at lower bound)
at upper bound)
at lower bound)

$+ 1(7) + 2(4) + 0(0) = 61$

applications. Also, many applications, structure, have embedded network sub- structure can be used to develop more effi- problems by solving the subproblems utilizing approach. This section presents a few of the network flow problems.

involving warehouses and retail outlets. Each commodity available, and each retail outlet / The objective is to find the shipping pattern that Shipments can be made directly from a ware- can be made through intermediate warehouses, between retail outlets if this results in

three warehouses and four retail outlets is the supply and demand quantities, there is a with each arc in the network. In the event that network can be balanced in the usual manner by a dummy retail outlet node. A simple variation as the transportation problem, is studied in

problem of Example 2.4, which is repeated

the monthly production of a certain item for the is estimated to be $12 for the first 2 months

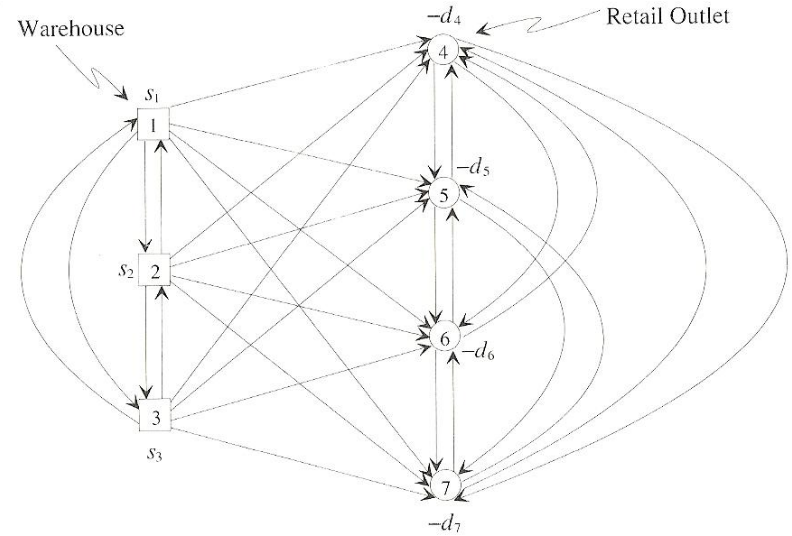

Figure 9.31 A transshipment problem.

and $14 for the last 2 months. The monthly demands are 400, 750, 950, and 900 units. IMC, Inc., can produce a maximum of 800 units each month. In addition, the company can employ overtime during the second and third months, which increases monthly production by an additional 200 units. However, the cost of production increases by $4 per unit. Excess production can be stored at a cost of $3 per unit per month, but a maximum of 50 units can be stored in any month. By assuming that beginning and ending inventory levels are zero, how should the production be scheduled so as to minimize the total costs?

Although a linear programming formulation of this problem was developed in Chapter 2, a minimum-cost network flow representation of this problem is shown in Figure 9.32. Node s represents the supply or production node. Note that node s has been assigned a supply of 3000 units because that is the sum of the quantities demanded in the 4-month planning period. Flows along the arcs from s to each node m_i represent the amounts produced during regular time and overtime. The flow from node i to m_1 represents the initial inventory, which for this example is zero. Similarly, the flow from node m_4 to node f represents the final inventory. Flow along the arc from m_i to d_i represents the transfer of the finished products to meet the demands. Finally, flows along the arcs from m_i to m_{i+1} represent the inventory held from month i to month $i + 1$.

Example 9.9: A Leasing Problem

Consider the problem of leasing warehouse space over the next 3-month period. The requirements for each month i, $i = 1, 2, 3$, are known and are given by r_1, r_2, and r_3 square feet, respectively. There are several short-term lease options available and the problem is to choose the leasing policy that meets the requirements at minimum cost. For example, one policy would be to lease r_i square feet during month i for 1