This course covers advanced-level multivariate statistical methods, including an overview of the general linear model, assumptions of multivariate statistical procedures, MANOVA and MANCOVA, discriminant function analysis, canonical correlation analysis, cluster analysis, and principal components analysis. The focus of this course will be on conceptual understanding and computer applications, with an introduction to the mathematical underpinnings of the procedures examined.

Course Objectives

The present course aims to address the following knowledge, skills, and dispositions:

By the end of this course, students will have an understanding of

Knowledge

- the rationale underlying the use of multivariate statistical procedures;
- the links between univariate and multivariate statistical procedures, underpinned by the general linear model;
- data structures appropriate for multivariate statistical analysis;
- the relationships among multivariate statistical procedures;
- the importance of and procedures for data screening and testing assumptions of multivariate statistical procedures;
- the rationale and procedures for one-way and factorial MANOVAs and MANCOVAs;
- the rationale and procedures for cluster analysis;
- the rationale and procedures for discriminant function analysis;
- the rationale and procedures for canonical correlation analysis;
- the rationale and procedures for basic principal components analysis.
Skills

By the end of this course, students will have the ability to

- screen data and test for assumptions underlying a variety of multivariate statistical procedures
- conduct multivariate statistical procedures, including
  - one-way and factorial MANOVAs and MANCOVAs;
  - cluster analysis;
  - discriminant function analysis;
  - canonical correlational analysis;
  - principal components analysis;
- Use computer software for the conduct of these analyses;
- Interpret statistical output and write-up results in line with APA 6th guidelines on the reporting of statistical data; and
- Critique of statistical procedures in the context of substantive research problems.

Dispositions

By the end of this course, it is anticipated that students will have developed

- increased interest in using advanced statistical techniques to answer substantive problems in educational psychology and cognate disciplines;
- The recognition that multivariate statistical procedures allow researchers to better statistically represent the complexity of real-world phenomena;
- enhanced motivation in conducting research that draws on multivariate statistical procedures; and
- Interest in pursuing further studies of advanced quantitative methods, including latent variable and multi-level modeling methodologies.

Materials

Required Materials

Text


Software

At a minimum, you will need SPSS to complete all assignments in the course. Furthermore, as there will be a strong computer application focus in our classes, you are strongly encouraged to bring a laptop with SPSS loaded on your machine to get the “hands on” experience that is oftentimes helpful in mastering the statistical procedures covered. You can purchase the student version of SPSS for a reasonable price at various online vendors, such as Hearne Software and Student Discounts. The “IBM SPSS Statistics 24” “Premium Grad Pack” is
sufficient for this class. Please note that the suggested vendors are just a few of many options, and you may wish to shop around to see if you can find a better price.

If you wish not to purchase SPSS, it is available in most open computer labs at UNLV including the Graduate Student lounge in the library and CEB-B 131. Before traveling to UNLV to access SPSS, check the following UNLV website to ensure lab availability: http://oit.unlv.edu/labs-classrooms. However, you should note the only the Standard, as opposed to the premium, SPSS package is available in the university labs. The standard package has reduced functionality relative to the premium option (e.g., the missing value analysis module is absent), which will limit your capacity to perform some analyses.

Supplementary Materials


Optional Journal Readings


Class Format and Teaching Approach

Across most weeks, the class will follow a “lecture-lab” structure for learning advanced statistical methods, comprising the theoretical/mathematical explication of advanced statistical
procedure followed by a computer-based demonstration of the procedure, and, finally, a lab-style practical application of the procedure. In all cases, statistical procedures will be introduced in the context of a plausible research problem in educational psychology to contextualize the selection and use of the procedure. In-class—lab-style—activities and frequent homework assignments are designed to give you authentic “hands-on” experiences with the procedures studied. A specific course schedule is included below to assist in your preparations for classes.

The approach to teaching and learning in this course is predicated on the theory of teaching and learning for understanding (TLfU) within a broad instructional-design framework (Perkins, 1993; Reigeluth, 1999). One teaching objective, based on this instructional design formulation, is to develop generative study topics that are (a) central to the discipline, (b) interesting to students, and (c) connected to their prior and present experiences. To this end, study activities typically foreground the practical implications of the topics examined. A second teaching objective, predicated on the TLfU framework, is to sufficiently induct students into their discipline, accounting for their prior knowledge and learning experiences (Perkins, 1992; Perkins & Simmons, 1988). Consistent with this objective, the course commences with an introductory topic explicating how the discipline functions as a system of thought and relates new knowledge to existing understandings. Students are introduced to basic concepts, such as the general linear model, matrices, levels of measurement, inter alia, to provide a core basis for their problem solving and inquiry within the course. A final objective of teaching, based on this framework, is to teach for transfer (Brown, 1989; Perkins, 1993). This is a complex, multistage objective that involves preparation for learning, acquiring new knowledge, rehearsing new knowledge, and applying new knowledge. Through this multistage process, learning in one context or with one set of materials (e.g., the textbook) is expected to positively impact performance in another context (e.g., solving a novel problem). This step in the learning process implicates several teaching and learning strategies, including self-reflection, self-regulated learning, cooperative-learning, independent investigation, and problem-based learning, and various combinations thereof.

### Assignments

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Description</th>
<th>Marks/Weighting</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>H/W Assign. #1</td>
<td>Interpretation of statistical output and results write-up concerning data screening and assumptions</td>
<td>20/10%</td>
<td>09/21</td>
</tr>
<tr>
<td>H/W Assign. #2</td>
<td>Interpretation of statistical output and results write-up concerning MANOVA</td>
<td>20/10%</td>
<td>10/12</td>
</tr>
<tr>
<td>Mid-semester Exam</td>
<td>Brief multiple-choice and short-answer exam on Topics 1-6.</td>
<td>30/15%</td>
<td>10/20</td>
</tr>
<tr>
<td>H/W Assign. #3</td>
<td>Interpretation of statistical output and results write-up</td>
<td>20/10%</td>
<td>11/9</td>
</tr>
<tr>
<td>Homework Assignment</td>
<td>Description</td>
<td>Weight</td>
<td>Due Date</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>H/W Assign. #4</strong></td>
<td>Interpretation of statistical output and results write-up concerning canonical correlation analysis</td>
<td>20/10%</td>
<td>11/30</td>
</tr>
<tr>
<td><strong>Project Report and Presentation</strong></td>
<td>Report: Critique of substantive articles with respect to their application of multivariate statistical procedures Presentation: Presentation of data from critique</td>
<td>Report: 50/20% Presentation: 20/10%</td>
<td>Report: 12/14 Presentation: 11/23</td>
</tr>
<tr>
<td><strong>In-class computer assignment</strong></td>
<td>Interpretation of statistical output and results write-up concerning principal components analysis</td>
<td>30/15%</td>
<td>12/14</td>
</tr>
</tbody>
</table>

Note. Task-specific information will be progressively released during the semester as per the guidelines below. Please note that I reserve the right to change the mode of administration of some of these tasks as required by institutional requirements.

**Homework Assignments**

In total, there will be four homework tasks designed to provide you with continuous “hand on” experience in performing the statistical procedures covered in the course. The focus of these tasks will be the conduct of statistical analyses using SPSS, interpretation of data, and write-up of results in line with APA6th guidelines. Each homework task will be appraised out of 20 and weighted at 10% of your final grade. This means, cumulatively, the homework tasks are worth 40% of your final grade. Please ensure that you follow the specific instructions for each homework task as the instructions may differ between tasks. Homework tasks, with instructions and rubrics, will be distributed one week before the listed due date and submitted via Web Campus. Assignments submitted late will be penalized at 10% of the raw mark achieved for each business day late.

**Mid-Semester Exam**

The mid-semester exam is a “take-home” exam, designed to be a summative assessment of the knowledge and skills learned in Topic 1 to 6 (inclusive). The exam will comprise a combination of multiple-choice, short-answer, and short-essay-style items. The exam will be administered electronically and you will have 24 hours to turn-in your paper. The exam will be scored out of 30 and weighted at 15% of your overall grade. Papers turned in late will be penalized at 2% of the raw mark achieved for each hour or part thereof late (e.g., if your work is 30 minutes late, you will be penalized 1% of the grade). I reserve the right to round up to the nearest 5-minute increment for the purpose of computing the late penalty. More specific details regarding the task will be given in the Week 7 class.
Project Report and Presentation

The present assignment contains two parts as follows: (a) project report; and (b) project presentation. The assignment is designed to give you an opportunity to critique the application of multivariate statistical methods in your substantive area of study. In principle, this should be an area of educational psychology or a closely related sub-discipline (e.g., personality psychology). You will choose 10 scientific journal articles and critique these articles in terms of their provision of desirable data according to the statistical procedure(s) used. The report detailing your critique is due 5 December 2016 and should be submitted via Web Campus. Assignments submitted late will be penalized at 10% of the raw mark achieved per business day late. The report is marked out of 50 and weighted at 20% of your final grade.

You will present a working version of your critique in the class session on 23 November 2016. The scheduling of the presentation prior to the submission of the final report is designed to give you the opportunity to revise your work in line with feedback on the presentation. The presentation is appraised out of 20 and weighted at 10% of your final grade. Specific details for each part of the assignment will be provided on 26 October 2016.

In-Class Computer Assignment

The in-class computer assignment is designed to assess your knowledge of and skills in the conduct of cluster analysis and principal components analysis under conventional test-taking conditions. You will conduct a variety of cluster analyses and PCAs using SPSS, interpret the output, and write-up results in line with APA6th requirements. You will have 2 hours 15 minutes to complete this task during the final class meeting on 12 December 2016. This task will be marked out of 30 and weighted 15% of your final grade.

Grading Policy

Course grades will be based on the following percentage points.

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percentage Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>95-100</td>
</tr>
<tr>
<td>A</td>
<td>93-94</td>
</tr>
<tr>
<td>A-</td>
<td>90-92</td>
</tr>
<tr>
<td>B+</td>
<td>87-89</td>
</tr>
<tr>
<td>B</td>
<td>83-86</td>
</tr>
<tr>
<td>B-</td>
<td>80-82</td>
</tr>
<tr>
<td>C+</td>
<td>77-79</td>
</tr>
<tr>
<td>C</td>
<td>73-76</td>
</tr>
<tr>
<td>C-</td>
<td>70-72</td>
</tr>
<tr>
<td>D+</td>
<td>67-69</td>
</tr>
<tr>
<td>D</td>
<td>63-66</td>
</tr>
<tr>
<td>D-</td>
<td>60-62</td>
</tr>
<tr>
<td>F</td>
<td>00-59</td>
</tr>
</tbody>
</table>
## Course Schedule and Readings

<table>
<thead>
<tr>
<th>Week</th>
<th>Week of</th>
<th>Topic</th>
<th>Readings</th>
<th>Optional Readings</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>09/05</td>
<td>2: Data screening and testing assumptions of multivariate statistical procedures: Part I</td>
<td>T &amp; F, Chp 4 (pp. 61-72)</td>
<td>Schafer and Graham (2002); Graham (2009); Enders &amp; Gottschall (2011)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>09/12</td>
<td>3: Data screening and testing assumptions of multivariate statistical procedure: Part II</td>
<td>T &amp; F, Chp 4 (pp. 72-116)</td>
<td>DeCarlo (1997); Finch (2012); Meade &amp; Craig (2012); Osborne &amp; Overbay (2004); Stevens (1984)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>09/26</td>
<td>5: MANOVA and MANCOVA: Part II</td>
<td>T &amp; F, Chp 7</td>
<td>Enders (2003); Mok, Kennedy, &amp; Moore (2011); Woodward &amp; Overall (1975)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10/03</td>
<td>6: Discriminant function analysis: Part 1</td>
<td>T &amp; F, Chp 9</td>
<td>Huberty (1984); Huberty &amp; Barton (1989); Press</td>
<td></td>
</tr>
<tr>
<td>Week</td>
<td>Date</td>
<td>Topic</td>
<td>Textbook</td>
<td>Readings</td>
<td>Assignment</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
<td>------------</td>
</tr>
<tr>
<td>7</td>
<td>10/10</td>
<td>7: Discriminant function analysis: Part II</td>
<td>T &amp; F, Chp 9</td>
<td>Achter, Lubinski, Benbow, &amp; Eftekhari-Sanjani (1999); Huberty, Wisenbaker, &amp; Smith (1987); Konishi &amp; Honda (1990); Thomas (1992)</td>
<td>H/W assignment 2 due</td>
</tr>
<tr>
<td>8</td>
<td>10/17</td>
<td>Mid-Semester examination (take-home)</td>
<td></td>
<td></td>
<td>Mid-semester examination (take-home)</td>
</tr>
<tr>
<td>9</td>
<td>10/24</td>
<td>8: Canonical correlation: Part I</td>
<td>T &amp; F, Chp 12</td>
<td>Lutz &amp; Eckert (1994); Sherry &amp; Henson (2005); Thompson (1991)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>11/21</td>
<td>Project Presentations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>11/28</td>
<td>12: Principal components analysis: Part I</td>
<td>T &amp; F, Chp 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>12/05</td>
<td>13: Principal components analysis: Part II</td>
<td>T &amp; F, Chp 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>12/12</td>
<td>In-class computer assignment</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: full reference details for the optional readings are available above. This course schedule is subject to change. T & F denotes Tabachnick and Fidel (2013). The full reference for Hair et al. (2010) is Hair Jr, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Cluster analysis. In *Multivariate data analysis* (pp. 483-543). Upper Saddle River, NJ: Prentice Hall (please note that a copy of this chapter will be provided well in advance of the class meeting that requires the text).
UNLV Policies

**Academic Misconduct**—Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLV’s function as an educational institution.

An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: https://www.unlv.edu/studentconduct/student-conduct.

**Copyright**—The University requires all members of the University Community to familiarize themselves with and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: http://www.unlv.edu/provost/copyright.

**Disability Resource Center (DRC)**—The UNLV Disability Resource Center (SSC-A 143, http://drc.unlv.edu/, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

**Religious Holidays Policy**—Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor within the first 14 calendar days of the course for fall and spring courses (excepting modular courses), or within the first 7 calendar days of the course for summer and modular courses, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: http://catalog.unlv.edu/content.php?catoid=6&navoid=531.

**Transparency in Learning and Teaching**—The University encourages application of the transparency method of constructing assignments for student success. Please see these two links for further information:

https://www.unlv.edu/provost/teachingandlearning

https://www.unlv.edu/provost/transparency

**Incomplete Grades**—The grade of I—Incomplete—can be granted when a student has satisfactorily completed three-fourths of course work for that semester/session but for reason(s) beyond the student’s control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of
F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.

Students may consult with a librarian on research needs. For this class, the Subject Librarian is (https://www.library.unlv.edu/contact/librarians_by_subject). UNLV Libraries provides resources to support students’ access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at https://www.library.unlv.edu/.

**Tutoring and Coaching**—The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit http://www.unlv.edu/asc or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of the SSC (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TEB second floor.

**UNLV Writing Center**—One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student’s Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: http://writingcenter.unlv.edu/.

Students may consult with a librarian on research needs. For this class, the Subject Librarian is (https://www.library.unlv.edu/contact/librarians_by_subject). UNLV Libraries provides resources to support students’ access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at https://www.library.unlv.edu/.

**Rebelmail**—By policy, faculty and staff should e-mail students’ Rebelmail accounts only. Rebelmail is UNLV’s official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students’ e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu. Emailing within WebCampus is acceptable.

**Final Examinations**—The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: http://www.unlv.edu/registrar/calendars.