Review for Exam I - STAT 642

Topics Covered on EXAM:

I. Experimental Design Principles:

1. Design experiments/studies to estimate and control variation
2. How to control variation
3. Six major principles of scientific experimentation
4. Properly Conducted Statistical Designed Experiments are
    a. Economical
    b. Allow the estimation of the impact of factors on response
    c. Allow the estimation of variability
    d. Allow the development of tests of hypotheses and confidence intervals
5. Experimental Design Terminology

    Experimental Unit, Measurement Unit, Homogeneous EU's, Blocks, Factor, Levels of Factors, Treatment, Replication, Subsampling, Repeated Measures, Response, Effect of Treatments, Interaction, Confounding, Covariates
6. Common Problems in Experimental Designs
    a. Masking of Factor Effects
    b. Uncontrolled Factors
    c. Erroneous Principles of Efficiency
7. Randomization
    a. Assignment of Treatments to EU's
    b. Randomly selecting EU's from Existing Populations
    c. Order in which measurements are taken or the position of EU's in Laboratories must be randomized
    d. Valid inferences only occur with proper randomization
    e. Permutation Tests

II. Components of a Designed Experiment:

1. C_1 : Randomization - Completely Randomized, Blocked, Latin Squares, Random Factor Levels, Subsampling, Incomplete Blocks, Split-Plot, Split-Split-Plot, Strip-Plot, Crossover, Repeated Measures
2. C_2 : Treatment Structure - Single Factor, Crossed, Nested, Crossed/Nested, Fractional Factorials

    Factor Levels - Fixed, Random
3. C_3 Measurement Structure - Single measurement, Subsampling, Repeated Measures-Spatial and/or Temporal

4. Given the description of an experiment:

    a. Identify the Treatment Structure and Whether the Levels of the Factors are Fixed or Random. Also, identify any blocking factors and/or covariates

    b. Describe the method of randomization and the EU's

    c. Identify the measurement structure and the MU's

III. Completely Random Design (CRD):

1. Model: Interpretation of parameters and LSE

    a. Cell Means: $y_{ij} = \mu_i + e_{ij};\ i = 1, \ldots, t;\quad j = 1, \ldots, n_i$

    b. Effects models with restrictions: $y_{ij} = \mu + \tau_i + e_{ij};\ i = 1, \ldots, t;\quad j = 1, \ldots, n_i$ with $\sum_{i=1}^{t} n_i \tau_i = 0$ or $\tau_t = 0$

    c. Matrix formulation of the models

2. AOV & F-Test

    a. F-test of $H_o : \mu_1 = \mu_2 = \cdots = \mu_t$ vs H_1 : At least one pair of means differ

    b. Power of F-test: noncentrality parameter, Use textbook's graphs to compute power

3. Determine Number of Reps

    For specified number of treatments, $\hat{\sigma}_e$, α, bound on power, bound on effect size

4. Estimation of Treatment Means

    LSE, standard errors, C.I., Treatment Effects

5. Treatment Comparisons

    a. Type I Error Rates - Per Comparison (PC) vs Familywise (FWER) vs False Discovery Rate (FDR)

    b. Bonferroni Procedures

    c. Scheffé Procedures

    d. Contrasts:

        i. Comparisons of linear combinations of treatment means: F-test, t-test

        ii. Orthogonal Polynomials

        iii. Tests for Trends

        iv. Scheffe, Bonferroni F-test

        v. Simultaneous tests of m contrasts using Hypothesis Matrix

    e. Control vs Treatment Means: Dunnett's Procedure

    f. Determine Group of Best Treatments: Hsu's Procedure

    g. All Pairwise Comparisons of Treatment Means: Tukey's procedure

    h. FDR procedure