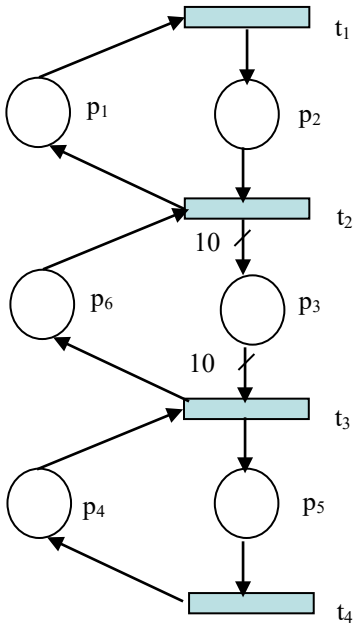
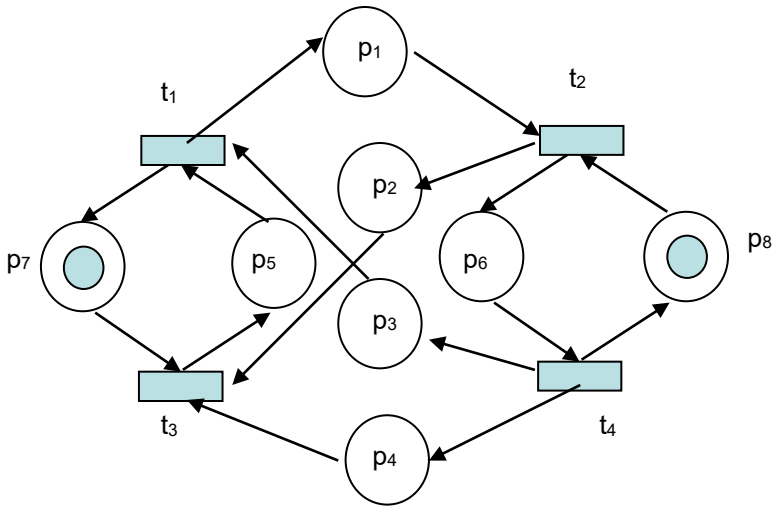
Homework #4

Due 11:59pm April 19th, 2019

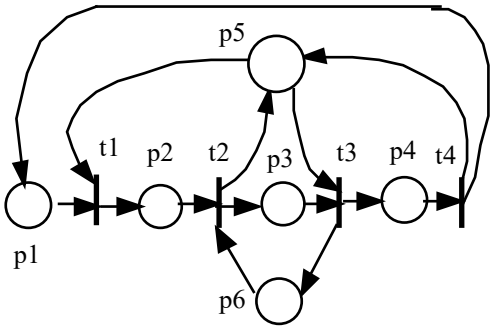
1. Find the incidence matrix of the PN in the following figure, then its independent P and T-invariants; and positive P and T-invariants



2. For the timed PN in the following figure, let the delay of transition i and place i be x_i, i=1 to 8. **x_i=the i-th digit of your banner ID.** Delay i+j is associated with arc (pi, tj) but none with arc (tj, pi), for i=1, 2,…, 8 and j=1, 2, …, 4. Places p2, p4-p8 are each initially marked with one token respectively. p1 and p3 are marked by $1+x_1$ and $1+x_3$ tokens respectively. A) find all the loops and their cycle times and the system cycle time. B) If you are given two more tokens, which place(s) do you want to put your tokens to reduce the system cycle time? What is the percentage of the improvement? C) If you are allowed to reduce the delay at one place to half, which place will you choose to reduce? What is the percentage of the improvement? D) If you are allowed to reduce the delay at a transition to half, which transition will you choose to reduce? What is the percentage of the improvement?



3. Reduce the PN in the following figure given the initial marking m_0=(2 1 0 0 0 4). *Hint: Do not over-do it. Apply only those applicable*



4. The stochastic PN in the following figure is used to model the manufacturing cell where incoming material (p_1) is first transported by R1 (p_7) to M1 (p_5) for processing (p_2 represents M1 is in processing), then loaded to a buffer (p_6), then transported by R 2 (p_9) to M2 (p_8) for processing. M1 may break down. On the average, M1 takes 2 time units to break down and ¼ time unit to be repaired (i.e., the average failure and repair rates are 0.5 and 4, respectively). M2 is failure-free. The loading rate for R1 is 40. The average rate for M1's processing a part plus R1's unloading is 5 per unit time. The average rate for M2's processing plus R2's loading and unloading is 4 per unit time. Calculate the average utilization of M1 and the system throughput if two parts are in the input area?

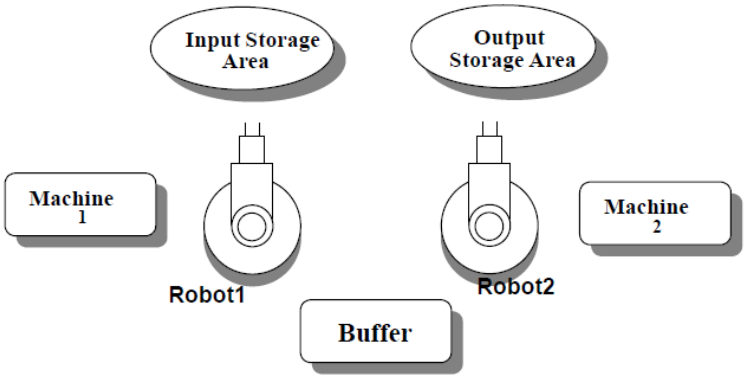


Fig. 2. The manufacturing cell

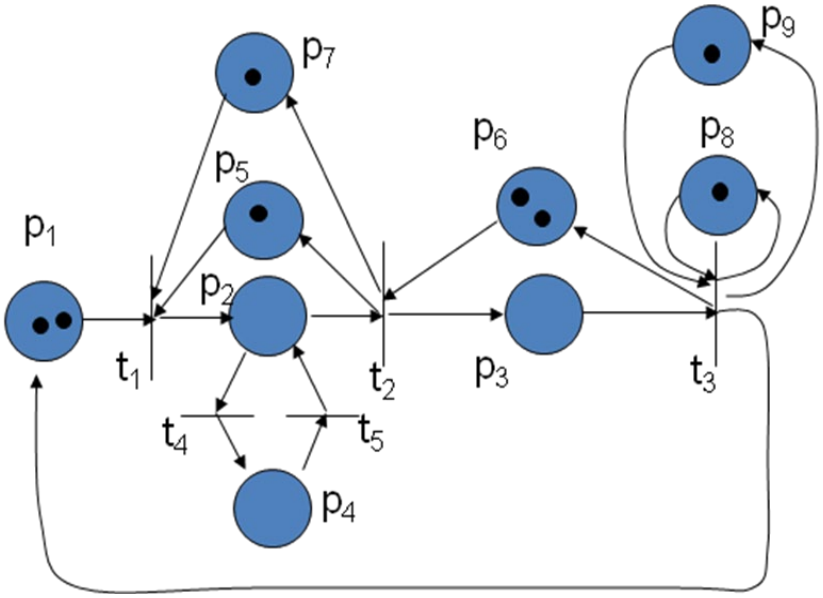


Fig. 3. The PN model for the manufacturing cell in Fig. 2

p1: parts are available
p2: M1 is in processing
p3: Part is ready for M2
p4: M1 is in repair
p5: M1 is available
p6: buffer is available
p7: R1 is available
p8: M2 is available
t5: repair (4)

p9: R2 is available
t1: R1 is loading part to M1 (40)
t2: M1 is processing and R2 is unloading (5)
t3: M2 is processing, R2 is loading & unloading (4)
t4: M1 is breaking down (0.5)