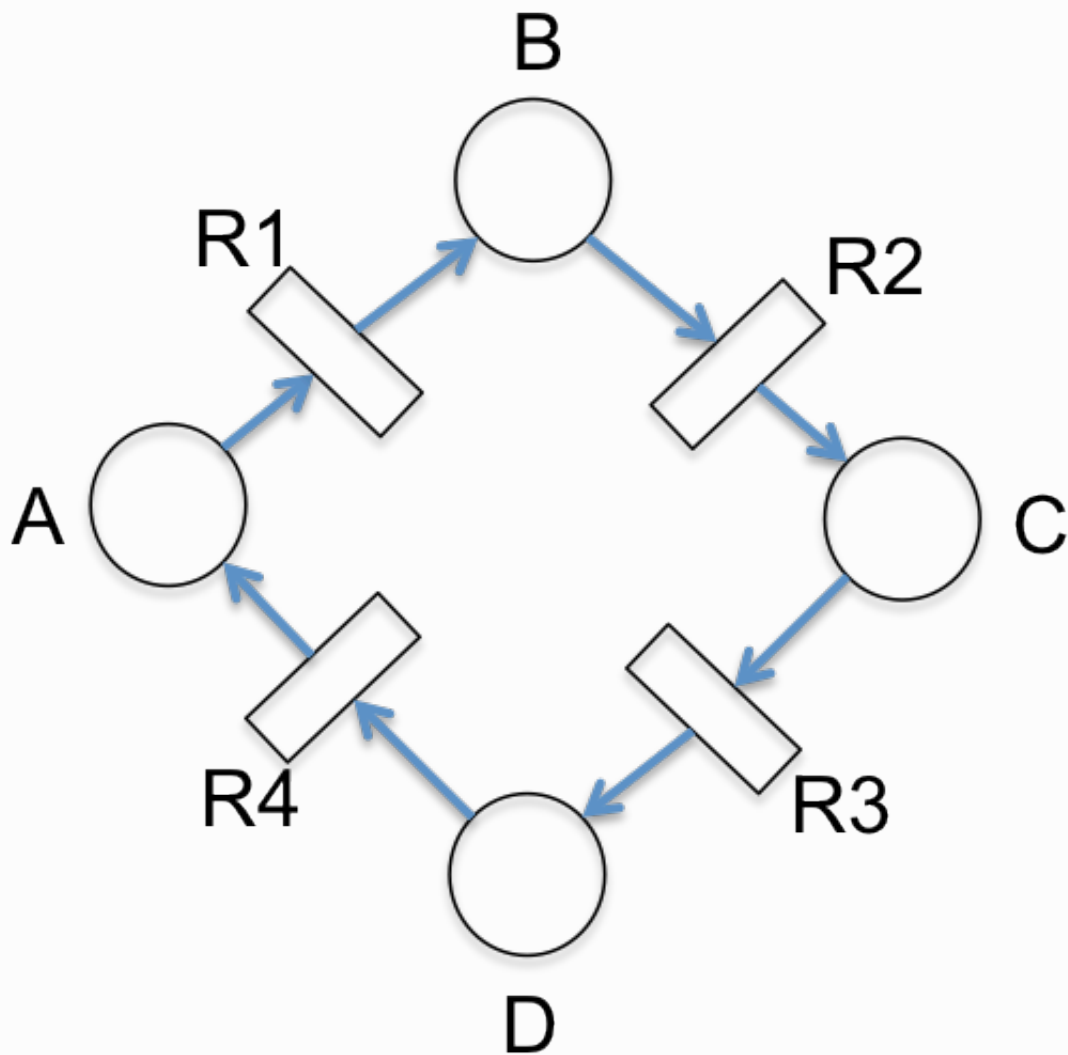


ASSIGNMENT 4

Exercise 1.1.13

Question 1



1. Without doing any calculations can you identify any i) conservation laws and ii) sets of reactions which will leave the state unchanged?

Conservation Laws: A, B, C and D are likely to be p-invariant

Set of Reactions which will leave the state unchanged: R1, R2, R3, R4 are potentially t-invariant.

2. In MATLAB construct the Petri net for this system by defining `ss`, `rr`, `wsrwsr`, `wrswsr` and `mm`. (Assume the state `mm` contains one token in species A only.)

```

1 % s = [A; B; C; D]
2 % r = [R1; R2; R3; R4]
3 W_sr = [1 0 0 0; 0 1 0 0; 0 0 1 0; 0 0 0 1];
4 W_rs = [0 1 0 0; 0 0 1 0; 0 0 0 1; 1 0 0 0];

```

3. Use these to calculate reaction matrix AA and stoichiometry matrix SS.

```

1 A = W_rs - W_sr
2 % -1    1    0    0
3 %  0   -1    1    0
4 %  0    0   -1    1
5 %  1    0    0   -1
6
7 S = A'
8 % -1    0    0    1
9 %  1   -1    0    0
10 %  0    1   -1    0
11 %  0    0    1   -1

```

4. Calculate the P and T invariants for this system and comment on their meanings. Did you identify them in part (a)?

```

1 t_invariant = null(S, 'r')
2 % 1
3 % 1
4 % 1
5 % 1
6
7 p_invariant = null(A, 'r')
8 % 1
9 % 1
10 % 1
11 % 1

```

The T invariant represents a set of reactions (R1-R4) that leave the system unchanged while the P invariant represents the individual species (A-D) that remain unchanged.

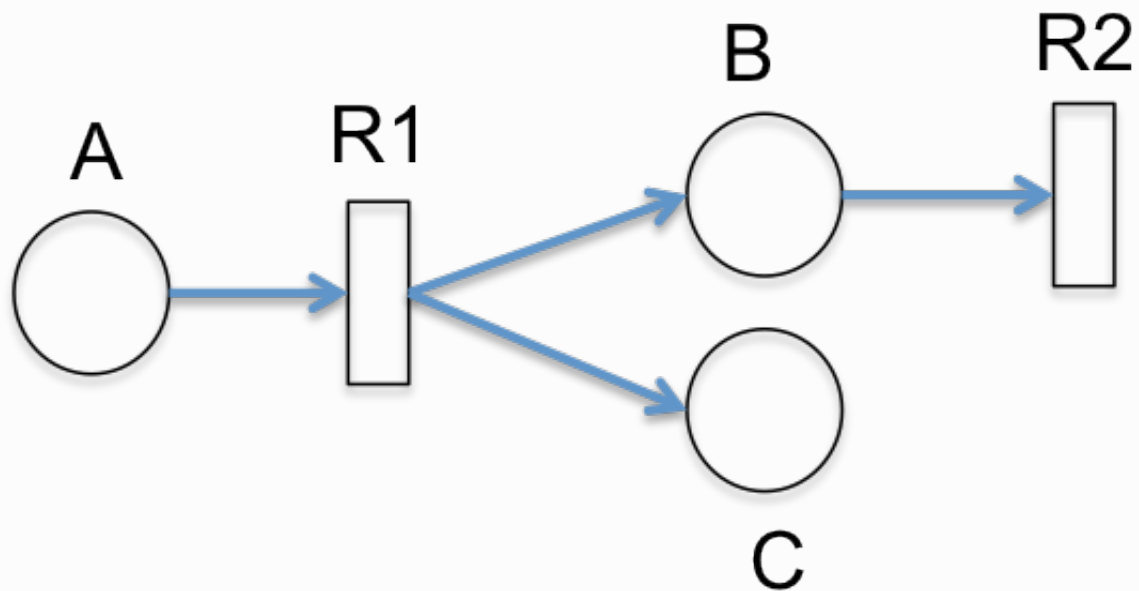
The conservation law for the system suggests that it is left unchanged as shown below:

```

1 nT - nP = nr - ns
2 4 - 4 = 4 - 4
3 0 = 0

```

Question 2



1. Repeat for the above network

```

1  % s = [A; B; C]
2  % r = [R1; R2]
3  % m = [1; 0; 0]
4  W_sr = [1 0 0; 0 1 0];
5  W_rs = [0 1 1; 0 0 0];
6
7
8
9  A = W_rs - W_sr
10 %   -1    1    1
11 %    0   -1    0
12
13 S = A'
14 %   -1    0
15 %    1   -1
16 %    1    0
17
18
19 t = null(S, 'r')
20 %   Empty matrix: 2-by-0
21
22 p = null(A, 'r')
23 %    1
24 %    0
25 %    1

```

As shown above there are no T-invariants while the P-invariant is $[1; 0; 1]$. This is value for B in the P-invariant is 0 is potentially due to the fact it undergoes a reaction with no products (i.e. such as a degradation reaction).