HW #1
Problem 2
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```
> 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)):
```

Part A

```
> eq1 := (R1 + R2 + L·s)·I1 - (R2 + L·s)·I2 - R1·I3 = V
```

$$eq1 := (L\,s + R1 + R2)\,I1 - (L\,s + R2)\,I2 - R1\,I3 = V \tag{1}$$

```
> eq2 := (R3 + 1/(C2·s) + L·s + R2)·I2 - (R2 + L·s)·I1 - (R3 + 1/(C2·s))·I3 = -Vr
```

$$eq2 := \left(R3 + \frac{1}{C2\,s} + L\,s + R2\right) I2 - (L\,s + R2)\,I1 - \left(R3 + \frac{1}{C2\,s}\right) I3 = -Vr \tag{2}$$

```
> eq3 := (1/(C1·s) + 1/(C2·s) + R1 + R3)·I3 - R1·I1 - (R3 + 1/(C2·s))·I2 = 0
```

$$eq3 := \left(\frac{1}{C1\,s} + \frac{1}{C2\,s} + R1 + R3\right) I3 - R1\,I1 - \left(R3 + \frac{1}{C2\,s}\right) I2 = 0 \tag{3}$$

```
> eq4 := Vr = R4·I2
```

$$eq4 := Vr = R4\,I2 \tag{4}$$

```
> solMesh := solve({eq1, eq2, eq3, eq4}, [I1, I2, I3, Vr]):
> TFMesh := simplify(expand(rhs(solMesh[ ][4]) / V))
```

$$TFMesh := \left(\left(L\,C1\,C2\,(R1 + R3)\,s^2 + ((((R2 + R3)\,R1 + R2\,R3)\,C1 + L)\,C2 + L\,C1)\,s + C2\,R2 + C1\,(R1 + R2)\right) R4\,s\right) \Big/ \left(L\,C1\,C2\,R4\,(R1 + R3)\,s^3 + ((((R2 + R3)\,R1 + R2\,R3)\,R4\,C1 + L\,(R1 + R3 + R4))\,C2 + L\,C1\,R4)\,s^2 + (((R2 + R3 + R4)\,R1 + R2\,(R3 + R4))\,C2 + R4\,(R1 + R2)\,C1 + L)\,s + R1 + R2\right) \tag{5}$$

```
> vals := R1 = 2, R2 = 2, R3 = 1, R4 = 3, C1 = 1/2, C2 = 1/3, L = 4:
> simplify(subs(vals, TFMesh))
```

$$\frac{9\,s^3 + 21\,s^2 + 12\,s}{9\,s^3 + 27\,s^2 + 25\,s + 6} \tag{6}$$

Part B

> $eq1Node := \left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right) \cdot V1 - \frac{1}{R1} \cdot Vs - \frac{1}{R3} \cdot V2 - \frac{1}{R2} \cdot V3 = 0$

$$eq1Node := \left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right) V1 - \frac{Vs}{R1} - \frac{V2}{R3} - \frac{V3}{R2} = 0 \quad \textbf{(7)}$$

> $eq2Node := \left(\frac{1}{R3} + C2 \cdot s\right) \cdot V2 - \frac{1}{R3} \cdot V1 - C2 \cdot s \cdot Vr = 0$

$$eq2Node := \left(\frac{1}{R3} + C2\, s\right) V2 - \frac{V1}{R3} - Vr\, C2\, s = 0 \quad \textbf{(8)}$$

> $eq3Node := \left(\frac{1}{R2} + \frac{1}{L \cdot s}\right) \cdot V3 - \frac{1}{R2} \cdot V1 = 0$

$$eq3Node := \left(\frac{1}{R2} + \frac{1}{L\, s}\right) V3 - \frac{V1}{R2} = 0 \quad \textbf{(9)}$$

> $eq4Node := \left(C1 \cdot s + C2 \cdot s + \frac{1}{R4}\right) \cdot Vr - C1 \cdot s \cdot Vs - C2 \cdot s \cdot V2 = 0$

$$eq4Node := \left(C1\, s + C2\, s + \frac{1}{R4}\right) Vr - C1\, s\, Vs - C2\, s\, V2 = 0 \quad \textbf{(10)}$$

> $solNode := solve(\{eq1Node, eq2Node, eq3Node, eq4Node\}, [V1, V2, V3, Vr]) :$

> $TFNode := simplify\left(expand\left(\frac{rhs(solNode[\,][4])}{Vs}\right)\right)$

$$TFNode := \left(\left(L\, C1\, C2\, (R1 + R3)\, s^2 + ((((R2 + R3)\, R1 + R2\, R3)\, C1 + L)\, C2 + L\, C1)\, s + C2\, R2 + C1\, (R1 + R2)\right) R4\, s\right) \Big/ \left(L\, C1\, C2\, R4\, (R1 + R3)\, s^3 + ((((R2 + R3)\, R1 + R2\, R3)\, R4\, C1 + L\, (R1 + R3 + R4))\, C2 + L\, C1\, R4)\, s^2 + (((R2 + R3 + R4)\, R1 + R2\, (R3 + R4))\, C2 + R4\, (R1 + R2)\, C1 + L)\, s + R1 + R2\right) \quad \textbf{(11)}$$

> $simplify(subs(vals, TFNode))$

$$\frac{9\, s^3 + 21\, s^2 + 12\, s}{9\, s^3 + 27\, s^2 + 25\, s + 6} \quad \textbf{(12)}$$

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