- Standard Mathematical Statement
  - ***Minimize*** $f(\boldsymbol{x}) = f(x_1, x_2, \ldots\ldots, x_n)$
  - ***subject to***

$$g_j(\boldsymbol{x}) \leq 0 \qquad j = 1, \ldots\ldots, n_g$$
$$h_k(\boldsymbol{x}) = 0 \qquad k = 1, \ldots\ldots, n_e$$
$$x_i^L \leq x_i \leq x_i^U \qquad i = 1, \ldots\ldots, n$$

- Graphical illustration of an optimization problem (possible for two or at most three design variable problems).
  - Plot the constraint equations
  - Identify the feasible design space
  - Plot objective function contours
  - Locate optimum by inspection

- When an explicit equality constraint is present, the problem size may be reduced by expressing one of the design variables in terms of the other ones.
- ***Minimize*** $f(x_1, x_2, x_3) = 5x_1 - 3x_2 + 7x_3$
- ***subject to***

$$g_1(\mathbf{x}) \le (x_1 - 2x_2 + x_3 \le 0)$$

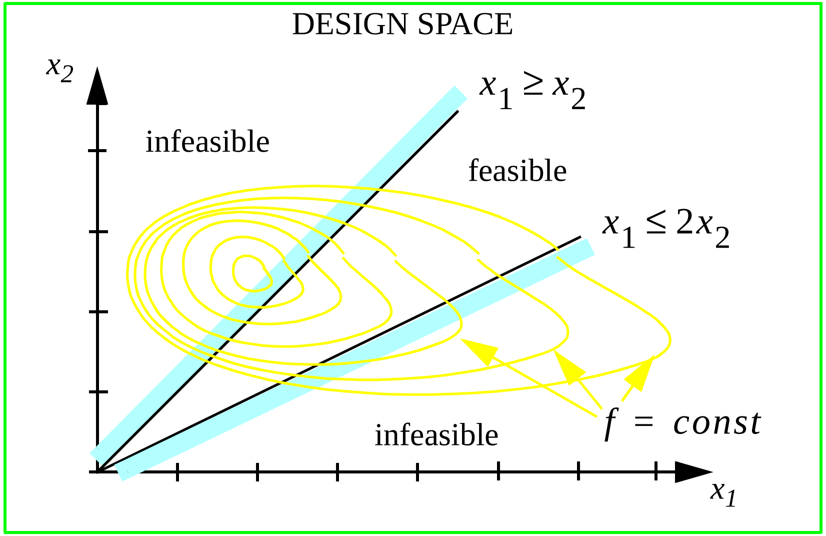
$$g_2(\mathbf{x}) \le (-x_1 + x_2 - x_3 \le 0)$$

$$h_1(\mathbf{x}) = -x_1 + 2x_2 + x_3 = 0$$

- ***Minimize*** $f(x_1, x_2) = 12x_1 - 17x_2$
- ***subject to***

$$g_1(\mathbf{x}) \le (2x_1 - 4x_2 \le 0)$$

$$g_2(\mathbf{x}) \le (-2x_1 + 3x_2 \le 0)$$



$$g_1(\boldsymbol{x}) = x_1 - 2x_2 \leq 0 \qquad g_2(\boldsymbol{x}) = -x_1 + x_2 \leq 0$$

$$S = \{\boldsymbol{x} | x_1 - 2x_2 \leq 0; -x_1 + x_2 \leq 0\}$$

- Design optimization problems that you should watch for.!
    - Unbounded problems
    - Problems with multiple solutions
    - Problems with no solution
    - Optimal designs with no active constraints