Course Outline

Course Number | Course Title | Credits
---------------|--------------|--------
MAT201         | Probability and Statistics for Science and Engineering | 4

Hours: Lecture/Lab/Other | Co- or Pre-requisite | Implementation sem/year
4 Lecture | MAT151 or MAT149 with a minimum of C grade | Fall 2012

Catalog Description (2014-2015 Catalog):
Calculus-based course designed for engineers, computer scientists and science majors. Topics include one variable data analysis, sample regression and correlation, probability, discrete and continuous distributions, random samples, confidence intervals and hypothesis testing, contingency tables, as well as one factor and factorial experimental design.

Is the course New, Revised or Modified? Modified Fall 2014

Required texts/other materials


2. Calculator: A graphing calculator such as the TI-84 is required. No calculator with a symbolic manipulator is allowed.

Revision date: Fall 2014
Course coordinator: Leslie Grunes (609) 570-3865 grunesl@mccc.edu

Information resources:

- The library has many books, CDs and videos available.
- The Library Computer Lab has Internet access and MINITAB installed for student use.
- The Learning Center has tutoring and help available to the students.
Course-specific General Education Knowledge Goals and Core Skills:

MCCC Core Skills:

- **Goal A. Written and Oral Communication in English.** Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
- **Goal B. Critical Thinking and Problem-solving.** Students will use critical thinking and problem solving skills in analyzing information.
- **Goal E. Computer Literacy.** Students will use computers to access, analyze or present information, solve problems and communicate with others.

General Education Knowledge/Goals

- **Goal 1. Communication.** Students will communicate effectively in both speech and writing.
- **Goal 2. Mathematics.** Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
- **Goal 4. Technology.** Students will use computer systems or other appropriate forms of technology to achieve personal and educational goals.

In the following Course-Specific Competencies/Goals, **MCCC Core Skills** will be denoted MCS and **General Education Knowledge/Goals** will be denoted GE.

Course-Specific Competencies/Goals:

The student will be able to:

1. analyze in-depth one variable data using appropriate techniques on an individualized student data set. (MCS A,B; MGE 1,2)
2. analyze in-depth bivariate data analysis using appropriate techniques stressing regression and correlation techniques on a personally chosen data set. ((MCS A,B; MGE 1,2)
3. calculate probability of an event. (MCS A,B; MGE 1,2)
4. calculate probability, mean and standard deviation for discrete and continuous distributions. (MCS A,B,E; MGE 1,2,4)
5. calculate probability, mean, and standard deviation for the following specific discrete distributions: Binomial and Poisson. (MCS A,B,E; GE 1,2,4)
6. calculate probability, mean, and standard deviation for the following specific continuous distributions: Normal, Uniform, Exponential and LogNormal. (MCS A,B,E; GE 1,2,4)
7. use technology to draw a random sample for any of the population distribution and calculate statistics. (MCS A,B,E; GE 1,2,4)
8. create and interpret probability plots to determine if the random sample comes from a specific population distribution. (MCS A,B,E; GE 1,2,4)

9. calculate interval estimation for a single random sample, two independent random samples, match pairs for quantitative data or binomial categorical data. (MCS A,B; GE 1,2)

10. perform and interpret the results of hypothesis testing for a single random sample, for two independent random samples; and on matched pairs for quantitative data or binomial categorical data. (MCS A,B; GE 1,2)

11. perform and interpret the results of hypothesis testing on categorical data using contingency tables. (MCS A,B; GE 1,2)

12. perform and interpret the results of a one factor, or factorial, experimental design. (MCS A,B,E; GE 1,2,4)

13. use appropriate technology to create and interpret statistical analyses. (MCS A,B,E; GE 1,2,4)

Course-Level Student Learning Outcomes

In the following course-level student learning outcomes, Course-Specific Competencies/Goals will be denoted as CG.

Unit I: One variable data analysis

(1.5 weeks)

The student will be able to:

1. recognize and distinguish between a quantitative variable or categorical variable for analysis. (CG1)
2. input a data set into a MINITAB worksheet or use an already existing MINITAB data set. The student will choose one quantitative variable and one categorical variable for analysis. (CG 1)
3. use MINITAB to graph (Categorical Variable) pie chart, bar chart, dot plot and (Quantitative Variable) stem-and-leaf, histogram, box plot, and side by side box plot and calculate descriptive statistics for quantitative variable for all observations and for each value of categorical variable. (CG 1,13)
4. define and calculate descriptive statistics. (CG 1,13)
5. determine and find the positions such as quartiles and percentiles given a data value or find the data value given the position. (CG 1)
6. recognize various distributional shapes. (skew to right, skew to left, symmetric or uniform) (CG 4,5,6,13)
7. calculate intervals for mild or extreme outliers. (CG 1)
8. analyze the chosen quantitative variable and categorical variable. (CG 1,4,13)
Unit II: Sample Regression and Correlation (1.5 week)

The student will be able to:

1. use MINITAB to graph a scatter plot, graph the regression line, and graph residual plots for two quantitative variables and calculate statistics for an individual data set of pairs of observations. (CG 2,7,13)
2. define, explain verbally and in written form, and find for a given sample the following:
   a. causation;
   b. sources of variation (sum of squares);
   c. coefficient of determination R^2;
   d. extrapolation;
   e. desirable residual plot;
   f. outliers; and
   g. influential observations. (CG 2, 7)
3. calculate the coefficients of the least squares equation. (CG 2,13)
4. define, by explaining verbally and in written form its purpose, and calculate for a given sample the correlation coefficient, r, which indicates association. (CG 2)

Unit III: Probability (3 weeks)

The student will be able to:

1. calculate probability of an event. (CG 3)
2. calculate the conditional probability of an event. (CG 3)
3. determine if two events are independent. (CG 3,4)
4. calculate the probability that a system in series or parallel is functioning. (CG 3)
5. calculate the probability, cumulative distribution mean, and standard deviation given a probability mass function (pmf) for a discrete distribution. (CG 3,4,13)
6. calculate the probability, cumulative distribution, mean, and standard deviation given a probability density function (pdf) for a continuous distribution. (CG 3,5,13)
7. calculate mean and standard deviation for a linear combination of independent random variables. (CG 5,6,13)

Unit IV: Population Distributions (2.5 weeks)

The student will be able to:

1. calculate the probability of X successes, the mean, and standard deviation from the formula when given a binomial population with the sample size, n, and probability of success, p. (CG 4,5)
2. determine the probability of exactly x successes or the x successes or less using the TI84 when given a binomial population with the sample size, n, and probability of success, p. (CG 4,5,13)
3. calculate the probability of the number of successes from simulation of drawing many runs from a binomial distribution (n,p). (CG 4,5,7,13)
4. calculate the probability of the number of occurrences using the Poisson formula or TI84 when given the intensity, \( \lambda \). (CG 4,5,13)
5. calculate the probability of the number of occurrences or less using a TI84 when given the intensity, \( \lambda \). (CG 4,5,13)
6. determine the \( z \)-score by formula before using a TI84 to find probability when given a normal distribution with parameters of mean, \( \mu \), and standard deviation, \( \sigma \). (CG 4,6,13)
7. determine the \( z \)-score by formula before using a TI84 to find probability to find the mean when given a normal distribution and percentile. (CG 4,6,13)
8. calculate the \( z \)-score before finding the probability when given a large sample, \( np > 10 \). (CG 4,6)
9. determine probability given an exponential distribution with parameter \( \lambda \) and \( X \)-interval using MINITAB. (CG 4,6,13)
10. determine the mean given percentile using MINITAB. (CG 4,6,13)
11. calculate probability by finding \( Z \) interval of \( \ln(Y) \) given a lognormal distribution with parameters of mean and standard deviation. (CG 4,6)
12. calculate percentile by applying formula \( \ln(Y) = \mu + Z \sigma \). (CG 4,6)

Unit V: Random Samples

The student should be able to:

1. create a probability plot from a random sample of a distribution. (CG 8,13)
2. compare the sample percentiles with the population percentiles. (CG 8,13)
3. state the Central Limit Theorem. (CG 7,8)
4. calculate the mean at least 1000 times having drawn a large random sample from an arbitrary population with mean and standard deviation. (CG 7,8,13)
5. demonstrate that the distribution of sample means is approximately normal. (CG 7,8,13)

Unit VI: Inferences

1. explain the properties of and determine the best point estimator. (CG 9)
2. calculate the confidence level. (CG 9,13)
3. determine the margin of error and the intervals with interpretation for various quantitative data and categorical data. (CG 9,13)
4. calculate the Prediction and Tolerance Intervals for a random sample from a normal population. (CG 9,13)
5. perform a test of a hypothesis and interpret the results of the test. (CG 10,11,13)
6. determine the mean for a single sample from a continuous population using \( Z \) or \( t \) test. (CG 10)
7. determine the means for 2 independent samples from continuous populations. (CG 10)
8. determine matched pairs for the distributions. (CG 10)
9. calculate proportion, \( p \), for a single sample from a binomial population. (CG 10)
10. calculate proportions, \( p_1, p_2 \), from 2 independent binomial populations. (CG 10)
11. apply the Chi-square test to find the variance for a single sample from a normal population. (CG 11,13)
12. apply the F test to determine the variances from 2 independent samples from normal populations. (CG 11,13)
13. perform and interpret the results of hypothesis testing using Chi-square to categorical data. (CG 11,13)
14. identify the populations under consideration and how the random samples are drawn. (CG 10,11)

**Unit 7: Experimental Design** (2.5 weeks)

The student will be able to:

1. identify the response variable, the factor(s), randomization, and treatment levels for an experimental design. (CG12)
2. state the hypothesis with conclusion for a one factor design. (CG12)
3. draw graphs for each treatment level. (CG12,13)
4. construct Analysis of Variance table by hand. (CG12)
5. perform the Tukey’s Multiple Comparison Test to determine which means are different. (CG12,13)

**Evaluation of Student Learning:**

Students will receive regular feedback on their work through assignments, quizzes, tests, and possibly projects. Each instructor will provide the students with a syllabus which should describe dates of tests, homework assignments to be done, projects if required and due dates. There are three tests, some written papers and some group work that will be graded and used in determining the students final grade. A possible plan for determining the students’ final grades is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Tests</td>
<td>60%</td>
</tr>
<tr>
<td>Group Projects</td>
<td>20%</td>
</tr>
<tr>
<td>Written Papers</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Statement of Academic Integrity:**

Under no circumstance should students knowingly represent the work of another as one’s own. Students may not use any unauthorized assistance to complete assignments or exams, including but not limited to cheat-sheets, cell phones, text messaging and copying from another student. Violations should be reported to the Academic Integrity Committee and will be penalized. Please refer to the Student Handbook for more details.