Math 584: Linear Models, Section 001, Summer 2022.

Instructor: David Olive, Webpage: (http://parker.ad.siu.edu/Olive/M584.html).

Text: Seber, G.A.F., and Lee, A.J. (2003), *Linear Regression Analysis,* 2nd ed., Wiley, NY. ISBN 0-471-41540-5. About $90 new. Get used copies from www.amazon.com and www.addall.com for about $30.

A webpage for course notes Olive, D.J. (2022) *Theory of Linear Models* is (http://parker.ad.siu.edu/Olive/M584.html), but I do take homework problems from Seber and Lee.

This class is one of the two theory courses for a Master's in Statistics: the other course is Math 580. The course is going to become eligible for a qual, perhaps only for Statistics majors.

PREREQUISITES: Linear algebra Math 221 and a course in multiple linear regression such as Math 484 with prerequisite Math 483, or Quan 507 with a C or better. I will waive Math 484 if you have had a B or higher in Math 580 or had a course that covers regression (generalized linear models, Cox proportional hazards regression). (Statistical Learning that covered regression or my Robust Statistics course will do.) Experimental design like Math 484 or Quan 508 is useful.

(Some electrical engineering courses on Digital and Spectral Analysis are least squares theory courses.)

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Office hours:

I am also available by appointment and on a walkin basis, especially before and after class.

This course examines the theory of linear models with applications to regression and to the design of experiments (analysis of variance). Least squares estimation and testing for full rank and less than full rank models. Column spaces, orthogonal projections, Gauss Markov theorem, large sample distribution of least squares and F tests, multivariate linear regression, and prediction intervals will be covered.

Recent material on lasso, elastic net, and variable selection will be covered. The bootstrap can be used for inference if the number of cases is large compared to the number of predictors. Otherwise data splitting can be used.

Final (emphasis is on the above topics) August 4 or 5.

The grading and schedule below are tentative.

Except for the last week of classes, 2 homeworks may be turned in one class period late (ie on Tuesday) with no penalty. A third late will be accepted with 25% penalty. One or more sheets of notes will be allowed on quizzes. A calculator is permitted. I sometimes give $A-$, $B+$, $B-$, and $C+$.

Useful for memorizing material before an exam: Lorayne, H., and Lucas J. (1974), *The Memory Book*, Stein and Day, Briarcliff Manor, NY.

Grading:

Week of		
June 13	M, App. A, B (2.1)	TU, App. A, B, 1.1, (2.1)
W, 1.2, 1.3, 1.4 (2.1,2.2)	TH, 1.5, 1.6, 2.1, 2.2, 2.3 (2.2)	F, 2.4, $\chi^2(n,\gamma)$, (2.2) HW1
June 20	M, $\chi^2(n,\gamma)$, (2.2,2.3), Q1	Tu, 3.1, (2.3), HW2
W, 3.1 3.2, (2.3) Q2	Th, 3.2,3.3, (2.3) HW3	F, 3.4,3.5, (2.3), Q3
June 27	M, 3.6, 3.9, (2.3)	Tu, Exam 1
W, 3.9, 3.10, (2.3,2.4,3.1), 4.1, 4.3, HW4	Th, 4.3, (2.3), Q4	F, 4.3, (2.3), HW5
July 4	M no class	Tu, 4.3, 4.4, (2.3)
W, 4.4, 5.1, (2.3), Q5	Th, 5.1,5.2, (2.3), HW6	F, 5.3,(PI 4.3), Q6
July 11	M, 9.1,9.2,9.3,9.4, (1.3,2.3) HW7	Tu, 9.5, 9.6, 9.7
W, Exam 2	Th, 10.1, 10.2,10.3, 10.4, (1.3) HW8	F, 12.1-12.3,
July 18	M, 12.4 (4.1) Q7	Tu, 12.4,12.5,8.1 (4.1,4.2,3.1,3.2), HW9
W, 8.1,(3.1,3.2), Q8	Th, bootstrap(4.5-4.6), HW10	F, bootstrap(4.5-4.6), Q9
July 25	M, data splitting (6.2),	Tu, mreg (8.1-8.4), Q10
W, mreg (8.1-8.4), bootstrap	Th, mreg (8.1-8.4), HW11	F, data splitting (6.2), mreg (8.1-8.4), Q11
Aug 1	M, Exam 3	Tu, student review
W, student review	Th, Final	F

HW	300		Quizzes	100	
exam1	100	exam 2	100	exam 3	100
final	300			total	1000
min. grade	points	min. grade	points	min. grade	points
A	900-1000	B	800-899	C	700-799
D	550-699				

Parentheses refer to Olive (2022).

Other references: Christensen, R. (2011), *Plane Answers to Complex Questions: the Theory of Linear Models,* 4th ed., Springer, New York, NY.

Freedman, D.A. (2005), *Statistical Models Theory and Practice*, Cambridge University Press, New York.

Graybill, F.A. (2000), *Theory and Application of the Linear Model,* Brooks/Cole, Pacific Grove, CA.

Guttman, I. (1982), *Linear Models: an Introduction*, Wiley, New York, NY.

Hocking, R.R. (2013), *Methods and Applications of Linear Models: Regression and the Analysis of Variance,* 3rd ed., Wiley, Hoboken, NJ.

Ravishanker, N. and Dey, D.K. (2002), *A First Course in Linear Model Theory,* Chapman and Hall/CRC, Boca Raton, FL.

Rencher, A.C., and Schaalje, G.B. (2008), *Linear Models in Statistics*, 2nd ed., Wiley, Hoboken, NJ.

Searle, S.R., and Gruber, M.H.J. (2017), *Linear Models*, 2nd ed., Wiley, Hoboken, NJ.

Linear Algebra: Anton, H., and Rorres, C. (2014), *Elementary Linear Algebra, Applications Version*, 11th ed., Wiley, New York, NY.

Leon, S.J. (2015), *Linear Algebra with Applications*, 9th ed., Pearson, Boston, MA.

Carol Ash's website (https://faculty.math.illinois.edu/∼ash/) has good notes for linear algebra.