1. Draw an arrow diagram or PERT network for the construction of a highway grade separation bridge consisting of the 27 activities listed below (use as few dummy arcs as possible to more directly represent the precedences). Recall that the activities become the arcs and nodes are used to create dependencies so that arcs \((i, j)\) and \((j, k)\) implies that activity \((i, j)\) must be completed before activity \((j, k)\). Some explanation of precedences as you see them should be explained. You can check terms using a dictionary. You might google a picture of a paving train!

1. Set up traffic detour
2. Order and deliver piles
3. Excavate for Abutment A
4. Excavate for Abutment B
5. Drive piles for Abutment A
6. Move pile driver to Abutment B
7. Drive piles for Abutment B
8. Construct footings for Abutment A
9. Construct footings for Abutment B
10. Construct Abutment A
11. Place backfill for Abutment A
12. Place backfill for Abutment B
13. Construct Abutment B
14. Construct bridge deck
15. Fabricate structural steel
16. Erect structural steel
17. Place backfill for approaches
18. Order and deliver bridge railings
19. Order and deliver guard rail
20. Erect bridge railing
21. Erect guard rail
22. Construct concrete curb and gutter
23. Set up paving train
24. Pave approach roadways
25. Delay seeding of slopes until April 1
26. Seed and sod approach slopes
27. Final inspection

2. I’d like you to explore our power plant construction schedule under various versions. The spreadsheet dynamicbuildasst.xls would be useful. Sheet 2 of that spreadsheet considers discount factors. Try solving with the three scenarios.

\[
\beta = .87 \text{ while fixed costs for construction in a year at 1.5M.}
\]

\[
\beta = .77 \text{ while fixed costs for construction in a year at 1M.}
\]

\[
\beta = .92 \text{ while fixed costs for construction in a year at .5M.}
\]

Give the optimal strategies in each case. Comment on the solutions obtained, perhaps explaining the changes to the solutions. What do you think your personal discount rate \(\beta\) should be?

3. Consider \(n\) countries currencies. Imagine we know that the \(a_{ij}\) is the amount of currency \(j\) you can buy by spending 1 unit of currency \(i\). Is \(A = (a_{ij})\) a symmetric matrix? Are there any properties of \(A\) you might suggest? We would be particularly interested in a money pump, namely
a directed cycle $c_1, c_2, \ldots, c_k, c_1$ where we convert 1 unit of currency of country $c_1$ in currency of country $c_2$ and then convert all that into currency of country $c_3$ etc until you convert all you money back from the currency of country $c_k$ back into the currency of country $c_1$ and discover you have more money than you started with. Describe how you could find a money pump given the matrix $A = (a_{ij})$. 