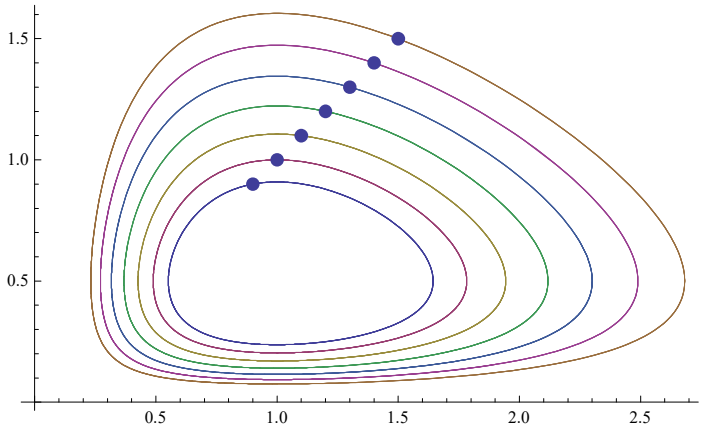


Question 05

In[7]:=
```
Remove[a, b, g, d]
a = 2 / 3; b = 4 / 3; g = 1; d = 1; i = .9;
table5 = Table[NDSolveValue[{x'[t] == x[t] (a - b * y[t]), y'[t] == y[t] (d * x[t] - g),
      x[0] == i, y[0] == i}, {x[t], y[t]}, {t, 0, 50}], {i, .9, 1.5, .1}];
```

In[10]:=
```
plot1 = ParametricPlot[table5, {t, 10, 50}];
plot2 = ListPlot[Table[{i, i}, {i, .9, 1.5, .1}], PlotStyle → PointSize[.02]];
Show[plot1, plot2]
```

Out[12]=



Question 06

In[281]:=
```
Clear[x, t, u]
```

In[282]:=
```
eq = D[u[x, t], {x, 2}] == D[u[x, t], {t, 2}]
init = {u[x, 0] → 3 * x, Derivative[0, 1][u][x, 0] → Sin[2 * x]}
```

Out[282]= $u^{(2,0)}[x, t] == u^{(0,2)}[x, t]$

Out[283]= $\{u[x, 0] \to 3\, x,\ u^{(0,1)}[x, 0] \to \text{Sin}[2\, x]\}$

In[284]:=
```
lp = LaplaceTransform[eq, t, s] /. init
```

Out[284]= $\text{LaplaceTransform}\left[u^{(2,0)}[x, t], t, s\right] == -3\, s\, x + s^2\, \text{LaplaceTransform}[u[x, t], t, s] - \text{Sin}[2\, x]$

In[285]:=
```
sol = DSolve[lp, u[x, t], x][[1, 1, 2]]
```

Out[285]= $e^{s\, x}\, C[1] + e^{-s\, x}\, C[2] + \dfrac{12\, x + 3\, s^2\, x + s\, \text{Sin}[2\, x]}{4 + s^2}$

In[286]:=
```
u[x, s] == sol
```

Out[286]= $u[x, s] == e^{s\, x}\, C[1] + e^{-s\, x}\, C[2] + \dfrac{12\, x + 3\, s^2\, x + s\, \text{Sin}[2\, x]}{4 + s^2}$

In[321]:=
```
ilp = InverseLaplaceTransform[sol, s, t]
```

Out[321]= $C[2]\, \text{DiracDelta}[t - x] + C[1]\, \text{DiracDelta}[t + x] + 3\, x\, (\text{DiracDelta}[t] - 2\, \text{Sin}[2\, t]) + 6\, x\, \text{Sin}[2\, t] + \text{Cos}[2\, t]\, \text{Sin}[2\, x]$

In[323]:=
```
Plot3D[ilp, {x, -10, 10}, {t, 0, 5}, ColorFunction → "Rainbow"]
```

Out[323]=