Chapter 1
HOMEWORK SOLUTIONS

1-1 Solution

(a)   Decision variables:
       Amount of sulfur dioxide to remove at each power plant in the Midwest (pounds per time period).

(b)   Parameters:
       1. Amount of untreated sulfur dioxide emitted by each power plant – prior to removal.
       2. Cost per pound for removal of sulfur dioxide at each power plant.
       3. Air quality degradation at each monitoring site in the Northeast caused by a pound of sulfur dioxide emitted at each plant in the Midwest.

(c)   Objective function:
       Minimize the system-wide cost of sulfur dioxide removal at all power coal-fired power plants in the Midwest.

(d)   Constraints:
       1. Desired air quality in the Northeast is achieved (concentrations at all monitoring sites less than or equal to an upper limit concentration).
       2. Treatment scheme is seen as equitable.

1-2 Solution

(a)   Decision variables:
       Head capacity of the pump, diameter (and material) of the pipeline.

(b)   Parameters:
       1. Flow required at the treatment plant.
       2. Delivered head at the treatment plant.
       3. Friction factor(s) for the pipeline.
       4. Elevation difference, pipeline length.
       5. Pump Characteristics.
       6. Cost for each capacity of pump and each diameter of pipeline.
       7. Discrete pump and pipeline size available.

(c)   Objective function:
       Minimize the total cost of pump and pipeline.

(d)   Constraints:
       1. Required flow is delivered.
       2. Required head is delivered.

1-3 Solution

(a)   Decision variables:
       Number of toll booths to be installed at the exit.

(b)   Parameters:
       1. Limit on average (across all lanes) number of cars in line.
       2. Length of the rush hour period.
       3. The number of arrivals at the toll exit during each two-minutes segment of the rush hour.
       4. Service time per car – or cars that can be serviced by one booth during each and every two-minute segment of the rush hour.

(c)   Objective function:
       Minimize the number of toll booths at the exit.

(d)   Constraints:
       A limit on the number of cars in the line (averaged across all lanes) in any two-minute period during the rush hour.

1-4 Solution

(a)   Decision variables:
       1. Width of beam.
       2. Depth of beam.
       3. Area of steel in beam.

(b)   Parameters:
       1. Imposed moment.
       2. Imposed shear.
       3. Allowed deflection for given span length.
       4. Unit cost of concrete.
       5. Unit cost of steel.
       6. Compressive strength of concrete.
       7. Yield strength of steel.