NATIONAL UNIVERSITY OF SINGAPORE
Department of Mathematics
Semester 1 (2003/2004)   MA4253 Mathematical Programming   Tutorial 3

Q1. Solve the following problem by the simplex method with bounded variables technique:

$$\begin{aligned}
\min \quad & -4x_1 - x_2 - 6x_3 \\
\text{s.t.} \quad & 3x_1 + 2x_2 + 4x_3 = 34 \\
& 2 \le x_1 \le 4 \\
& 2 \le x_2 \le 4 \\
& 2 \le x_3 \le 4 \,.
\end{aligned}$$

Q2. Find the dual form of the following problem

$$\begin{aligned}
\min \quad & c^T x \\
\text{s.t.} \quad & Ax \le b \\
& l \le x \le u,
\end{aligned}$$

where $x \in \Re^n$ is unknown, $c, l, u \in \Re^n$, $l \le u$, and $A \in \Re^{m \times n}$.

Q3. Consider the following problem

$$\begin{aligned}
\max \quad & 4x_1 + 2x_2 + 6x_3 \\
\text{s.t.} \quad & 4x_1 + x_2 \qquad\;\; \le 9 \\
& x_1 - x_2 + 2x_3 \le 8 \\
& 1 \le x_1 \le 3 \\
& 0 \le x_2 \le 5 \\
& 0 \le x_3 \le 2 \,.
\end{aligned} \tag{1}$$

(i) Give the dual problem of (1).

(ii) Find an optimal solution to the dual problem obtained in (i).

Q4. Consider the linear program

$$\begin{aligned}
\min \quad & -x_1 - x_2 \\
\text{s.t.} \quad & x_1 - x_2 + x_3 = 2 \\
& 4x_1 + 9x_2 \le 18 \\
& -2x_1 + 4x_2 \le 4 \\
& x_1, x_2, x_3 \ge 0 \,.
\end{aligned}$$

Treat the first constraint as the constraint set $Ax = b$ and the second and the third constraints as the set $Cx \ge d$. Find a Dantzig-Wolfe restricted master program and solve it.