

In[]:= **ClearAll**
清除全部

Out[]:= **ClearAll**

Problem 1, plot the solution

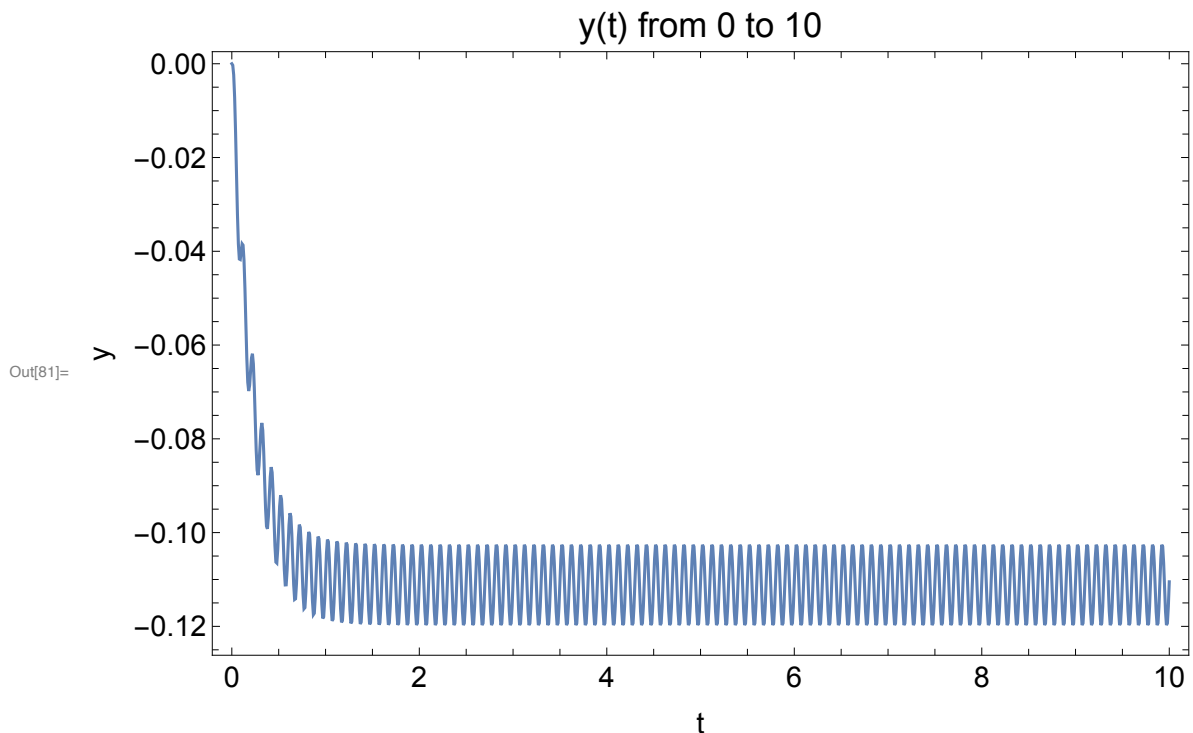
In[14]:= **DSolve**[{y'[t] == -5 y[t] - $\frac{1}{2} (1 - \text{Cos}[2 \text{ Pi} * 10 * t]) (1 - y[t])$, y[0] == 0}, y[t], t]
求解微分方程 余弦 圆周率

Out[14]= $\left\{ \left\{ y[t] \rightarrow e^{-\frac{9t}{2} - \frac{\text{Sin}[20\pi t]}{40\pi}} \int_0^t \frac{1}{2} e^{\frac{9K[1]}{2} + \frac{\text{Sin}[20\pi K[1]]}{40\pi}} (-1 + \text{Cos}[20\pi K[1]]) dK[1] \right\} \right\}$

In[79]:= **value[t_]** := $e^{-\frac{9t}{2} - \frac{\text{Sin}[20\pi t]}{40\pi}}$ **NIntegrate** $\left[\frac{1}{2} e^{\frac{9tt}{2} + \frac{\text{Sin}[20\pi tt]}{40\pi}} (-1 + \text{Cos}[20\pi tt]) \right]$, {tt, 0, t}];
数值积分 余弦

yValues = **Table**[**value**[t], {t, 0, 10, 0.01}];
表格

In[81]:= **ListLinePlot**[**yValues**, **DataRange** → {0, 10},
绘制点集的线条 数据范围
FrameLabel → {"t", "y"}, **LabelStyle** → {**Directive**[15], **Black**},
边框标签 标签样式 指令 黑色
PlotLabel → "y(t) from 0 to 10", **Frame** → **True**, **ImageSize** → **Large**]
绘图标签 边框 真 图像尺寸 大



Problem 2, power for different f

In[38]:= `DSolve` $\left[\left\{y'[t] == -5 y[t] - \frac{1}{2} (1 - \text{Cos}[2 \text{Pi} * f * t]) (1 - y[t]), y[0] == 0\right\}, y[t], t\right]$
求解微分方程 余弦 圆周率

Out[38]= $\left\{ \left\{ y[t] \rightarrow e^{-\frac{9t}{2} - \frac{\text{Sin}[2 f \pi t]}{4 f \pi}} \int_0^t \frac{1}{2} e^{\frac{9K[1]}{2} + \frac{\text{Sin}[2 f \pi K[1]]}{4 f \pi}} (-1 + \text{Cos}[2 f \pi K[1]]) dK[1] \right\} \right\}$

In[68]:= `solutionWithf` $[t_, f_] :=$
 $e^{-\frac{9t}{2} - \frac{\text{Sin}[2 f \pi t]}{4 f \pi}} \text{NIntegrate}\left[\frac{1}{2} e^{\frac{9tt}{2} + \frac{\text{Sin}[2 f \pi tt]}{4 f \pi}} (-1 + \text{Cos}[2 f \pi tt]), \{tt, 0, t\}\right]$
数值积分 余弦

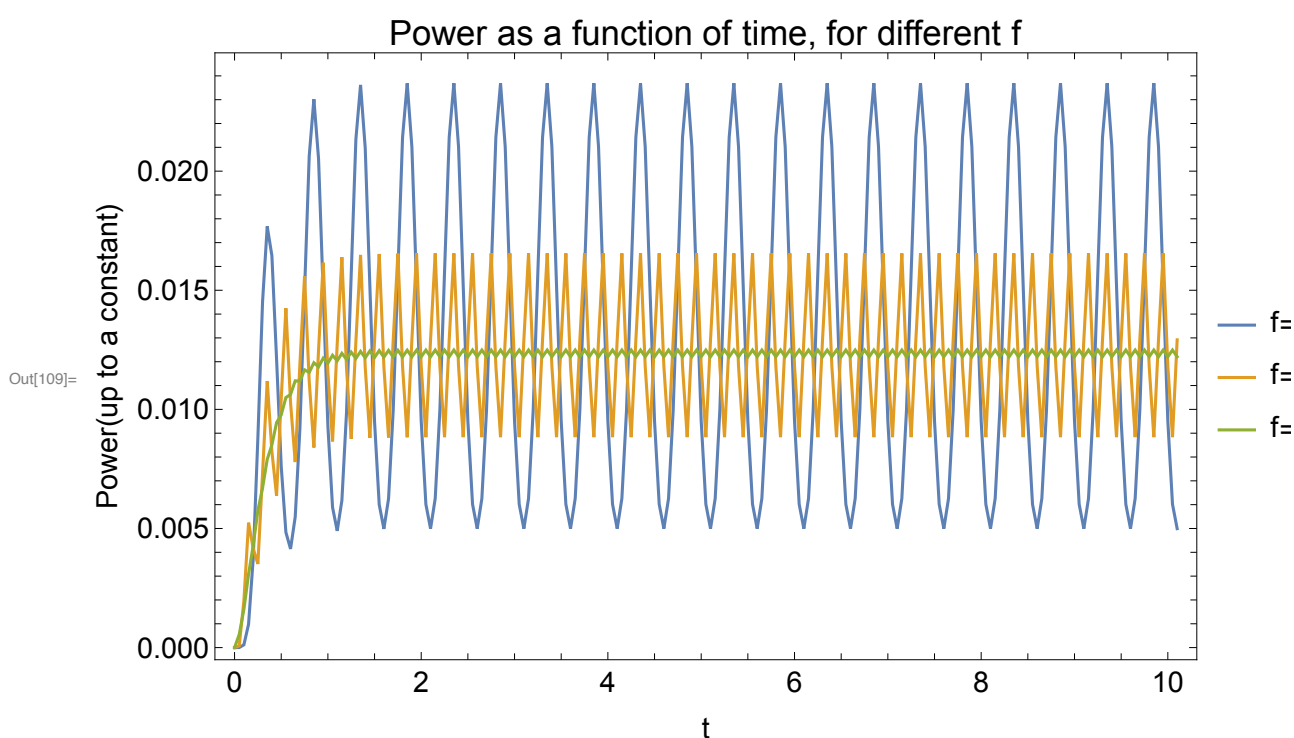
What we solved above is $y(t)$, which is voltage. In this problem current scales with voltage, thus power scales with voltage square.

For example, for $f=5$, the power as a time would be:

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In[109]:= ListLinePlot[Table[solutionWithf[t, 2]^2, {t, 0, 10.1, 0.05}],
  Table[solutionWithf[t, 5]^2, {t, 0, 10.1, 0.05}],
  Table[solutionWithf[t, 10]^2, {t, 0, 10.1, 0.05}]],
  DataRange -> {0, 10.1}, FrameLabel -> {"t", "Power(up to a constant)"},
  LabelStyle -> {Directive[15], Black},
  PlotLabel -> "Power as a function of time, for different f", Frame -> True,
  ImageSize -> Large, PlotLegends -> {"f=2", "f=5", "f=10"}, PlotRange -> All]

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We could see that for larger f , the mean power is smaller and the osculation is weaker.

Problem 3 mean power

Power is osculating strongly, therefore, I need to average over time. I will average the solution between 9 and 10. Since at $t=9$, the system is already reached its steady state, which can be considered as $t = \text{infinity}$.

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In[95]:= power[f_] := Mean[Table[solutionWithf[t, f]^2, {t, 9, 10, 0.01}]]

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In[96]:= ListLinePlot[Table[power[f], {f, 1, 10, 0.1}],
  |绘制点集的线条 |表格
  DataRange -> {1, 10}, FrameLabel -> {"f", "Power(up to a constant)"},
  |数据范围 |边框标签 |幂
  LabelStyle -> {Directive[15], Black}, PlotLabel -> "Power as a function of f",
  |标签样式 |指令 |黑色 |绘图标签 |幂
  Frame -> True, ImageSize -> Large, PlotRange -> All]
  |边框 |真 |图像尺寸 |大 |绘制范围 |全部

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