1) Given the circuit:

\[ V_0 = \sin(1000t) \]

a) Write down a set of equations describing this circuit.

b) Implement the above equations in a Dynola model class that lists the three state variables and their derivatives as well as the time variable as cut variables.

c) Implement a Dynola model class that represents the following DIRK algorithm for one state variable:

\[
\begin{align*}
P(z) &= \frac{768 - 96z^2 - 16z^3 + 10z^4}{768 - 768z + 288z^2 - 48z^3 + 3z^4} \\
\hat{P}(z) &= \frac{3072 - 768z - 384z^2 + 32z^3 + 28z^4}{3072 - 3840z + 1920z^2 - 480z^3 + 60z^4 - 3z^5} \\
E(z) &= \frac{28z^4 - 10z^5}{3072 - 3840z + 1920z^2 - 480z^3 + 60z^4 - 3z^5}
\end{align*}
\]
d) Implement a Dymola model that invokes one circuit model for each stage and one integrator model for each state variable, and connect them together correctly. Inputs of the model are the state variables at the beginning of the step. Outputs are the same state variables at the end of the step.

2) Given the function:

Design a Dymola model class for this function.
3) Using the following "pseudorandom number" generator:

\[
\begin{align*}
\xi_{i+1} &= \xi_i + \xi_{i-1} \\
\xi_{i+1} &= \text{if } \xi_{i+1} > 1 \text{ then } \xi_{i+1} - 1.0 \end{align*}
\]

Start with
\[\xi_1 = 0.3 \text{, } \xi_2 = 0.4\]

How many "random" numbers can you draw until the sequence repeats itself? What do you conclude?

4) I used the same "random" number generator:

```c
// [x] = rrand(n, x1, x2)

// Pseudorandom Number Generator
//
x = [x1, x2];
for i=3:n, ...
    xx = x(1,i-2) + x(1,i-1); ...
    if xx > 1, xx = xx - 1; end, ...
    x = [x, xx]; ...
end
return
```
but this time with:
\[ \xi_1 = \frac{\pi}{6}; \quad \xi_2 = \frac{\theta}{3} \]
The first 20 "random" numbers are:

\[ x = \text{rrand}(n, x_1, x_2) \]

\[
\begin{array}{cccccccc}
\text{Starting at row} & 1 \text{ columns} & 1 \text{ thru} & 8 & 0.5236 & 0.9061 & 0.4297 & 0.3358 & 0.7655 & 0.1013 & 0.8667 & 0.9680 \\
\text{Starting at row} & 1 \text{ columns} & 9 \text{ thru} & 16 & 0.8348 & 0.8028 & 0.6375 & 0.4403 & 0.0778 & 0.5181 & 0.5959 & 0.1140 \\
\text{Starting at row} & 1 \text{ columns} & 17 \text{ thru} & 20 & 0.7100 & 0.8240 & 0.5340 & 0.3580 & & & & \\
\end{array}
\]

a) Any suspicion why the cycle is longer now? Any recipe for choosing decent seed values?

b) Use the Kolmogorov/Smirnov test to determine whether these numbers can be accepted as \( U[0, 1] \).