Experiment 2.2
Ryan St. Pierre (ras70)
October 11, 2017

```
> restart
```

Helpful functions

```
> with(inttrans):
> u := t -> Heaviside(t):
> PAR := (Za, Zb) -> simplify( Za·Zb / (Za + Zb) ):
> SCS := X -> sort(collect(simplify(expand(numer(X))/expand(denom(X))), s), s):
> IL := (X, s, t) -> simplify(convert(invlaplace(convert(X, parfrac, s), s, t), expsincos)):
> ILTS := (X, s, t) -> simplify(convert(invlaplace(X, s, t), expsincos)):
```

Prelab

Loop 1

```
> eqn1 := (R1 + R2 + L1·s + 1/(C1·s))·I1 - (L1·s + R2)·I2 - R1·I3 = V
```

$$eqn1 := \left(R1 + R2 + L1\,s + \frac{1}{C1\,s}\right) I1 - (L1\,s + R2)\,I2 - R1\,I3 = V \tag{1}$$

Loop 2

```
> eqn2 := -(L1·s + R2)·I1 + (R2 + R3 + (L1 + L2)·s + 1/(C2·s))·I2 - (R3 + L2·s)
      ·I3 = 0
```

$$eqn2 := -(L1\,s + R2)\,I1 + \left(R2 + R3 + (L1 + L2)\,s + \frac{1}{C2\,s}\right) I2 - (L2\,s + R3)\,I3 = 0 \tag{2}$$

Loop 3

```
> eqn3 := -R1·I1 - (R3 + L2·s)·I2 + (R1 + R3 + R4 + L2·s + 1/(C3·s))·I3 = 0
```

$$eqn3 := -R1\,I1 - (L2\,s + R3)\,I2 + \left(R1 + R3 + R4 + L2\,s + \frac{1}{C3\,s}\right) I3 = 0 \tag{3}$$

Lab

a)

```
> f := t -> 0.0075 - 0.00034·exp(-2.5·t)·cos(22·t) + 0.087·exp(-2.5·t)·sin(22·t)
      - 0.0072·exp(-8·t)
```

$$f := t \mapsto 0.0075 - 0.00034\,e^{-2.5\,t}\cos(22\,t) + 0.087\,e^{-2.5\,t}\sin(22\,t) - 0.0072\,e^{-8\,t} \tag{4}$$

b)

```
> G := 2·((s + 3)·(s + 5)·(s + 7)) / (s·(s + 8)·(s^2 + 10·s + 100))
```

$$G := \frac{2\,(s + 3)\,(s + 5)\,(s + 7)}{s\,(s + 8)\,(s^2 + 10\,s + 100)} \tag{5}$$

c)

```
> F := SCS(laplace(f(t), t, s))
```

$$F := -\frac{1}{s^4 + 13.\,s^3 + 530.250000000000\,s^2 + 3922.\,s}\,(0.00004000000000\,(s + 5.01080464882136)\,(s + 2.97645642235782)\,(s - 49306.2372610712)) \tag{6}$$

d)

```
> g := IL(G, s, t)
```

$$g := \frac{79\,e^{-5\,t}\sin\left(5\sqrt{3}\,t\right)\sqrt{3}}{420} + \frac{237\,e^{-5\,t}\cos\left(5\sqrt{3}\,t\right)}{140} + \frac{5\,e^{-8\,t}}{112} + \frac{21}{80} \tag{7}$$

Part F

Define the values

```
> vals := C1 = 1/5, R1 = 5, L1 = 1, R2 = 2, L2 = 1, R3 = 2, C2 = 1/3, C3 = 1/4, R4 = 1 :
```

Solve the system of equations

```
> sol := solve({eqn1, eqn2, eqn3}, [I1, I2, I3]) :
```

Loop 1

TF I1/V

```
> TFloop1 := simplify(expand(rhs(sol[ ][1])/V)) :
> simplify(subs(vals, TFloop1))
```

$$\frac{s\,(s^4 + 16\,s^3 + 39\,s^2 + 40\,s + 12)}{s^5 + 26\,s^4 + 205\,s^3 + 396\,s^2 + 284\,s + 60} \tag{8}$$

Loop 2

TF I2/V

```
> TFloop2 := simplify(expand(rhs(sol[ ][2])/V)) :
> simplify(subs(vals, TFloop2))
```

$$\frac{(s + 2)\,(s^2 + 13\,s + 4)\,s^2}{s^5 + 26\,s^4 + 205\,s^3 + 396\,s^2 + 284\,s + 60} \tag{9}$$

Loop 3

TF I3/V

```
> TFloop3 := simplify(expand(rhs(sol[ ][3])/V)) :
> simplify(subs(vals, TFloop3))
```

$$\frac{(s^3 + 14\,s^2 + 24\,s + 15)\,s^2}{s^5 + 26\,s^4 + 205\,s^3 + 396\,s^2 + 284\,s + 60} \tag{10}$$