

# Evolutionary Analog Amplifier Optimization

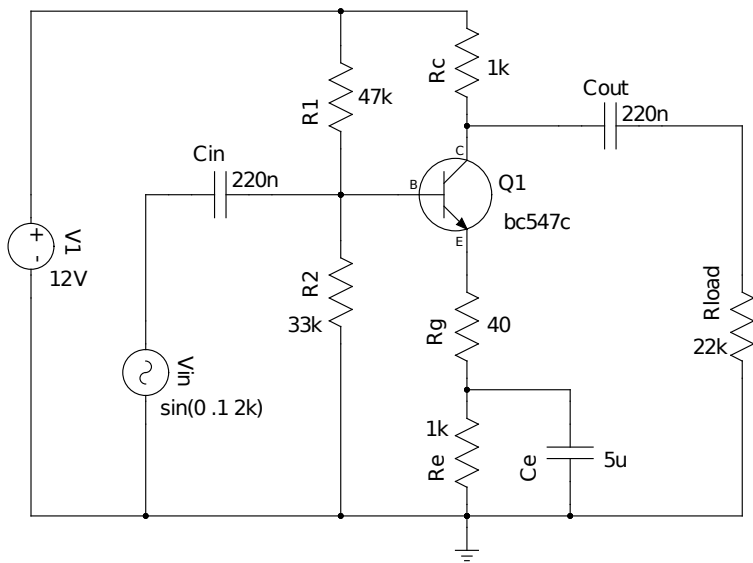
Marek Bielik

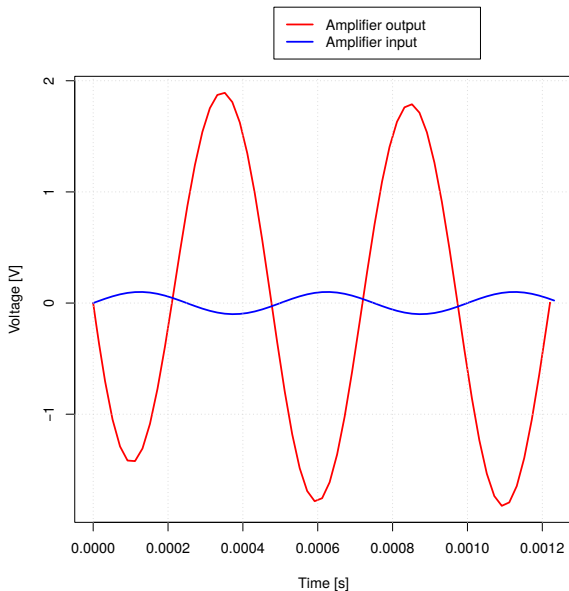
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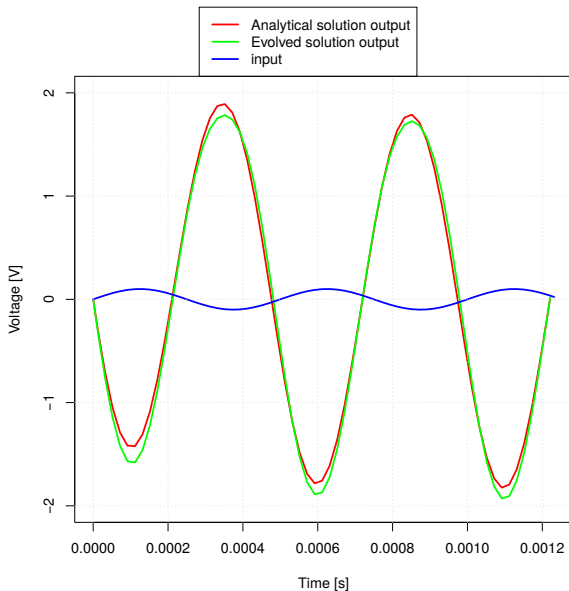


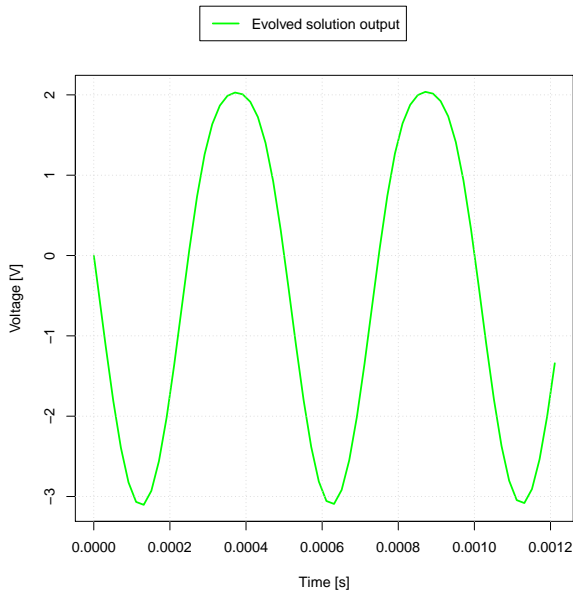
June 12, 2017

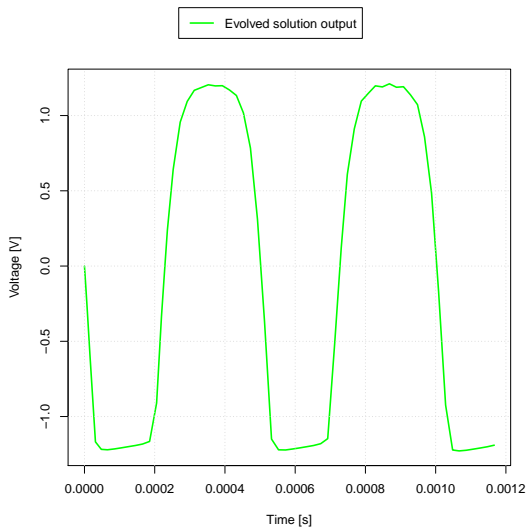
- Demonstrate the capabilities of evolutionary algorithms.
- Implement the concept of Evolution Strategies.
- Incorporate the ngSPICE simulator.
- Develop methods for evaluating the amplifiers.
- Find the best parameters for the optimization.



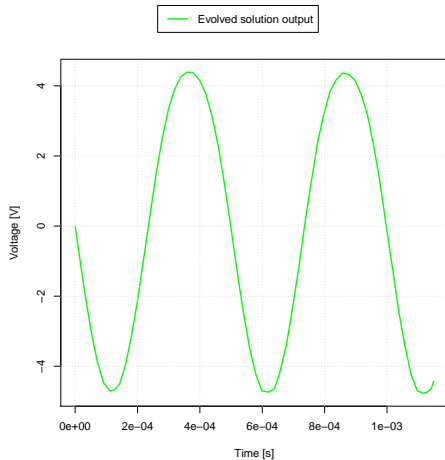








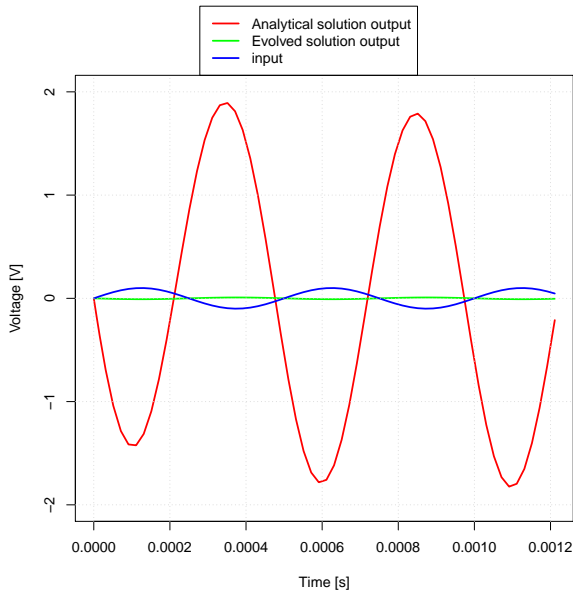
$$result = (|peak + trough| + 1) \cdot fitness$$

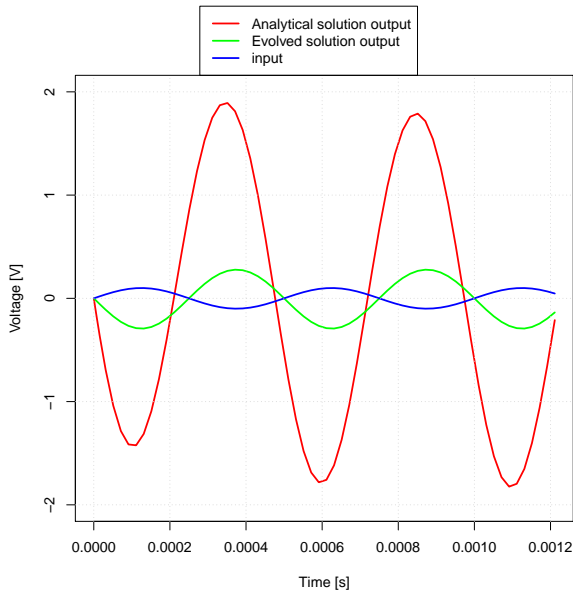


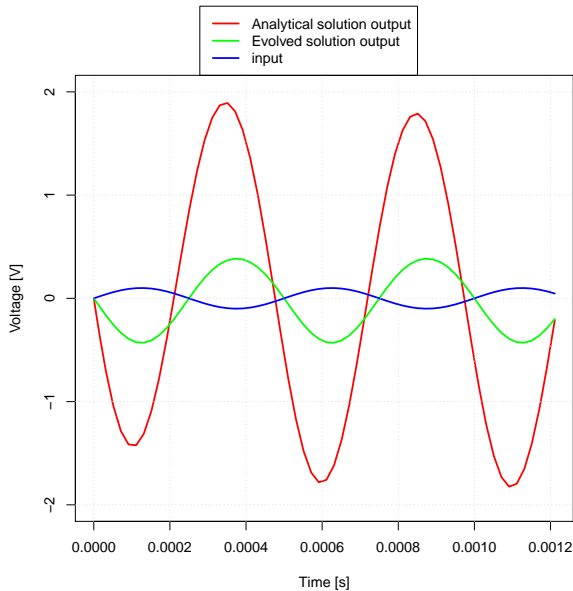
$R_1$ (k $\Omega$ )	$R_2$ (k $\Omega$ )	$R_e$ ( $\Omega$ )	$R_g$ ( $\Omega$ )	$R_c$ (k $\Omega$ )	$C_e$ ( $\mu$ F)	$C_{in}$ ( $\mu$ F)	$C_{out}$ (nF)
168	15.1	169	49	4.21	16	274	86

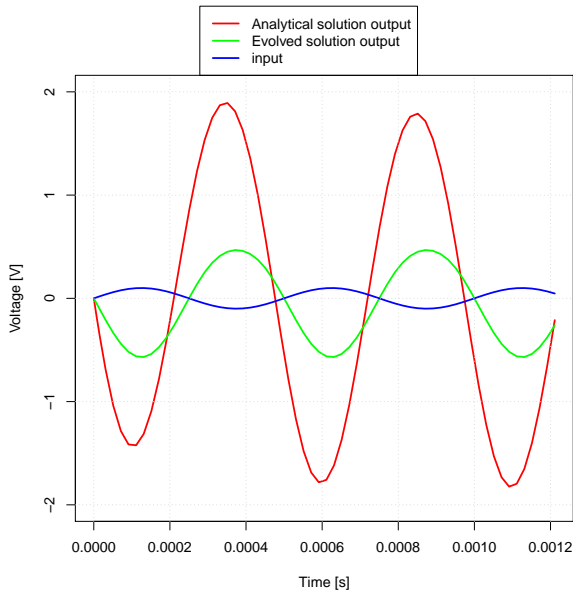


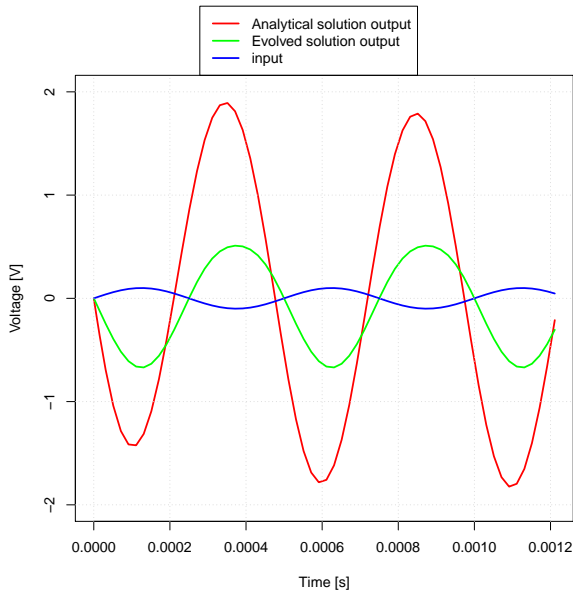
- A demonstration of evolution strategies.
- Contribution to the ngSPICE project:
  - *'Hello Marek,  
Thank you for this patch. It is a good pointer to some places.  
....  
we will see where it fits best.  
Thank You.'*  
Robert Larice
- A tool for designing analog amplifiers.

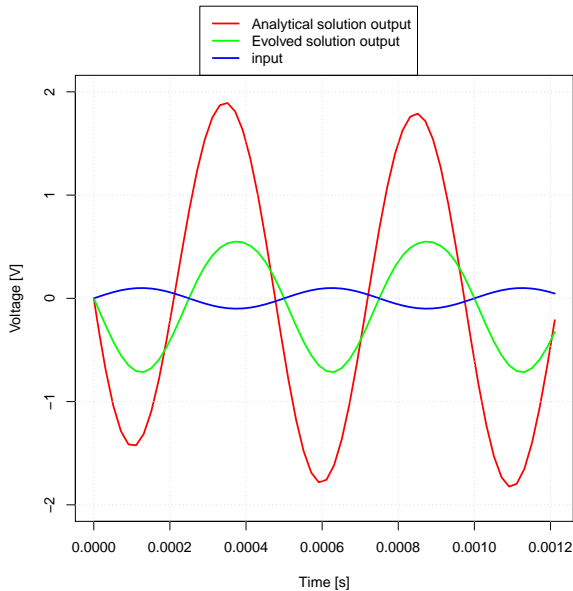


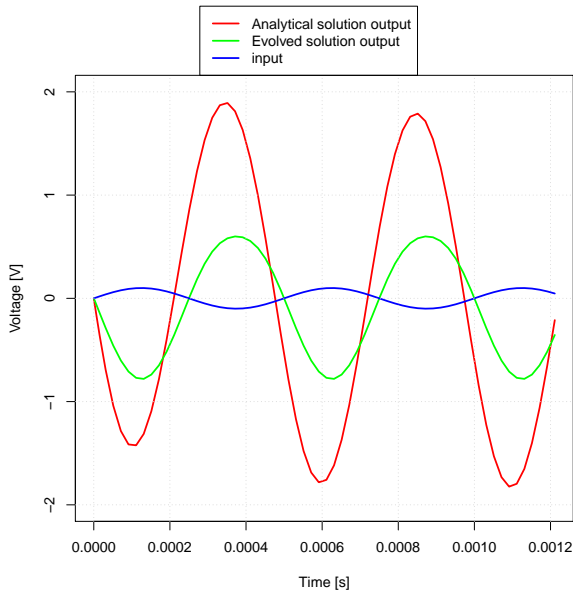




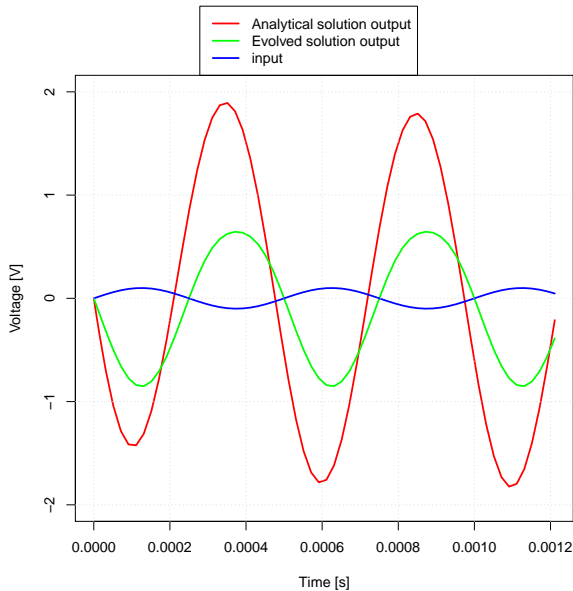


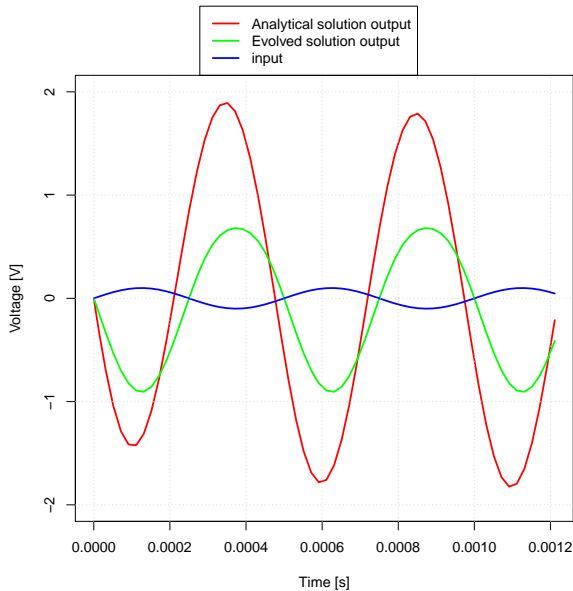


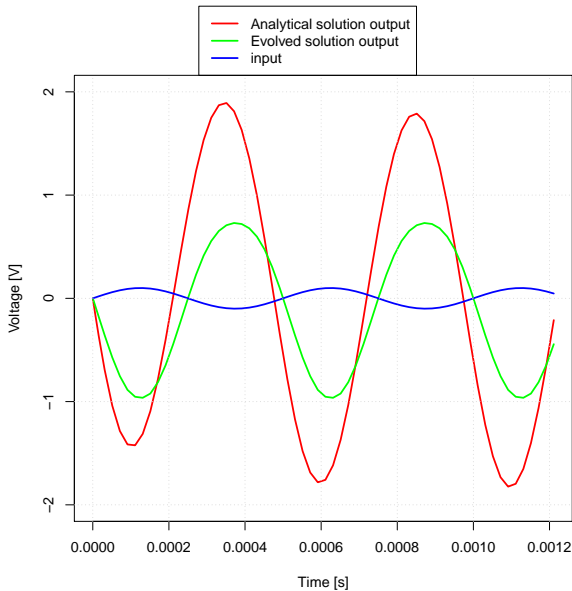


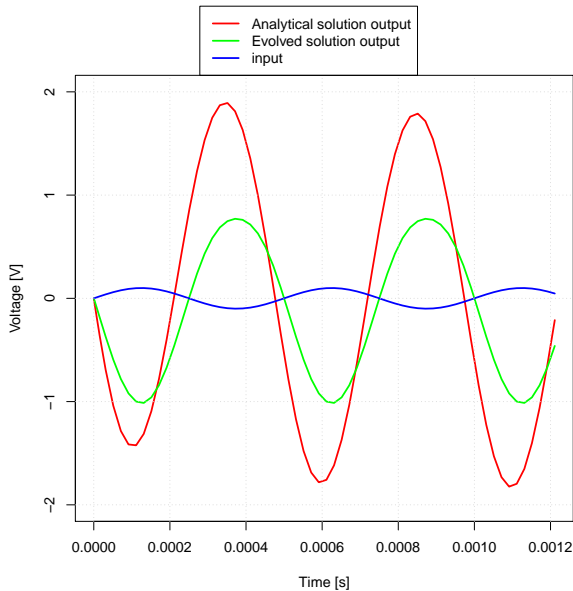


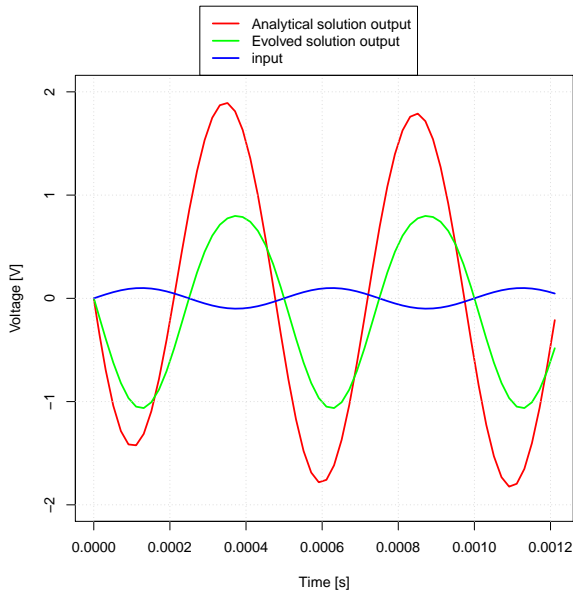


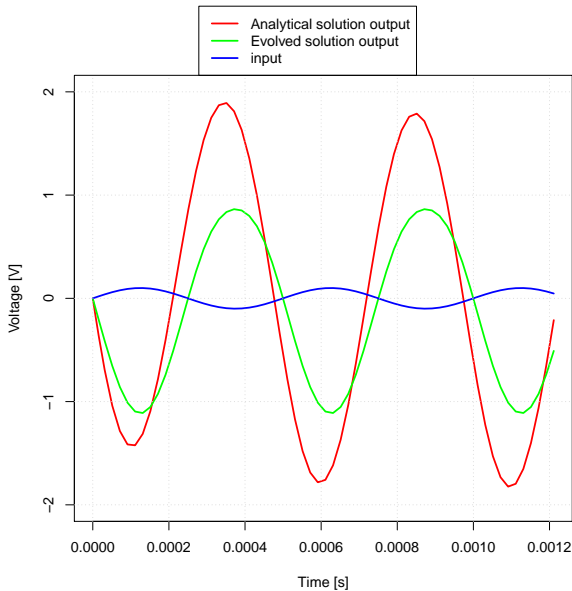


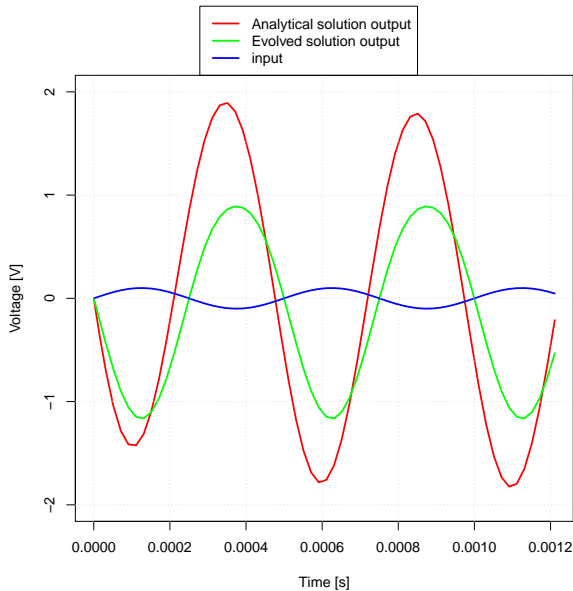


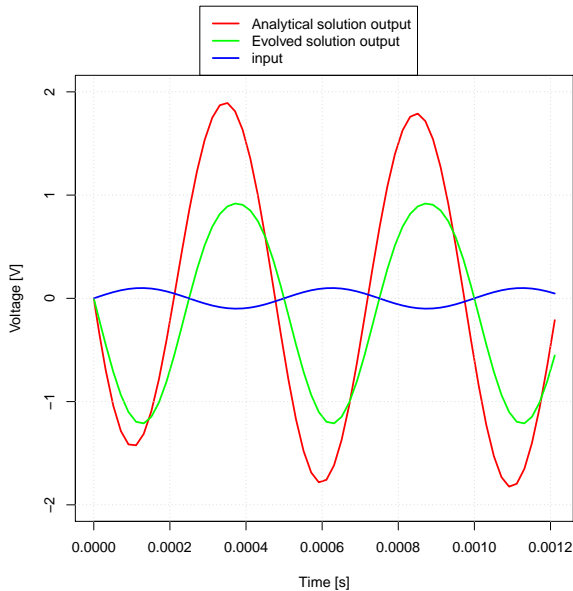




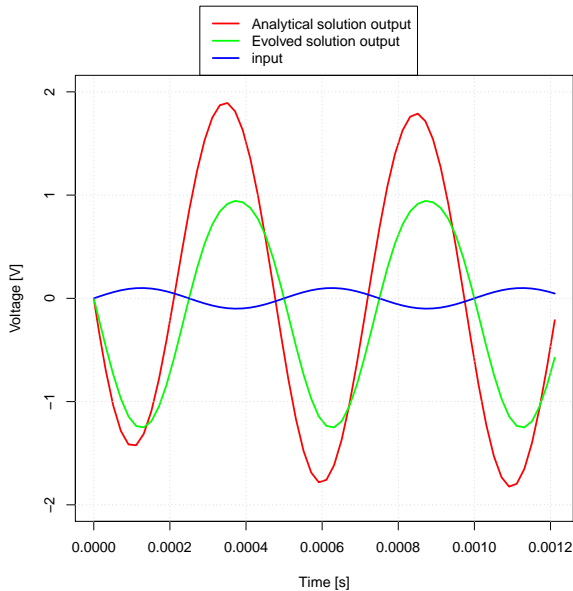


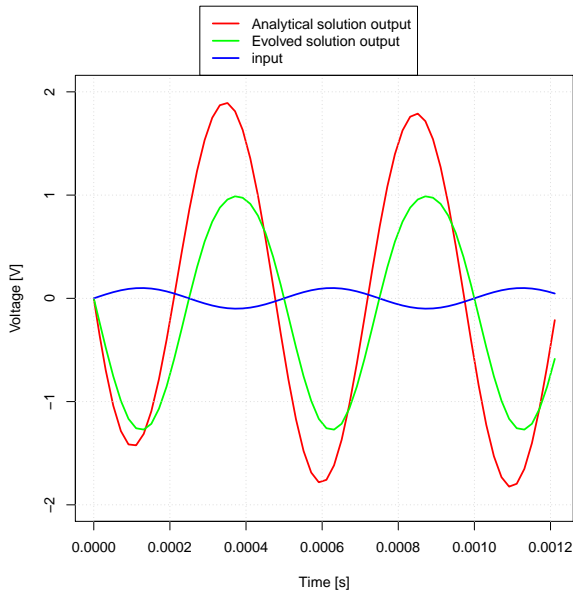


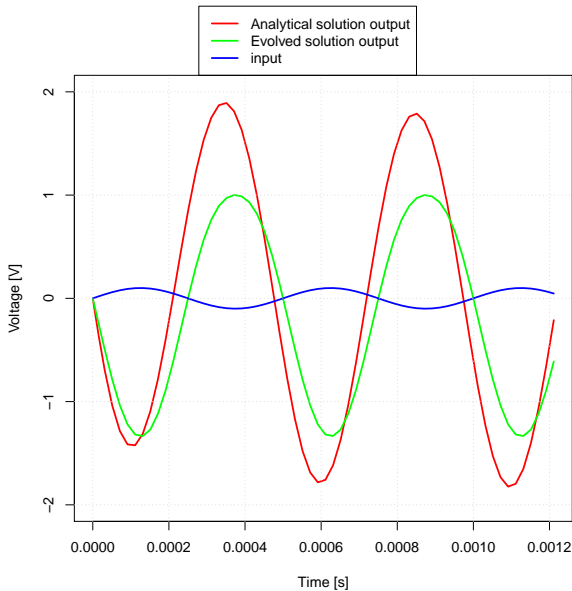


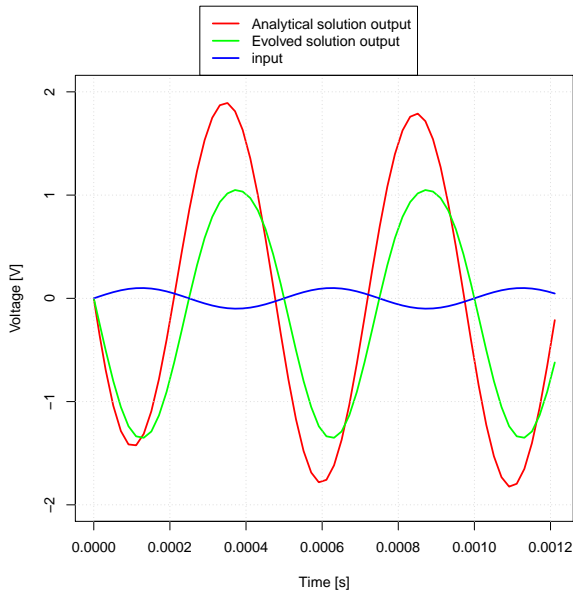


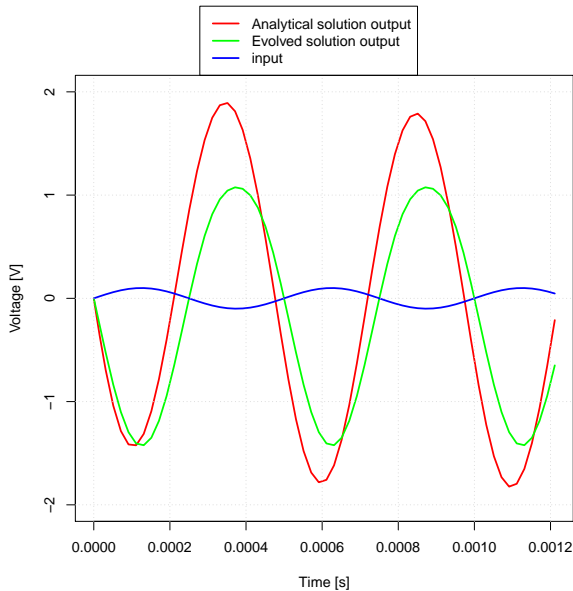


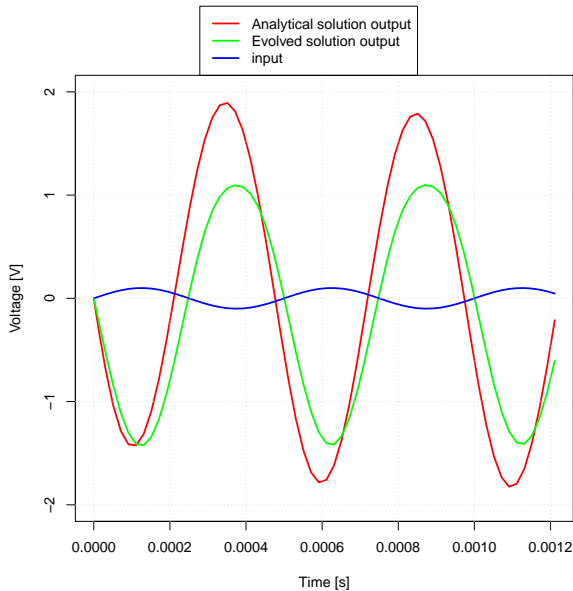


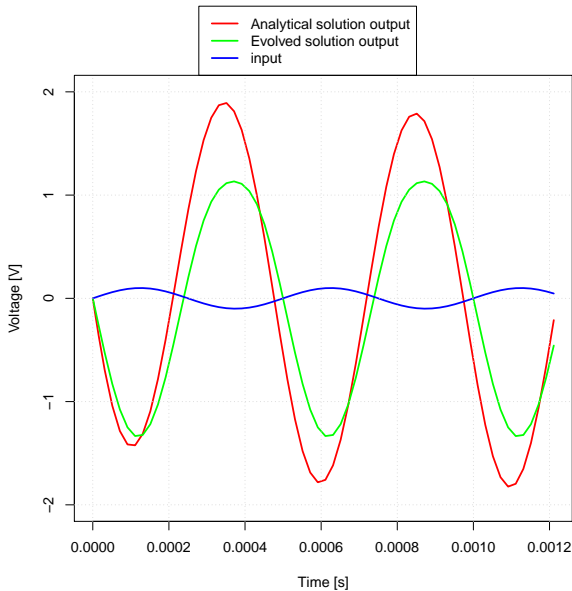


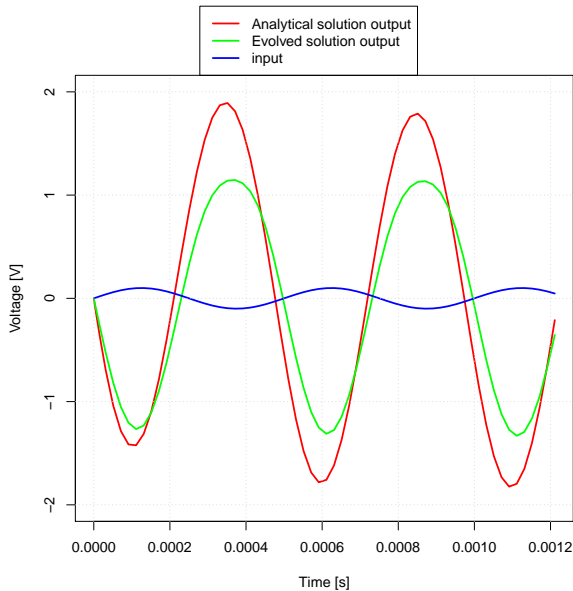




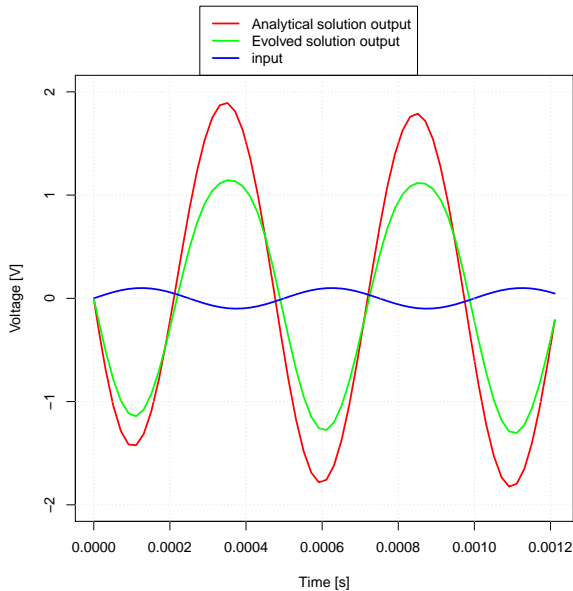


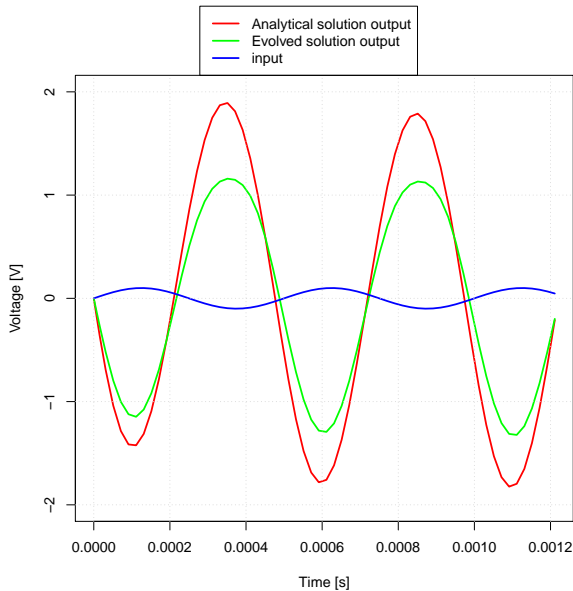


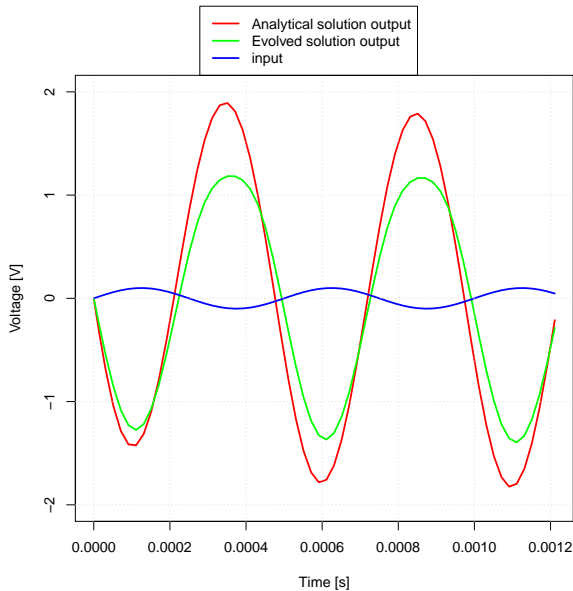


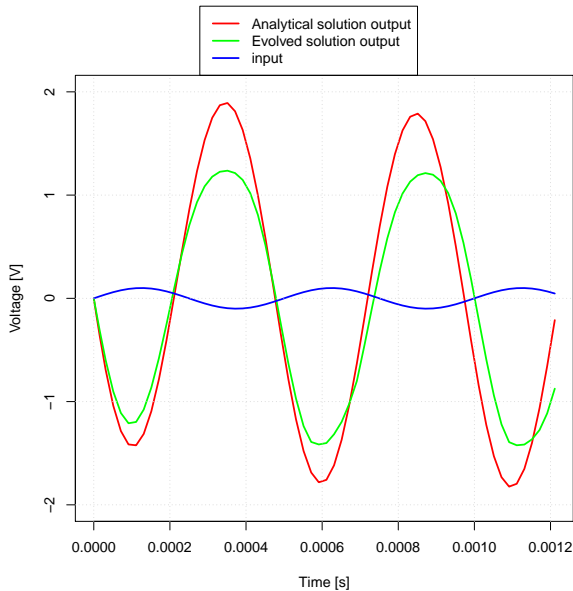


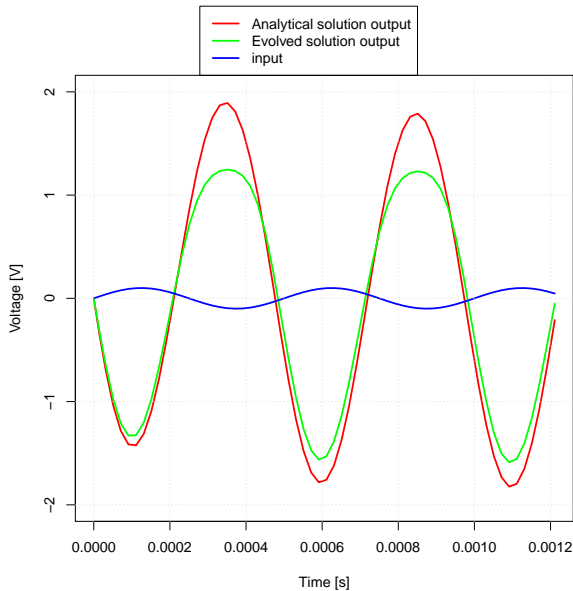


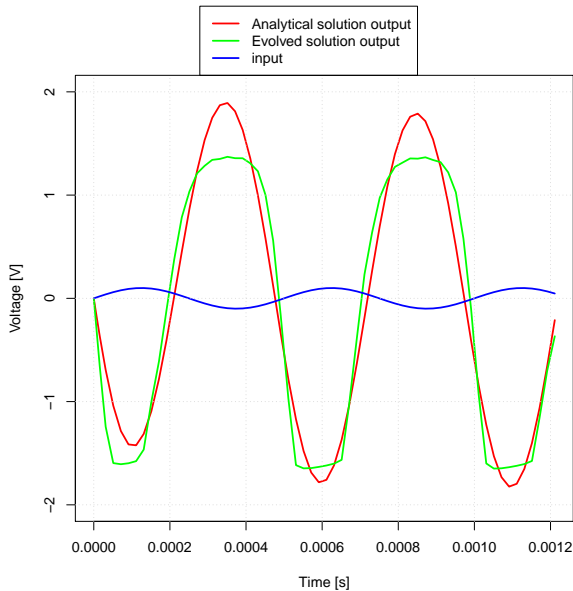


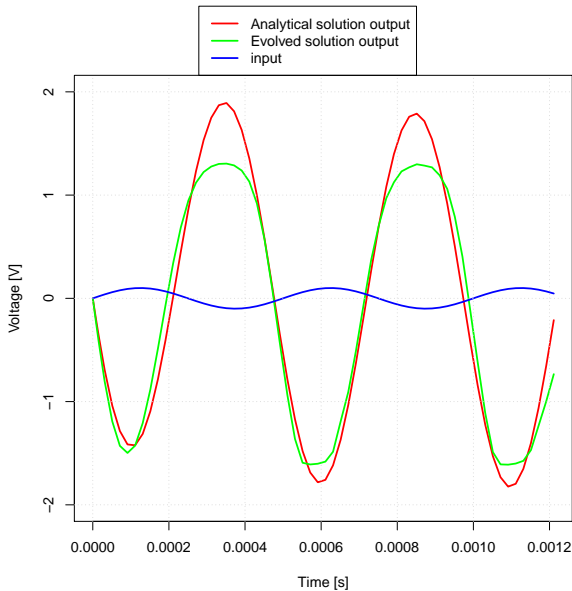


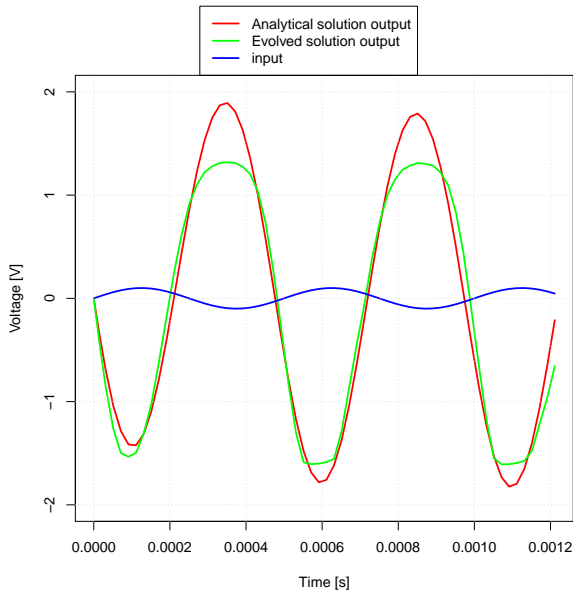




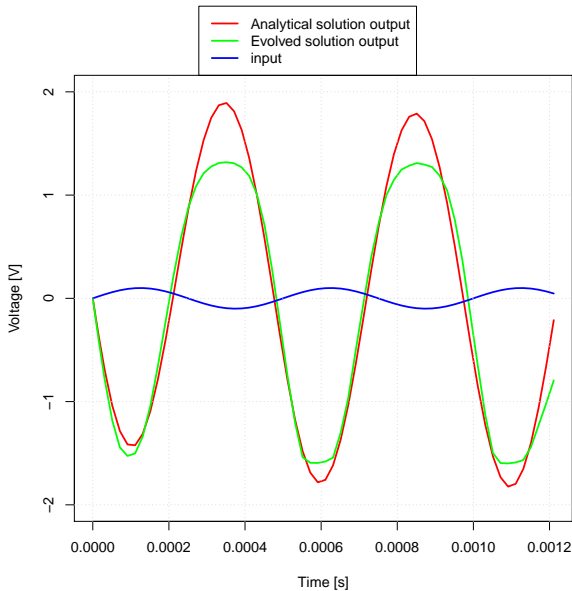


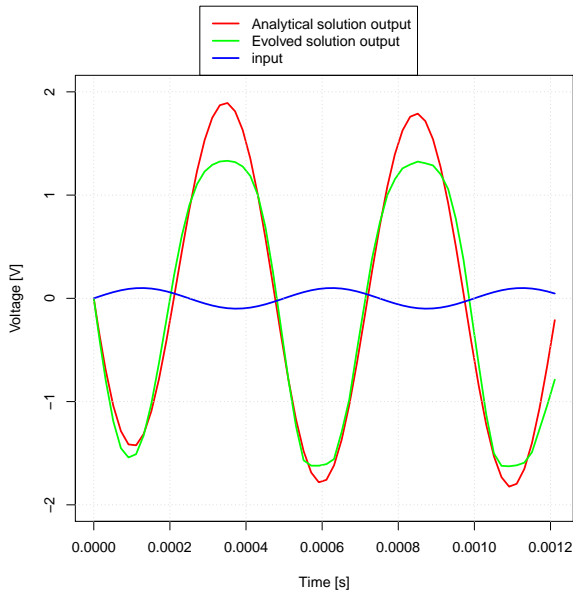


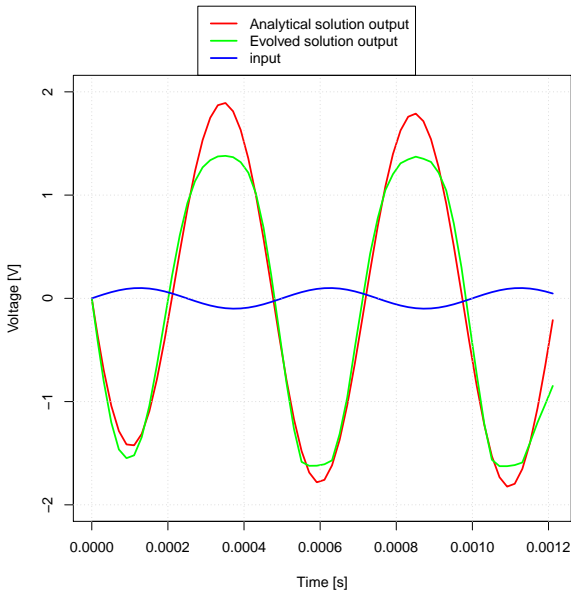


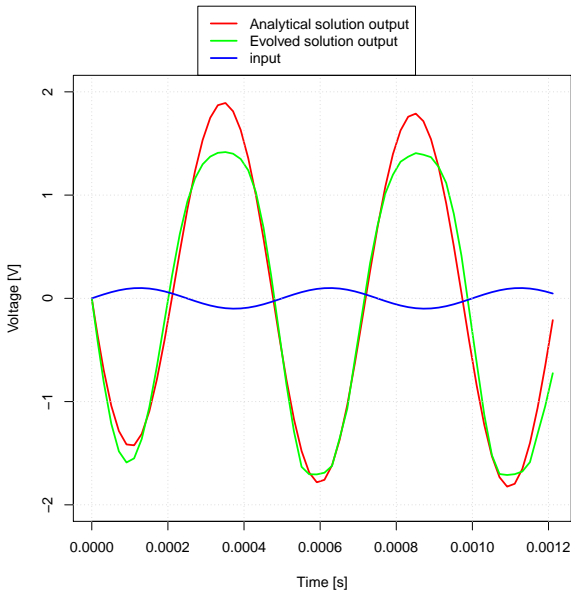


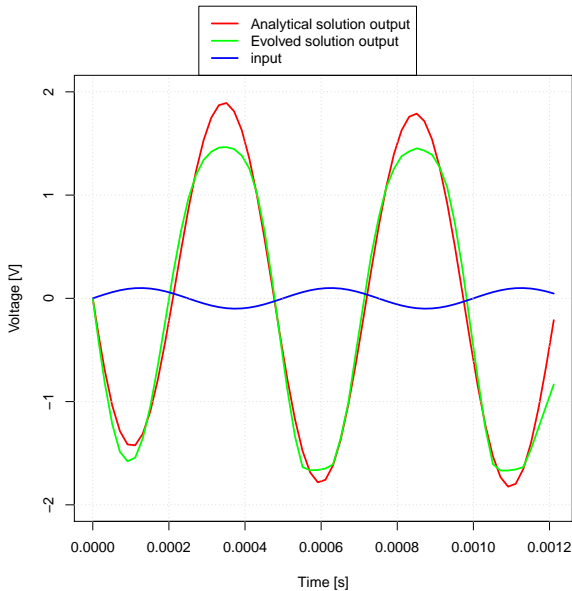


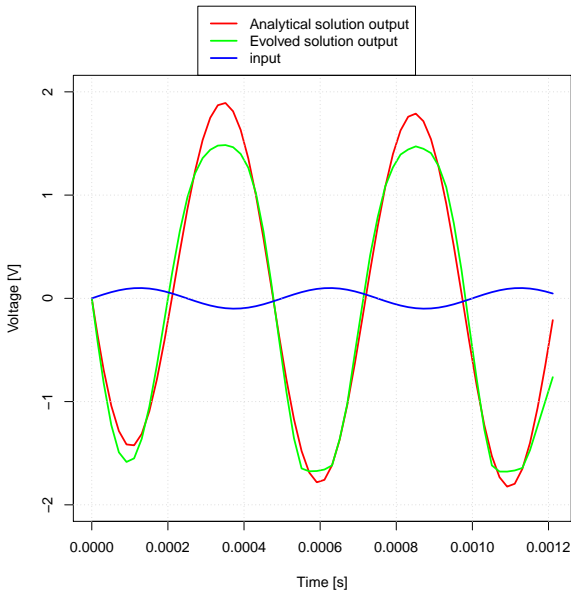


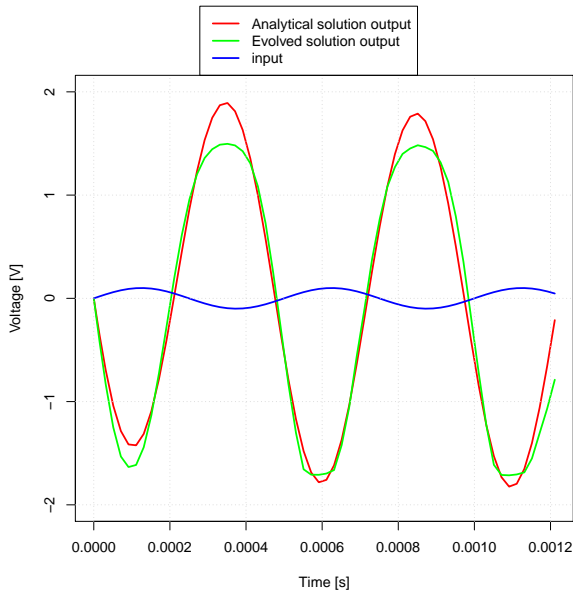


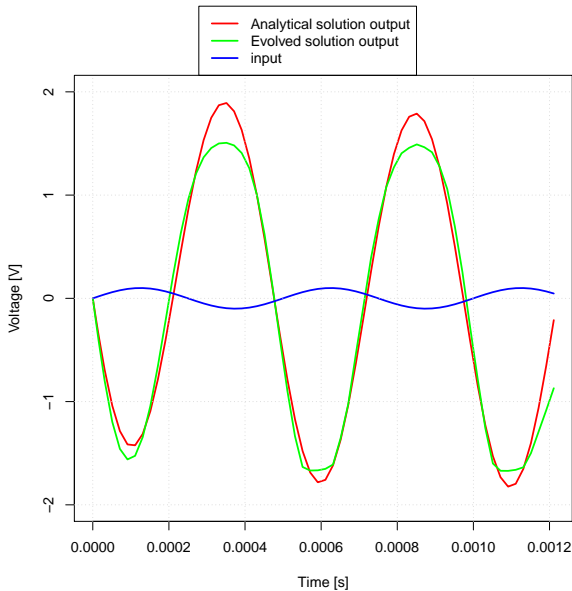




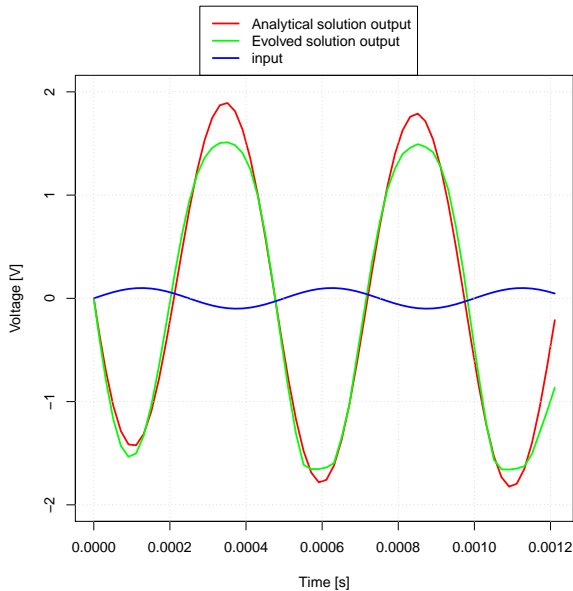


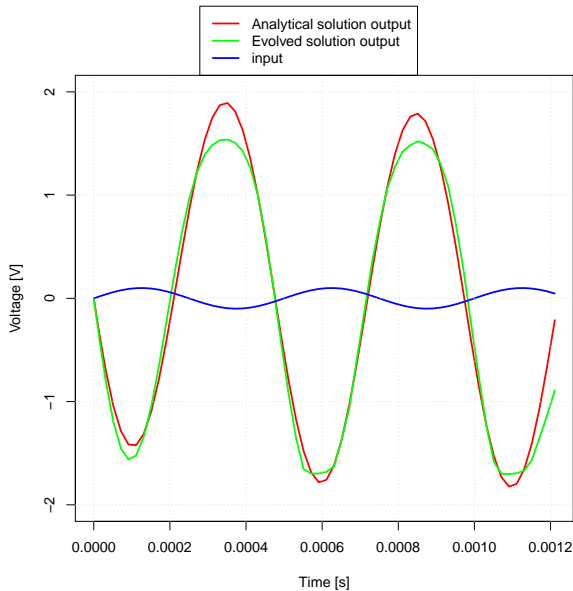


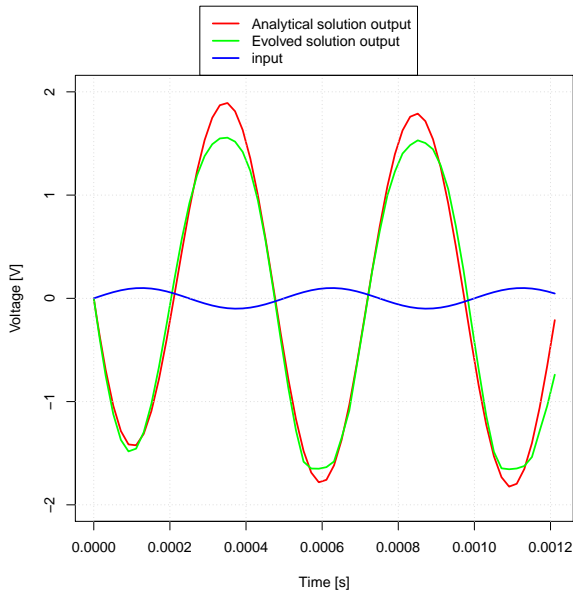


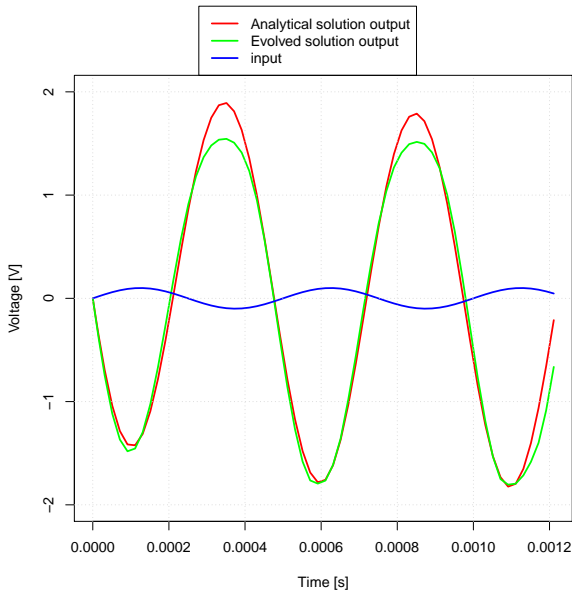


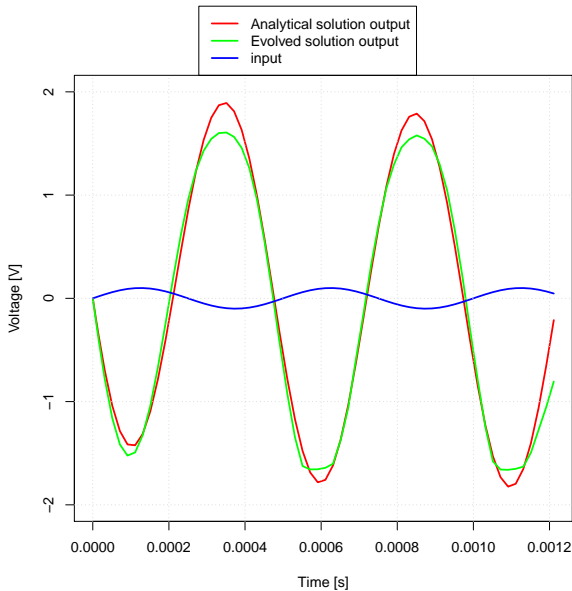


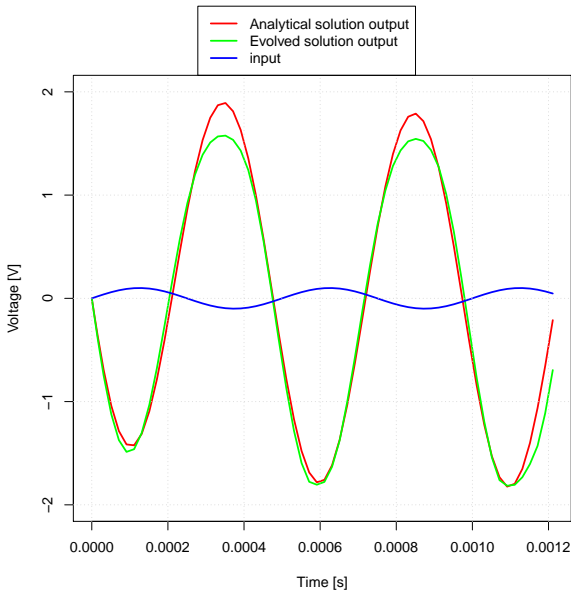


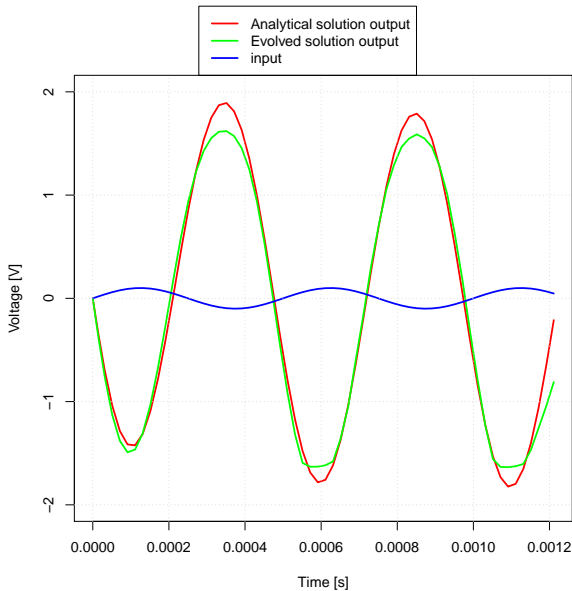


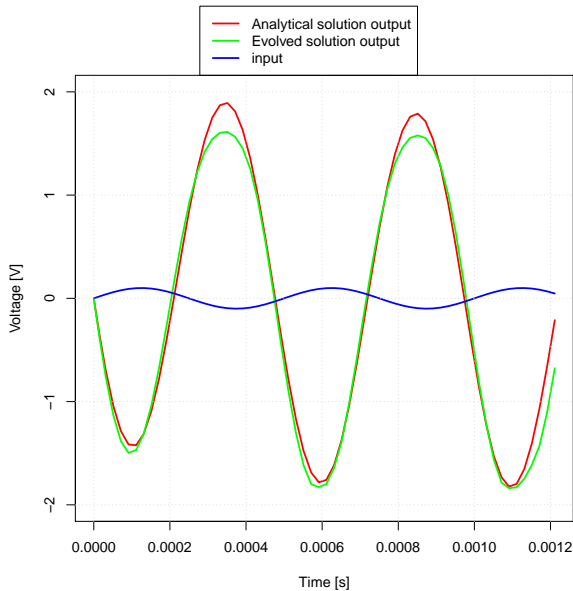




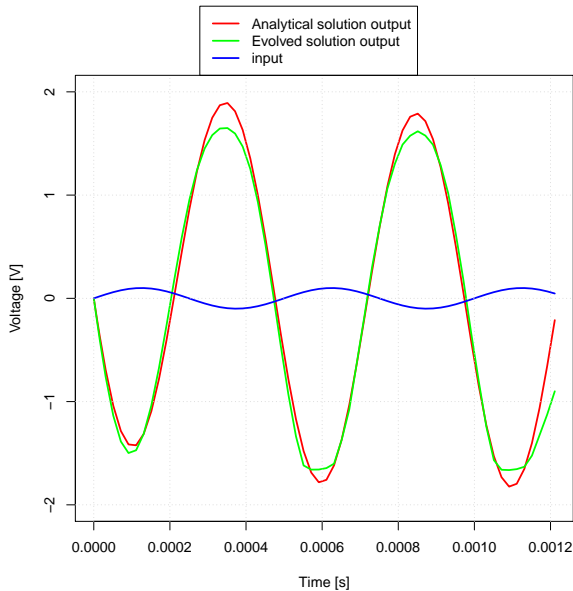


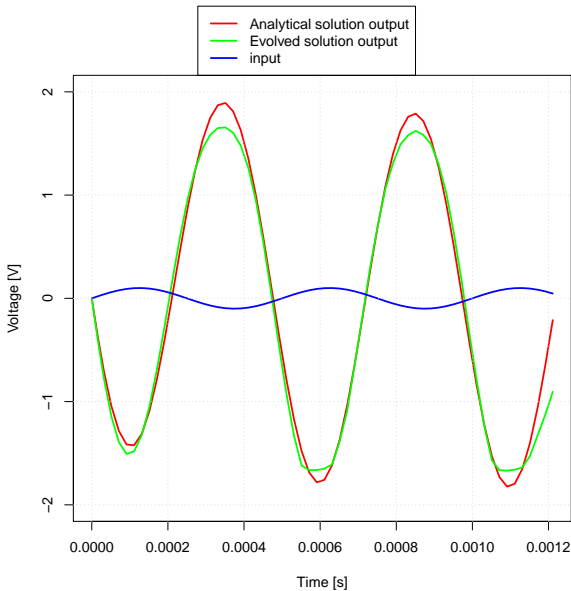


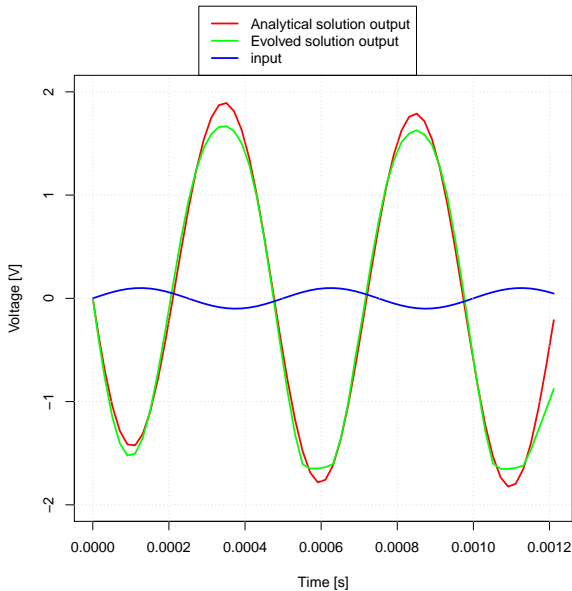


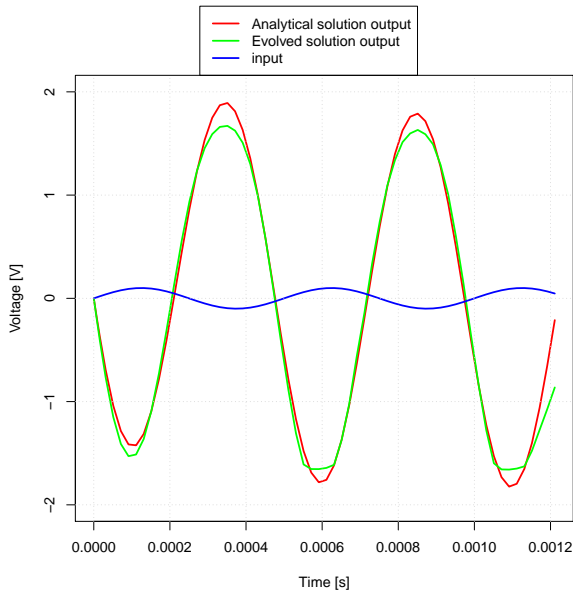




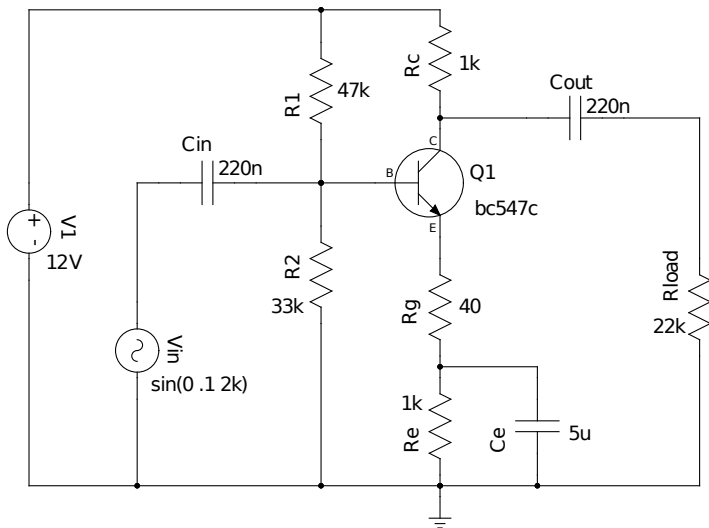




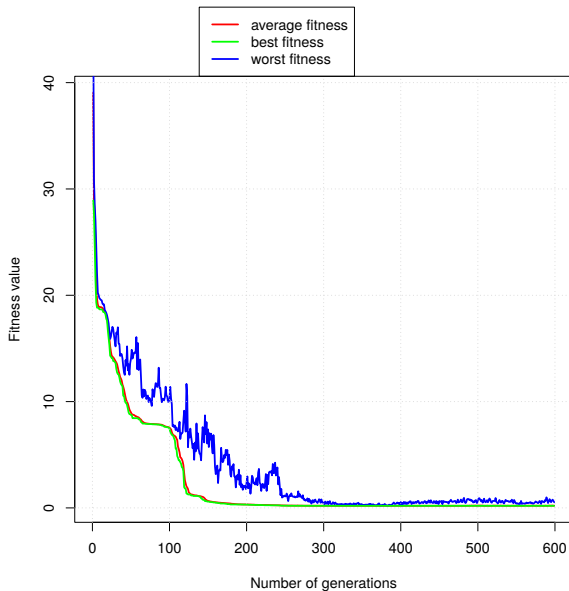




Thank you.



$$\vec{x} = ((x_1, \dots, x_n), \sigma_1, \dots, \sigma_n)$$



	$\mu$	$\lambda$	$(\mu, \lambda)$ -ES			$(\mu + \lambda)$ -ES		
			best match	ideal sin	max. ampl.	best match	ideal sin	max. ampl.
1.	1	1	N/A	N/A	N/A	21.82	99.00	2.90
2.	1	5	20.82	113.75	1.98	13.44	57.91	2.69
3.	1	10	18.84	76.81	1.40	24.70	75.01	2.84
4.	1	15	18.43	128.75	2.26	19.52	34.11	1.02
5.	5	5	<b>49.62</b>	<b>169.02</b>	<b>36.50</b>	9.81	56.61	3.18
6.	5	25	7.28	55.00	3.12	12.12	34.88	2.72
7.	5	50	16.18	64.22	3.21	9.75	43.73	3.57
8.	5	75	3.70	58.82	3.10	4.20	38.84	3.52
9.	10	10	<b>49.41</b>	<b>154.66</b>	<b>26.40</b>	8.94	53.77	3.18
10.	10	50	9.09	60.93	2.68	7.02	45.04	3.58
11.	10	100	6.97	38.02	3.16	4.91	26.06	3.10
12.	10	150	8.06	25.54	3.10	2.52	23.07	3.07
13.	15	15	<b>44.48</b>	<b>165.76</b>	<b>34.99</b>	2.54	47.69	3.18
14.	15	75	4.64	56.18	2.25	4.96	51.74	3.56
15.	15	150	6.63	47.32	3.52	6.36	12.19	1.60
16.	15	225	7.56	31.17	2.65	0.70	19.31	1.08