

1. Consider the block diagram shown in Figure 1.

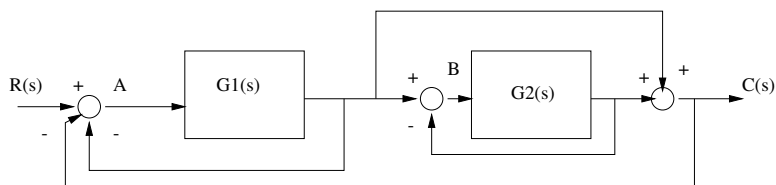


Figure 1: Block Diagram for Problem 1

- (a) Draw the equivalent flow graph.
  - (b) Use Mason's formula to find the transfer function from  $R$  to  $C$
  - (c) Verify your answer by writing three equations relating the signals  $R, A, B, C$  and solving these to get  $C$  as a function of  $R$
2. Consider the flow graph shown in Figure 2.

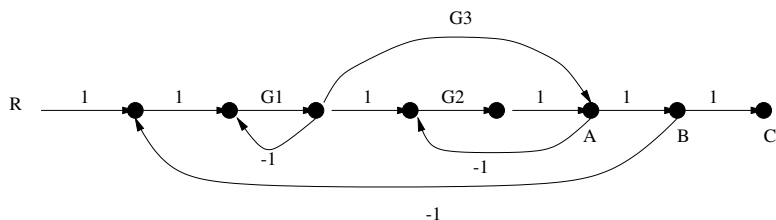


Figure 2: Flow Graph for Problem 2

- (a) Find the transfer function from  $R$  to  $C$
  - (b) Indicate which branches can be eliminated without changing the overall Transfer Function.
  - (c) Eliminate these branches, draw the simplified graph and use Mason's formula to verify that the Transfer Function has not changed.
3. Figures 3 and 4 show two digital filter structures or realizations for second-order filters.
    - (a) Write the difference equation for the 3D structure of Fig. 3, expressing  $y(k)$  as a function of  $y(k-i)$  and  $e(k-i)$ .
    - (b) Derive the filter transfer function  $Y(z)/E(z)$  for the 3D structure by taking the  $z$ -transform of the equation in part (a).
    - (c) Write the difference equation for the 1D structure of Fig. 4. Two equations are required: one for  $f(k)$  and one for  $y(k)$ .
    - (d) Derive the filter transfer function  $Y(z)/E(z)$  for the 1D structure by taking the  $z$ -transforms of the equations in part (c) and eliminating  $F(z)$ .

- (e) From parts (b) and (d) relate the coefficients  $\alpha_i, \beta_i$  to  $a_i, b_i$  such that the 2 filters realize the same transfer function.
4. Find the  $z$ -transform of the number sequence generated by sampling the time function  $f(t) = e^{-t}$  every  $T$  seconds, beginning at  $T = 0$ . Can you express this transform in closed form?
5. Find the  $z$ -transform, in closed form, of the number sequence generated by sampling, every  $T$  seconds the function  $f(t)$  whose Laplace transform is given by

$$F(s) = \frac{2(1 - e^{-5s})}{s(s + 2)}, \quad T = 1 \text{ s}$$

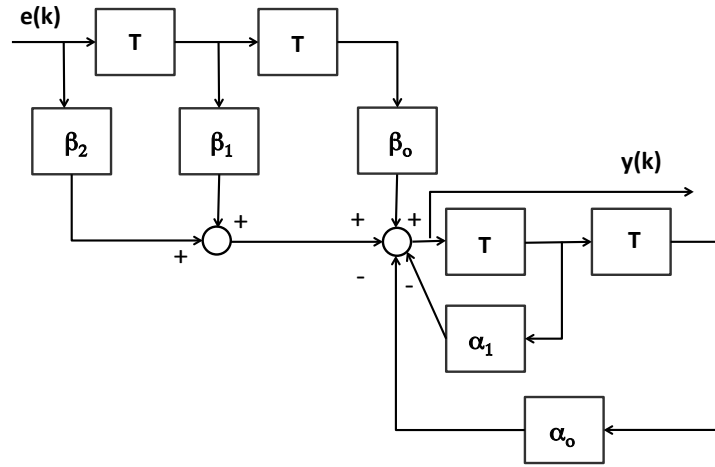


Figure 3: 3D structure for Problem 3, part (a)

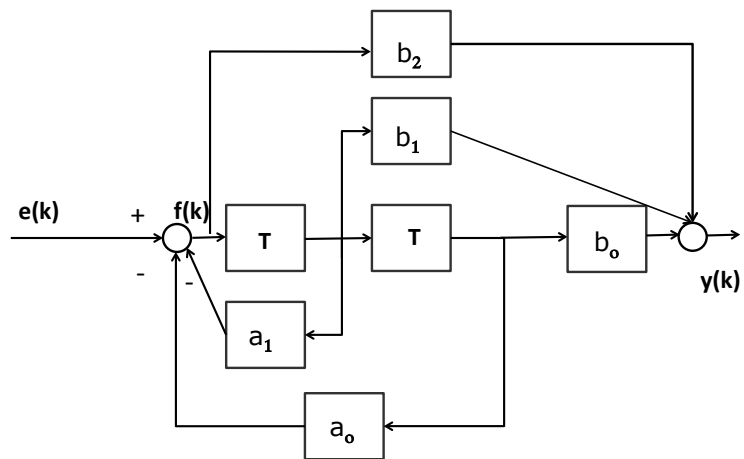


Figure 4: 1D structure for Problem 3, part (c)