



October 23, 2018

To: Undergraduate studies committee
Oliver Dasbach, Chair
The mathematics faculty

From: Lawrence Smolinsky, Professor
Department of Mathematics

Re: Proposed changes to Actuarial Science Concentration
Atch: Syllabi MATH 4040, MATH 4041, MATH 4045, MATH 4046, and EXST 4142.

Introduction. As of fall 2018, 50 of our 169 mathematics majors are in the actuarial science concentration. It is our important responsibility to guide their education and employment opportunities. Students who are able to pass exams should be able to obtain employment in actuarial science and receive a background in the more difficult areas to pass future exams. Other students should receive a background that will make them desirable for positions in risk management, business analytics, statistics, data analytics, and one-year master's degree programs in these areas.

The Society of Actuaries has made substantial changes to its credentialing requirements. The number of content exams has gone from five to seven. We previously offered regular courses for two of the exams with a reading course for a third exam. Two of the exams were made easier and there is substantial competition for entry level jobs. Hence, it is expected that more will be required to obtain entry level positions.

After discussion and approval from Oliver and Chip, the following changes to the concentration are proposed. The proposed changes to the actuarial concentration will cost the department only the addition of one 3-hour course a year. We should also qualify for the Society of Actuaries designation "Advanced Curriculum" moving up from our present status as an "Introductory Curriculum." We will be the only Advanced Curriculum in Louisiana, Mississippi, Arkansas, or Alabama. In Texas, UT Austin and UT Dallas are the only schools that presently qualify. The process to be approved may be lengthy and might be complicated by a proposed unification of the two major actuarial organizations.

We could consider a Master's or certificate program once everything is running, but there are issues to consider.

Summary of changes.

Drop MATH 4058 (may stop offering).
Drop MATH 4153 as a requirement.

Create two sequences in Mathematics to be offered in alternating years:
Short-term Actuarial Mathematics (STAM): MATH 4040 and MATH 4041
Long-term Actuarial Mathematics (LTAM): MATH 4045 and MATH 4046

Create one course in Experimental Statistics:
EXST 4142: Introduction to R and Statistical Data Mining.

Require four courses in Computer Science that constitute an introduction to the computer science for predictive analytics: CSC 1253, CSC 1254, CSC 3102, and CSC 3730.

The new program will cover 6 of the 7 Society of Actuaries exams and include an introduction to predictive analytics, which is the 7th exam. Students could routinely have preparation for 5 of the exams including one of Exam STAM and Exam LTAM. (This is required for an SOA designated Advanced Curriculum.)

The program.

Required courses common to all concentrations: MATH 1550 or MATH 1551; MATH 1552 or MATH 1553; MATH 2057 or MATH 2058; MATH 2085 or MATH 2090; two of MATH 2020, 2025, or 2030.

Other required courses: MATH 3355; MATH 3050; MATH 4056; two¹ of MATH 4040, MATH 4041, MATH 4045, or MATH 4046; ACCT 2001; ECON 2030 or ECON 2031 (also fulfills a general education requirement); FIN 3716; EXST 2201; EXST 3201; CSC 1253; CSC 1254; CSC 3102; CSC 3730 or CSC 2730; and one of MATH 4020, MATH 4997, EXST 4087, EXST 4025, or EXST 4041.

Highly recommended but not presently required: FIN 3440, FIN 4850, and EXST 4142.

All of MATH 4020, MATH 4997, EXST 4087, EXST 4025, and EXST 4041 include group projects. We would continue to allow MATH 4999 under the condition it is a properly supervised and documented actuarial internship.

In the sample program below, the courses highlighted in yellow are not be required because of outside constraints but are the highly recommended electives. This program is a desirable sample program for students and advisors, which includes recommendations. It is not the “sample 8-semester recommended path (concentration) layout” for the C&C Form E.

General requirements highlighted in blue.

* denotes courses that satisfy an SOA VEE requirement or are awaiting SOA approval.

** denotes courses that prepare for an SOA exam.

*** denotes courses for data science.

Total hours range from 120 to 122 depending on the choices of general education labs.

¹ While one of the sequences MATH 4040-4041, MATH 4045-4046 is desired, the present college administration’s policy would delay the graduation of a student who failed to complete such a requirement for one or two full years. Hence, to accommodate the Dean’s office present substitution practice, we make the requirement as two of the four courses.

Semester 1 (14 or 15 hours)

MATH 1550 (5)

CSC 1253

ENGL 1001 English Composition

General Education - Natural Science sequence (Biological or Physical Science) part 1
Lab 0-1Semester 2 (14 or 15 hours)

MATH 1552 (4)

CSC 1254

MATH 2020 (bridge course)

General Education - Natural Science sequence (Biological or Physical Science) part 2
Lab 1-2Semester 3 (15 hours)

MATH 2057

MATH 3050^{2,**} (5)

EXST 2201 (4)

ENGL 2000 English Composition

Semester 4 (16 hours)MATH 3355^{**}

MATH 2085

ACCT 2001^{*}ECON 2030^{*} (fulfills a General Education 2000-level social science requirement)

EXST 3201 (4)

Semester 5 (15 hours)MATH 4056^{*}FIN 3716^{*}CSC 3102^{***}

General Education course - Arts

Free elective (3)

Semester 6 (15 hours)Free elective (3) highly recommend FIN 3440³

² A student only has to meet the admission requirements of the College of Science to enroll in a 3000-level course: Earned 24 semester hours; have a 2.0 gpa on both LSU and cumulative averages, and have passed ENGL 1001, all mathematics courses, and all science courses with a grade of "C-" or better.

³ FIN 3440 is listed in the LSU catalog with a BLAW 3201 prerequisite. Finance has agreed to admit actuarial students to FIN 3440 who have had FIN 3716 (or FIN 3715) and MATH 3050. The mainframe registration system does not prevent a student from registering for FIN 3440 without having taken BLAW 3201, so they do not need any special attention.

Free elective (3) highly recommend **FIN 4850**^{4,**}
 CSC 3730^{***} (new in 2019-2020) or CSC 2730^{***}
 Free elective (3)
 MATH 2025 or 2030 (second gateway class—department may remove in 2018)

Semester 7 (16 hours)

Free elective (3) recommend highly **EXST 4142**^{5,**}
 MATH 4040^{**} or MATH 4045^{**}

Foreign Language Course (4)

General Education - Natural Sciences (Alternate Science)

General Education course – Humanities

Semester 8 (15 hours)

MATH 4041^{**} or MATH 4046^{**}

Capstone (MATH 4020, MATH 4997, or EXST 4087)

Free elective (3)

General Education course - Humanities (English/Honors 2000-level)

General Education course - Social Sciences

Substitutions.

Students in concentrations or older catalogues that require MATH 4058 would be allowed to substitute MATH 4040, MATH 4045, or EXST 4142 for the MATH 4058.

⁴ FIN 4850 is listed in the LSU catalog as *Open only to Finance majors; open to others with permission of department* and has FIN 3826 as a prerequisite. Finance has agreed to admit actuarial students to FIN 4850 who have had FIN 3716 (or FIN 3715) and MATH 3050. Students will have to be manually added by the Finance Department's UG advisor, (presently Kurtay Ogunc).

⁵ Being piloted fall 2018. Approval proceeding through Experimental Statistics.

Mathematics 4040: Fall 2019

Instructor: Richard Moscatello
148 Lockett Hall
Telephone: 578-6596
E-mail: rmoscatello@lsu.edu
Office hours: TBA

TA: TBA

MATH 4040 Short-term Actuarial Mathematics I (3) Prereq.: MATH 3355.
Actuarial models for insurance and annuities. Severity-of-loss and frequency-of-loss models, aggregate models, risk models, empirical estimation.

Class information.

Classroom: TBA
Meeting time: TBA

Work expectations. Math 4040 is a 3-credit hour class. Students are expected to spend *a minimum* of 9 hours per week on attending class, reading material, completing homework, and preparing for tests.

Text. *Loss Models: From Data to Decisions*, Fourth Edition, 2012, by Klugman, S.A., Panjer, H.H. and Willmot, G.E., Wiley, ISBN: 978-1-118-31532-3

Calculators. Students may only use Society of Actuaries approved calculators for this course: BA-35, BA II Plus, or BA II Plus Professional Edition, TI-30X, TI-30Xa, TI-30Xs, or TI-30X II. You may use both one of the BA series and TI-30 series on a test. No other calculators will be allowed during tests, quizzes, or the final exam.

Disability statement. The University is committed to making reasonable efforts to assist individuals with disabilities in their efforts to avail themselves of services and programs offered by the University. To this end, Louisiana State University will provide reasonable accommodations for persons with documented qualifying disabilities. If you have a disability and feel you need accommodations in this course, you must present a letter to me from Disability Services in 115 Johnston Hall, indicating the existence of a disability and the suggested accommodations.

Outline of the course. MATH 4040 and MATH 4041 cover the material for the actuarial exam given by the Society of Actuaries as Exam STAM (Short-term actuarial mathematics). MATH 4040 will cover approximately the first 14 chapters of Klugman et al.

Week	Topics
1	The model-based approach
2	Key functions and four models
3	Basic Distributional Quantities
4	Characteristics of Actuarial Models
5	Continuous Models
6	Discrete Distributions
7	Advanced Discrete Distributions
8	Frequency and Severity with Coverage Modifications
9	Aggregate Loss Models
10	Empirical Models
11	Estimation for Complete Data
12	Estimation for Modified Data
13	Parametric Statistical Methods
14	Frequentist Estimation
15	Final exam week

Grade computation.

Item	Provisional Date	Grade contribution
Test 1	Wednesday TBA	17%
Test 2	Wednesday TBA	17%
Test 3	Wednesday TBA	17%
Final Exam	TBA	25%
Homework	Various dates	24%

During any quiz, test, or exam you may not use any electronic device other than a *Society of Actuaries* approved calculator. Cell phones must be shut off—not just on silent mode—and put away while you are in the exam room on an exam day. Smart watches should not be accessible.

Homework assignments will usually be weekly. They will be collected and graded. Any in-class quiz will count as a homework assignment and be included in the homework grade. Homework assignments and other information will be posted on Moodle.

Grade scale.

Grade	Range
A+	97%-100%
A	94%-96.9%
A-	90%-93.9%
B+	87%-89.9%
B	84%-86.9%
B-	80%-83.9%
C+	77%-79.9%
C	74%-76.9%
C-	70%-73.9%
D+	67%-69.9%
D	64%-66.9%
D-	60%-63.9%
F	59.9%-0%

The instructor reserves the right to curve the score of graded items. Hence the grading above scale is a guaranteed minimum grade.

Integrity and Ethical Conduct. Students are required to conduct themselves in the accordance to the Code of Student Conduct. Student violations of the code will result in the student being charged with academic and/or behavioral misconduct.

Work on tests, quizzes, and the final exam must be your own work with no assistance from anyone else. During an exam, attempts to look at other students' exams, the use of crib sheets or formula sheets, accessing cell phones, or other forbidden electronics are violations of the LSU Code of Student Conduct.

Mathematics 4041: Spring 2020

Instructor: Richard Moscatello
148 Lockett Hall
Telephone: 578-6596
E-mail: rmoscatello@lsu.edu
Office hours: TBA

TA: TBA

MATH 4041 Short-term Actuarial Mathematics II (3) Prereq.: MATH 4040 and one of MATH 4056, EXST 3201, or EXST 4050. Actuarial models for insurance and annuities. Statistical estimation procedures, credibility theory, and pricing and reserving.

Class information.

Classroom: TBA
Meeting time: TBA

Work expectations. Math 4041 is a 3-credit hour class. Students are expected to spend *a minimum* of 9 hours per week on attending class, reading material, completing homework, and preparing for tests.

Texts.

- *Loss Models: From Data to Decisions*, Fourth Edition, 2012, by Klugman, S.A., Panjer, H.H. and Willmot, G.E., Wiley, ISBN: 978-1-118-31532-3
- Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance (Fourth Edition), 2015, by Brown and Lennox, ACTEX, ISBN: 978-1625424747
- Chapter 2
- Chapter 3
- Chapter 4
- Chapter 5

The following study notes may be downloaded for free from the Society of Actuaries at <https://www.soa.org/education/exam-req/edu-exam-stam-detail.aspx> under *syllabus and study materials*.

- STAM-21-18 Replacement pages for Section 16.5.3 from *Loss Models: From Data to Decisions*, Fourth Edition
- STAM-22-18 *Foundations of Casualty Actuarial Science* (Fourth Edition), 2001, Casualty Actuarial Society Chapter 8, Section 1 (background only) Sections 2?5
- STAM-23-18 *Topics in Credibility* by Dean, C.G.
- STAM-24-18 Supplement to Chapter 3 of *Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance*, Fourth Edition
- STAM-25-18 *Individual Health Insurance* (Second Edition), 2015, by Bluhm and Leida, Chapter 2, Sections 2.1, 2.9

Calculators. Students may only use Society of Actuaries approved calculators for this course: BA-35, BA II Plus, or BA II Plus Professional Edition, TI-30X, TI-30Xa, TI-30Xs, or TI-30X II. You may use both one of the BA series and TI-30 series on a test. No other calculators will be allowed during tests, quizzes, or the final exam.

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Week	Topics
1	Frequentist Estimation for Discrete Distributions
2	Bayesian Estimation
3	Conjugate prior distributions
4	Computational issues
5	Model Selection
6	Credibility
7	Limited Fluctuation Credibility
8	Full and Partial Credibility
9	Buhlmann and Buhlmann-Straub models
10	Insurance and reinsurance coverages for short-term insurances
11	Pricing and Reserving for Short-Term Insurance Coverages
12	Chain ladder and Bornhuetter Ferguson
13	Statistical models for the methods
14	Premiums using the pure premium and loss ratio methods
15	Final exam week

Grade computation.

Item	Provisional Date	Grade contribution
Test 1	Wednesday TBA	17%
Test 2	Wednesday TBA	17%
Test 3	Wednesday TBA	17%
Final Exam	TBA	25%
Homework	Various dates	24%

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Grade	Range
A+	97%-100%
A	94%-96.9%
A-	90%-93.9%
B+	87%-89.9%
B	84%-86.9%
B-	80%-83.9%
C+	77%-79.9%
C	74%-76.9%
C-	70%-73.9%
D+	67%-69.9%
D	64%-66.9%
D-	60%-63.9%
F	59.9%-0%

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Mathematics 4045: Fall 2020

Instructor: Lawrence Smolinsky
382 Lockett Hall
Telephone: 578-1570
E-mail: smolinsk@math.lsu.edu
Office hours: TBA

TA: TBA

MATH 4045 Long-term Actuarial Mathematics I (3) Prereq.: MATH 2085, MATH 3050, and MATH 3355. Survival models and their estimation. Distribution of the time-to-death random variable and its significance for insurance and annuity functions, net premiums, and reserves.

Class information.

Classroom: TBA
Meeting time: TBA

Work expectations. Math 4045 is a 3-credit hour class. Students are expected to spend *a minimum* of 9 hours per week on attending class, reading material, completing homework, and preparing for tests.

Text. *Actuarial Mathematics for Life Contingent Risks*, 2nd Edition, 2013, Dickson, D., Hardy, M., and Waters, H., Cambridge University Press, ISBN: 978-1-10704-407-4.

Calculators. Students may only use Society of Actuaries approved calculators for this course: BA-35, BA II Plus, or BA II Plus Professional Edition, TI-30X, TI-30Xa, TI-30Xs, or TI-30X II. You may use both one of the BA series and TI-30 series on a test. No other calculators will be allowed during tests, quizzes, or the final exam.

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Outline of the course. MATH 4045 and MATH 4046 cover the material for the actuarial exam given by the Society of Actuaries as Exam LTAM (Long-term actuarial mathematics). MATH 4045 will cover approximately the first 275 pages of Dickson et al.

Week	Topics
1	Life insurance and annuity contracts
2	Other insurance contracts
3	Survival models: future lifetime and other random variables
4	Curtate future lifetime, K_x , e_x , \dot{e}
5	Survival models: force of mortality
6	Life tables and selection: Fractional ages, force of mortality
7	Life tables and selection: select and ultimate models, mortality trends
8	Insurance benefits: Introduction and assumptions, valuation of insurance benefits
9	Insurance benefits: Valuation of insurance benefits
10	Insurance benefits: Uniform distributions of deaths, variable benefits, select lives
11	Annuities: Contingent annuities
12	Annuities: Continuous, 1/m-ly, deferred, and other variations
13	Premium calculation
14	Policy values
15	Final exam week

Grade computation.

Item	Provisional Date	Grade contribution
Test 1	Wednesday TBA	17%
Test 2	Wednesday TBA	17%
Test 3	Wednesday TBA	17%
Final Exam	TBA	25%
Homework	Various dates	24%

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A	94%-96.9%
A-	90%-93.9%
B+	87%-89.9%
B	84%-86.9%
B-	80%-83.9%
C+	77%-79.9%
C	74%-76.9%
C-	70%-73.9%
D+	67%-69.9%
D	64%-66.9%
D-	60%-63.9%
F	59.9% and 0%

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Mathematics 4046: Spring 2021

Instructor: Lawrence Smolinsky
382 Lockett Hall
Telephone: 578-1570
E-mail: smolinsk@math.lsu.edu
Office hours: TBA

TA: TBA

MATH 4046 Long-term Actuarial Mathematics II (3) Prereq.: MATH 4045 and one of MATH 4056, EXST 3201, or EXST 4050. Parametric survival models with multiple-life states; life insurance and annuity premium calculations; reserving and profit measures; participating insurances, pension plans, and retirement benefits.

Class information.

Classroom: TBA
Meeting time: TBA

Work expectations. Math 4046 is a 3-credit hour class. Students are expected to spend *a minimum* of 9 hours per week on attending class, reading material, completing homework, and preparing for tests.

Texts.

- *Actuarial Mathematics for Life Contingent Risks*, 2nd Edition, 2013, Dickson, D., Hardy, M., and Waters, H., Cambridge University Press, ISBN: 978-1-10704-407-4.

The following study notes may be downloaded for free from the Society of Actuaries at <https://www.soa.org/education/exam-req/edu-exam-ltam-detail.aspx> under *syllabus and study materials*.

- LTAM-21-18 Supplementary Note on Long Term Actuarial Mathematics. The entire note is required reading.
- LTAM-22-18 Chapters 10-12 from *Loss Models, From Data to Decisions*, 5th edition, 2018 by Klugman, Panjer, and Willmot. Chapters 10 and 11 are provided for background reading. Chapter 12 is required reading, except for Sections 12.4 and 12.6.
- Notation and Terminology used on Exam LTAM.

Calculators. Students may only use Society of Actuaries approved calculators for this course: BA-35, BA II Plus, or BA II Plus Professional Edition, TI-30X, TI-30Xa, TI-30Xs, or TI-30X II. You may use both one of the BA series and TI-30 series on a test. No other calculators will be allowed during tests, quizzes, or the final exam.

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Outline of the course. MATH 4045 and MATH 4046 cover the material for the actuarial exam given by the Society of Actuaries as Exam LTAM (Long-term actuarial mathematics). MATH 4046 is a continuation of MATH 4045. The course covers approximately 215 pages of Dickson et al., the 78 page *Supplementary Note on Long Term Actuarial Mathematics*, and two chapters of *Loss Models*.

Week	Topics
1	Multiple state models: Through Thiele's differential equation
2	Multiple state models: Including Markov multiple state models
3	Joint life and last survivor distributions
4	Models with independent future lifetimes and dependent future lifetimes.
5	Pension mathematics
6	Valuation of benefits
7	Emerging costs for traditional insurance
8	Profit testing principles and measures
9	Multiple state models for long term health and disability insurance
10	Recursions for policy values with multiple states
11	Mortality improvement modelling
12	Some mathematical statistics
13	Maximum likelihood estimation
14	Estimation based on empirical data
15	Final exam week

Grade computation.

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Test 2	Wednesday TBA	17%
Test 3	Wednesday TBA	17%
Final Exam	TBA	25%
Homework	Various dates	24%

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D+	67%-69.9%
D	64%-66.9%
D-	60%-63.9%
F	59.9% and 0%

The instructor reserves the right to curve the score of graded items. Hence the grading above scale is a guaranteed minimum grade.

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EXST4142: Introduction to R and Statistical Data Mining

Instructor: Dr. Bin Li
Office: Office: Rm 173 Woodin Hall, LSU
Contact info: Telephone: 578-1343; Email: bli@lsu.edu

Recommended Textbooks: *An Introduction to Statistical Learning with Applications in R*, James, G., Witten, D., Hastie, T., and Tibshirani, R., (1st Ed.), Springer.
The Elements of Statistical Learning - Data Mining, Inference and Prediction, Hastie, T., Tibshirani, R., and Friedman, J. (2nd Ed.), Springer.
Extending the Linear Model with R: Generalized Linear, Mixed Effects and Nonparametric Regression Models, Faraway, J.J. (2nd Ed.), Chapman and Hall/CRC.

Required Handouts: The handouts can be purchased in LSU Barnes & Noble Bookstore. The address is 2 Union Square, Baton Rouge, LA 70803. The telephone number is (225) 578-51370.

Course Description: Introduction to R and advanced statistics for data mining, machine learning, and predictive analytics; topics include shrinkage methods in linear models; generalized linear models; cross-validation; decision trees; bagging and random forest; principal components analysis, cluster analysis and association rules mining.

Prerequisites: MATH 2085 or MATH 2090, EXST 3201, and MATH 4056 or EXST 4050.

15-week Course Outline:

Week 1 Introduction to R, data objects and manipulation in R
Week 2 Graphic tool, data import/export, loops and functions in R
Week 3 Basic inference and linear regression in R
Week 4 Generalized linear models (GLM), GLM in R
Week 5 Introduction to statistical data mining
Week 6 Cross-validation, model assessment and selection
Week 7 Regularized linear regression, classification and regression tree (CART)
Week 8 CART, ensemble methods: bagging
Week 9 Ensemble methods: random forest, case study of statistical data mining
Week 10 Group project presentation
Week 11 Artificial neural networks
Week 12 Cluster analysis
Week 13 Principal component analysis
Week 14 Association rule mining, case study of statistical data mining
Week 15 Individual project presentation

Computing: The lecture examples will be illustrated in R. No restrictions on softwares used in projects.

Grade: LSU letter grades will be assigned according to the following table. Your end of semester numerical grades will be rounded up to whole number.

A+	98-100
A	94-97
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	71-76
C-	68-70
D+	65-67
D	62-64
D-	58-61
D-	58-61
F	57 and below

Final grades will be computed from the following activities:

Homework	40%
One team project presentation	20%
Final exam (cumulative)	20%
Final individual project	20%.

Description of Activities that will be graded:

Homework A homework will be assigned every one or two weeks, and will be collected at the next week. The homework grade is calculated as an average of the individual percent grades.

Final Exam A comprehensive final exam will be taken at the date and time published in the LSU Final Exam schedule. the exam grade will be calculated as a percentage.

Team project The team project will be assigned to at Week 7 and will be presented in Week 11. Each team has 3-4 students. The team project will be calculated as a percentage. the rubrics of the team project is attached.

Final project The final project will be assigned to at Week 12 and will be presented in Week 15. Each student will work independently on the project. The final project will be calculated as a percentage. the rubrics of the final project is attached.

Expectations

EXST 4142 is a 3-credit hour class. Students are expected to spend a minimum of 9 hours per week on attending class, reading material, completing homework, working on the projects, and preparing for test. Contemporary statistical methodology explores various ways of estimating functional dependencies between a response variable and possibly a large set of features, when one is trying to find and understand the unknown underlying mechanism within the realm of noisy and/or complex data. Modern regression and pattern recognition analyses fall in this framework. The aim of the course is to provide an overview of modern statistical data mining and machine learning in regression and pattern recognition problems such as regularized linear regression and classification methods, tree-based methods, neural networks, principal component analysis and cluster analysis. The emphasis will be on the conceptual understanding of the methods and the ability to apply the underlying models and algorithms in practice.

Academic Integrity

The LSU student code of conduct explains student rights, excused absences, and what is expected of student behavior. Students are expected to understand this code as described at: <http://students.lsu.edu/saa/students/code>. Students are required to abide by the LSU Student Code of Conduct. Any violations of the LSU student code will be duly reported to the Dean of Students. Students may not use cell phones, apple watches, or any other electronic devices in an exam unless approved by the instructor prior to the exam.

Disability Statement

Louisiana State University is committed to providing reasonable accommodations for all persons with disabilities. If you have a disability that may affect your work in this class and for which you may require accommodations, please see a staff member in Disability Services so that such accommodations can be considered. Students who receive accommodation letters should meet with me to discuss the provisions of those accommodations as soon as possible.