PRACTICAL 1

(i) Lake Polution Model

In[37]:=
```
DE = C'[t] == F/V c_in - F/V C[t]
soln = DSolve[{DE, C[0] == c0}, C[t], t]
soln /. {c_in → 4 * 10^6, V → 28 * 10^6, F → 4 * 10^6, c0 → 3 * 10^6}
```

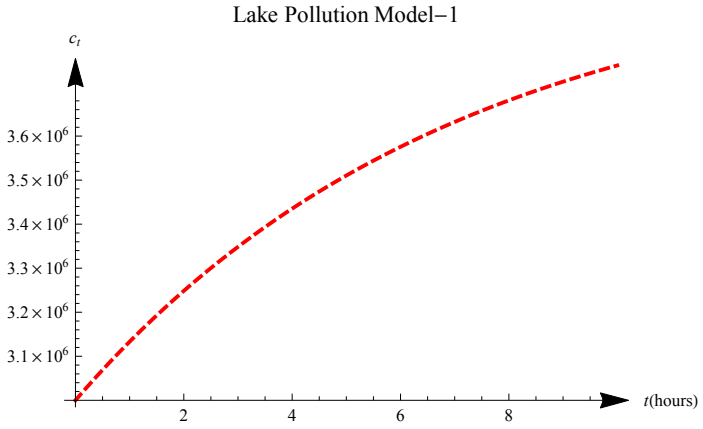
Out[37]= $C'[t] == -\frac{F\,C[t]}{V} + \frac{F\,c_{in}}{V}$

Out[38]= $\left\{\left\{C[t] \to e^{-\frac{Ft}{V}}\left(c0 - c_{in} + e^{\frac{Ft}{V}}\,c_{in}\right)\right\}\right\}$

Out[39]= $\left\{\left\{C[t] \to e^{-t/7}\left(-1\,000\,000 + 4\,000\,000\,e^{t/7}\right)\right\}\right\}$

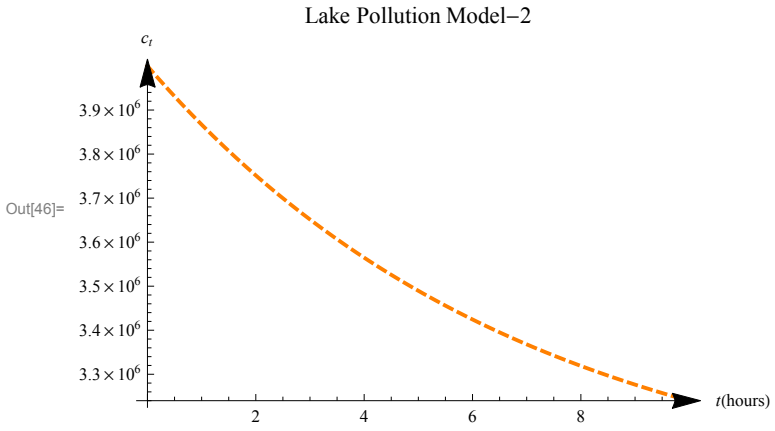
In[45]:=
```
Plot[
 Evaluate[C[t] /. soln /. {c_in → 4 * 10^6, V → 28 * 10^6, F → 4 * 10^6, c0 → 3 * 10^6}],
 {t, 0, 10}, AxesLabel → {t[hours], C[t]}, AxesStyle → Arrowheads[{0, 0.05}],
 PlotStyle → {Red, Thick, Dashed}, PlotLabel → "Lake Pollution Model-1"]
```

Out[45]=



In[46]:=
```
Plot[Evaluate[C[t] /. soln /. {c_in → 3 * 10^6, V → 28 * 10^6, F → 4 * 10^6, c0 → 4 * 10^6}],
 {t, 0, 10}, AxesLabel → {t[hours], C[t]}, AxesStyle → Arrowheads[{0, 0.05}],
 PlotStyle → {Orange, Thick, Dashed}, PlotLabel → "Lake Pollution Model-2"]
```

Out[46]=



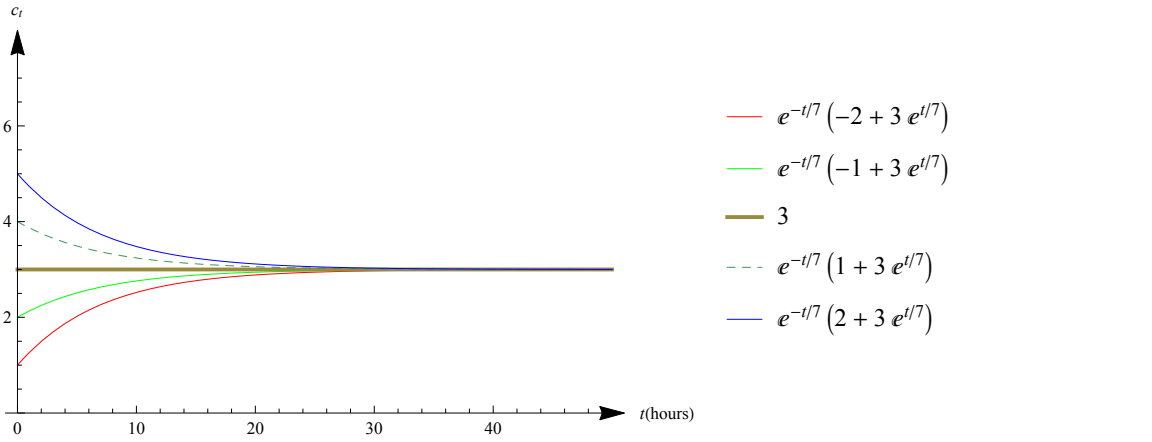
In[54]:=
```
DE = C'[t] == F/V c_in - F/V C[t]
soln = DSolve[{DE, C[0] == c0}, C[t], t]
soln /. {c_in → 3, V → 28, F → 4, c0 → Range[1, 5]}
Plot[Evaluate[C[t] /. soln /. {c_in → 3, V → 28, F → 4, c0 → Range[1, 5]}],
 {t, 0, 50}, AxesLabel → {t[hours], C[t]}, PlotRange → {0, 8},
 AxesStyle → Arrowheads[{0, 0.04}], PlotLegends → "Expressions",
 PlotStyle → {Red, Green, Thick, Dashed, Blue}]
```

Out[54]= $C'[t] == -\frac{F\,C[t]}{V} + \frac{F\,c_{in}}{V}$

Out[55]= $\left\{\left\{C[t] \to e^{-\frac{Ft}{V}}\left(c0 - c_{in} + e^{\frac{Ft}{V}}\,c_{in}\right)\right\}\right\}$

Out[56]= $\left\{\left\{C[t] \to \left\{e^{-t/7}\left(-2 + 3\,e^{t/7}\right),\ e^{-t/7}\left(-1 + 3\,e^{t/7}\right),\ 3,\ e^{-t/7}\left(1 + 3\,e^{t/7}\right),\ e^{-t/7}\left(2 + 3\,e^{t/7}\right)\right\}\right\}\right\}$

Out[57]=



Interpretation of Graph :- As the time increase the concentration of pollutants in the lake will approach the cocentration of the polluted water entering the lake [C[t] = c_{in}] Here c_0 = c_{in} then the level of pollution in the lake decreases monotonically to c_{in} . If $c_0 < c_{in}$ then the level of pollution in the lake increase monotonically to c_{in}.

(ii) Case of a single cold pill and a course of cold pills

Example :- Solve drug single cold pill model and plot its graph

In[108]:=
```
eqn1 = x'[t] == -k1 x[t];
eqn2 = y'[t] == k1 x[t] - k2 y[t];
sol = DSolve[{eqn1, eqn2, x[0] == 1, y[0] == 0}, {x[t], y[t]}, t]
solx1 = x[t] /. sol /. {k1 → 1.3860, k2 → 0.1386}
solx2 = x[t] /. sol /. {k1 → 0.6931, k2 → 0.0231}
solx3 = x[t] /. sol /. {k1 → 0.6931, k2 → 0.08}

soly1 = y[t] /. sol /. {k1 → 1.3860, k2 → 0.1386}
soly2 = y[t] /. sol /. {k1 → 0.6931, k2 → 0.0231}
soly3 = y[t] /. sol /. {k1 → 0.6931, k2 → 0.08}

Plot[{solx1, solx2, solx3}, {t, 0, 15},
 PlotStyle → {Thickness[0.02], {Red, Thickness[0.01]}, Thick},
 Epilog → Inset[Framed[GI - Tract]], PlotLegends → "Expressions"]
Plot[{soly1, soly2, soly3}, {t, 0, 15},
 PlotStyle → {Thickness[0.02], {Red, Thickness[0.01]}, Thick},
 Epilog → Inset[Framed[Bloodstream]], PlotLegends → "Expressions"]
```

Out[110]= $\left\{\left\{x[t] \to e^{-k1\,t},\ y[t] \to -\frac{e^{-k1\,t-k2\,t}\left(-e^{k1\,t}+e^{k2\,t}\right) k1}{k1-k2}\right\}\right\}$

Out[111]= $\left\{e^{-1.386\,t}\right\}$

Out[112]= $\left\{e^{-0.6931\,t}\right\}$

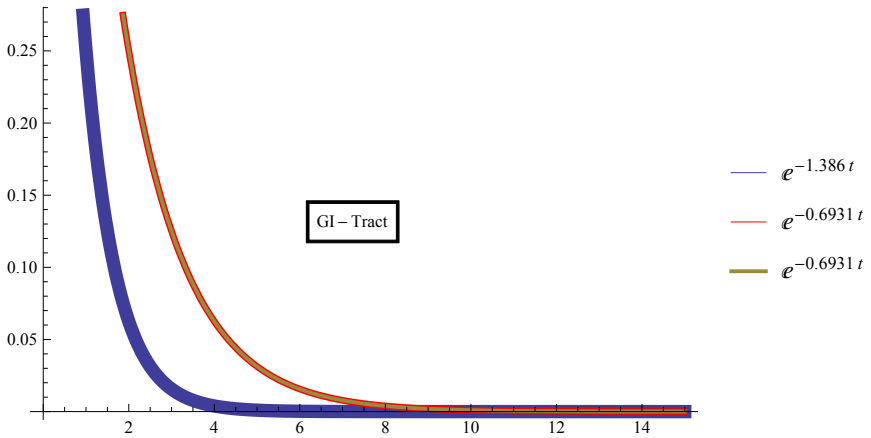
Out[113]= $\left\{e^{-0.6931\,t}\right\}$

Out[114]= $\left\{-1.11111\,e^{-1.5246\,t}\left(e^{0.1386\,t}-e^{1.386\,t}\right)\right\}$

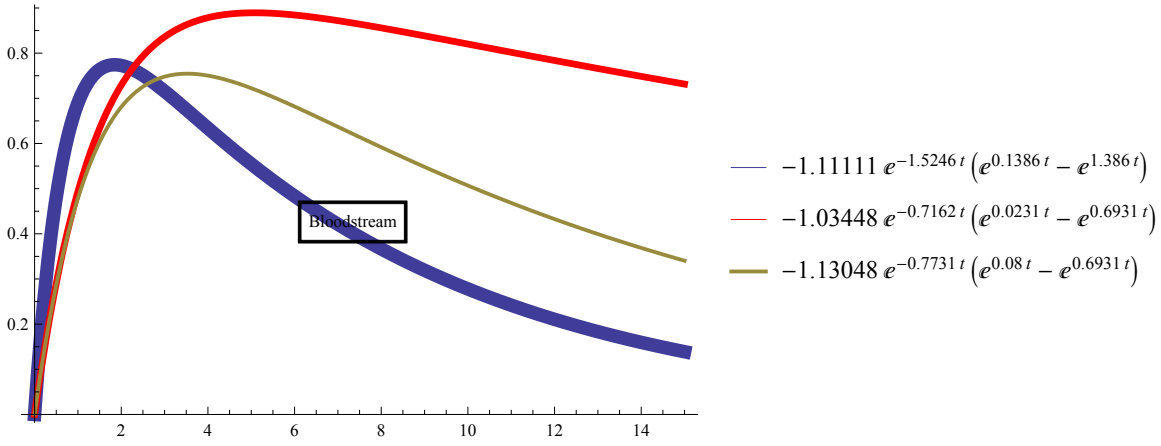
Out[115]= $\left\{-1.03448\,e^{-0.7162\,t}\left(e^{0.0231\,t}-e^{0.6931\,t}\right)\right\}$

Out[116]= $\left\{-1.13048\,e^{-0.7731\,t}\left(e^{0.08\,t}-e^{0.6931\,t}\right)\right\}$

Out[117]=



Out[118]=


0.8
0.6
0.4
0.2
2
4
6
8
10
12
14
Bloodstream
$-1.11111\, e^{-1.5246\, t}\left(e^{0.1386\, t} - e^{1.386\, t}\right)$
$-1.03448\, e^{-0.7162\, t}\left(e^{0.0231\, t} - e^{0.6931\, t}\right)$
$-1.13048\, e^{-0.7731\, t}\left(e^{0.08\, t} - e^{0.6931\, t}\right)$

Example :- Solve course of cold pills model and plot its graph.

In[119]:=
```
Clear[eqn1, eqn2, sol]
eqn1 = x'[t] == I - k1 x[t]
eqn2 = y'[t] == k1 x[t] - k2 y[t]
sol = DSolve[{eqn1, eqn2, x[0] == 0, y[0] == 0}, {x[t], y[t]}, t]
sol /. {k1 → {1.3860, 0.6931}, k2 → {0.1386, 0.0231}, I → 1}
```

Out[120]= $x'[t] == i - k_1\, x[t]$

Out[121]= $y'[t] == k_1\, x[t] - k_2\, y[t]$

Out[122]= $$\left\{\left\{x[t] \to \frac{i\, e^{-t\, k_1}\, \left(-1 + e^{t\, k_1}\right)}{k_1},\ y[t] \to \frac{i\, e^{-t\, k_1 - t\, k_2}\, \left(e^{t\, k_1}\, k_1 - e^{t\, k_1 + t\, k_2}\, k_1 - e^{t\, k_2}\, k_2 + e^{t\, k_1 + t\, k_2}\, k_2\right)}{k_2\, \left(-k_1 + k_2\right)}\right\}\right\}$$

Out[123]= $$\left\{\left\{x[t] \to \left\{0.721501\, e^{-1.386\, t}\, \left(-1 + e^{1.386\, t}\right),\ 1.44279\, e^{-0.6931\, t}\, \left(-1 + e^{0.6931\, t}\right)\right\},\right.\right.$$
$$\left.\left.y[t] \to \left\{-5.78404\, e^{-1.5246\, t}\, \left(-0.1386\, e^{0.1386\, t} + 1.386\, e^{1.386\, t} - 1.2474\, e^{1.5246\, t}\right),\right.\right.\right.$$
$$\left.\left.\left.-64.612\, e^{-0.7162\, t}\, \left(-0.0231\, e^{0.0231\, t} + 0.6931\, e^{0.6931\, t} - 0.67\, e^{0.7162\, t}\right)\right\}\right\}\right\}$$