**Exercise 10.4** An airline operates a fleet of 15 jet aircraft, all equipped with the JET32 engine. The airline performs its own engine-related repairs and maintenance at its repair facility. The maintenance director is reviewing the spare parts ordering and stocking policy for the next three years. The JET32 engine consists of 4 main modules, A, B, C, and D. When planes come in for repairs, sometimes the entire engine must be replaced because of extensive damage and wear. More often, however, only certain modules need replacement. The following table contains the forecasted requirements for individual engine modules and complete engines for the next 3 years. The airline places orders for complete engines and modules at the beginning of the year with JET Inc., the manufacturer of the JET32 engine. The following table shows the projected prices for engines and modules that JET Inc. might charge in the next three years.

| Year | Module A | Module B | Module C | Module D | Complete Engine |
|---|---|---|---|---|---|
| 1 | 5 | 4 | 4 | 2 | 1 |
| 2 | 2 | 1 | 1 | 7 | 0 |
| 3 | 3 | 4 | 3 | 0 | 2 |

**Table 10.1:** Forecasted engine/module requirements.

| Year | Module A | Module B | Module C | Module D | Complete Engine |
|---|---|---|---|---|---|
| 1 | 0.5 | 2.0 | 5.0 | 1.0 | 7.8 |
| 2 | 0.6 | 2.2 | 5.5 | 1.1 | 7.5 |
| 3 | 0.7 | 2.5 | 6.0 | 1.3 | 7.0 |

**Table 10.2:** Forecasted engine/module prices.

Note that complete engines cost less than the total cost of buying one module of each type. Assume that the cost of "cannibalizing," i.e., breaking a complete engine into four individual modules, is negligible compared to the cost of these modules. The mix of engines and modules that the airline orders from JET Inc. must, therefore, account for the economies in ordering complete engines. Assuming that the airline does not have any inventory of modules or engines in hand, formulate an integer programming problem to determine the order quantities for the next 3 years, while minimizing the total cost of purchases. Assume that there are no inventory carrying costs.

First formulate it and then solve it with MATLAB or AMPL