1. Problem 15.3, page 672.

We generate a random permutation of $T_1, T_1, T_2, T_2, T_2, T_3, T_3, T_3, T_4, T_4, T_4$. For example, $T_2, T_1, T_3, T_2, T_4, T_1, T_3, T_4, T_4, T_3, T_2$ is a randomized assignment of treatments to experimental units.

2. Problem 15.5, page 673.

In a geriatric study, we would like to study the effect of regular exercising on reducing the systolic blood pressure. We have three regular exercise levels low, medium and high and it is known that as the level of exercise increases, on average the systolic blood pressures decrease. Since the general effectiveness of the treatments under study is known, there is no need for a control group on this study.

3. Problem 15.9, page 673.

a. Observational, since we do not have a random assignment of treatments to the experimental units.
b. Factor: expenditures for research and development in the past three years. Factor levels: low, moderate, high.
c. Cross-sectional study.
d. Firm.

4. Problem 15.15, page 674.

a. Observational.
b. Factor 1: treatment duration, with 2 levels (short, long). Factor 2: weight gain, with 3 levels (slight, moderate, substantial).
c. Cross-sectional study.
d. Patient.

5. Problem 15.21, page 676.

a. Section of clothing.
b. Factor: household detergents, with 4 levels (detergent 1, detergent 2, detergent 3, detergent 4).
c. Two potential blocking factors are material of the fabric (for example, cotton, wool, or nylon), and color of the fabric (for example, light or dark).
d. Every detergent will be assigned randomly to a section of clothing with stain and the effectiveness will be measured. We will also have replications. For example, if we decide to have 3 replications, we can use a random permutation of $T_1, T_1, T_1, T_2, T_2, T_2, T_3, T_3, T_3, T_4, T_4, T_4$ as we did in Exercise 15.3.
16.5. b. $E\{MSTR\} = (2.8)^2 + \frac{100(11)}{3} = 374.507$

$E\{MSE\} = 7.84$

c. $E\{MSTR\} = (2.8)^2 + \frac{100(15.46)}{3} = 523.173$

16.9. b. $\hat{Y}_{1j} = \hat{Y}_1 = 38.0, \hat{Y}_{2j} = \hat{Y}_2 = 32.0, \hat{Y}_{3j} = \hat{Y}_3 = 24.0$

c. $\epsilon_{ij}$:

\[
\begin{array}{ccccccc}
  i & j = 1 & j = 2 & j = 3 & j = 4 & j = 5 \\
 1 & -9.0 & 4.0 & 0.0 & 2.0 & 5.0 \\
 2 & -2.0 & 3.0 & 7.0 & -4.0 & -1.0 \\
 3 & 2.0 & 8.0 & -3.0 & -4.0 & -1.0 \\
 4 & 8.0 & -4.0 & 2.0 & -1.0 & 2.0 \\
 5 & -3.0 & 1.0 & -2.0 & 3.0 & 0.0 \\
\end{array}
\]

\[
\begin{array}{ccccccc}
  i & j = 6 & j = 7 & j = 8 & j = 9 & j = 10 \\
 1 & 2.0 & -8.0 & 4.0 & -3.0 & 1.0 \\
 2 & -1.0 & -3.0 & 3.0 & -3.0 & 1.0 \\
 3 & -2.0 & -4.0 & 2.0 & -1.0 & 2.0 \\
 4 & 8.0 & -4.0 & 2.0 & -1.0 & 2.0 \\
 5 & -3.0 & 1.0 & -2.0 & 3.0 & 0.0 \\
\end{array}
\]

Yes

d. | Source               | $SS$ | $df$ | $MS$  |
---|----------------------|------|------|-------|
| Between treatments   | 672.0| 2    | 336.00|
| Error                | 416.0| 21   | 19.81 |
| Total                | 1,088.0| 23  |       |

e. $H_0$: all $\mu_i$ are equal $(i = 1, 2, 3), H_A$: not all $\mu_i$ are equal.

$F^* = \frac{336.00}{19.81} = 16.96, F_{(0.99; 2, 21)} = 5.78$. If $F^* \leq 5.78$ conclude $H_0$, otherwise $H_A$. Conclude $H_A$. P-value = 0+