To: Mathematics and Statistics Teaching Faculty
From: Kent Pearce, Chair
Date: August 2009

This handbook describes the undergraduate and graduate programs offered by our department. It also contains syllabi, textbook information and course descriptions of our undergraduate and graduate mathematics courses.

University policy requires that during the first week of class each instructor provide every organized class with a syllabus, explaining how final course grades are to be determined and listing student outcomes and assessment procedures. A sample syllabus and examples of assessment practices and student learning outcomes are provided on pages 13-16 of this document. Student learning outcomes and assessment statements must be included in every syllabus. Please note the special statements that have been provided for the courses in the Mathematics Core Curriculum-M1300, M1320, M1420, M1321, M1330, M1430, M1331, M1351, M1352, M1550, M2300, M2345, M2350, M2360, M2370, and M2371. Suggestions for statements regarding ADA, student civility, illness and death notification, and absences due to religious observance are also provided. Please include the name of the course coordinator as indicated in the sample.

Please inform your classes about the "Missouri Club" that meets in Room 106. Early in the semester, you will receive a notice of the hours of operation.

Students need to be aware of class progress before the deadlines for dropping a class, declaring Pass/Fail or withdrawing from a class. You are requested to keep your students informed of their progress by administering examinations or quizzes prior to these deadlines.

Do not dismiss your classes to extend holidays and do not give hour exams in the last week of the semester. Unless you are prepared to deal with the issue of students working collaboratively together on outside-of-class projects and exams (in spite of instructions to the contrary), do not give take-home exams.

Final examinations must be given at the scheduled time. You should include information in your syllabus delineating the scheduled time for your final exam, especially if it is a common departmental final. If you teach a course which has a common departmental final, you will be assigned a course coordinator for that course. The course coordinator will be responsible for putting together the departmental examination and establishing the guidelines under which it is to be administered. Such guidelines usually include policy regarding calculators, formula sheets, or other aids. In such a course, you are expected to administer the common departmental final and to follow the guidelines established for it. It is highly recommended to follow the same guidelines for the in-semester tests/exams.

When you leave Texas Tech University permanently, you must turn in your Texas Tech University keys, grade books (or a copy), and a copy of all recent final exams.

Thank you for your professional and conscientious efforts in helping the department meet its teaching mission.

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Degrees Offered

The department offers five degrees. Undergraduate degree requirements are listed on pages 8 - 12, and graduate degree requirements are listed on pages 42- 46.

The Bachelor of Arts Degree: This degree provides traditional liberal arts training with a specialization in mathematics of at least 21 hours of upper level courses in mathematics (i.e., courses numbered 3000 or above).

The Bachelor of Science Degree: Placing greater emphasis on scientific training and requiring 27 hours of upper level courses in mathematics (i.e., courses numbered 3000 or above). This degree is particularly recommended to students intent upon graduate study.

The Departments of Mathematics and Statistics and Computer Science offer a Dual Degree Program: A five-year program leading to a B.S. in mathematics from the College of Arts and Sciences, and a B.S. in computer science from the College of Engineering.

Students electing any of the above degrees may also complete the requirements for certification as high school teachers.

The Master of Arts Degree in Mathematics: The program of study leading to the M.A. degree is designed for teachers of pre-university mathematics.

The Master of Science Degree in Mathematics: The M.S. program is designed to prepare students for one or more of the following areas: pre-college or junior college teaching, industrial employment, or further graduate study. A minimum of specific course requirements allows the student a great deal of freedom in his or her program of study and thereby fulfills the purpose of the program.

The Master of Science Degree in Mathematics with an emphasis in Computer Science: This degree calls for a balance of mathematics courses and computer courses designed for the student with little or no background in computer science.

Master of Science in Statistics: This program is a concentrated study in statistics.

Combined Bachelor's and Master's Degree Program in Mathematics: Undergraduate mathematics majors may apply for admission to the master's degree program during their junior year so that they can begin taking graduate courses during their senior year. This program can result in a BA/MA, BA/MS or BS/MS, depending on the needs of the student. The combined bachelor's and master's degrees in Mathematics differ only in the final two years; the first three years are the same as the standard Bachelor of Science in Mathematics program. See either the Graduate or Undergraduate Advisor for details.

The Ph.D. Degree: The principal goal of the Ph.D. program is to train research oriented mathematicians for college or university teaching, and for governmental and industrial employment. The student has the option of concentrating in one of five specialty areas: Algebra, Analysis, Applied Mathematics, Probability and Statistics, or Topology. Minimum course requirements have been established in each of these areas to ensure that the student obtains a broad based background in mathematics and, in addition, attains depth in his or her specialty area.

Entrance Credit

The Department of Mathematics and Statistics does not award credit on the basis of SAT or ACT (Aptitude) scores. However, credit is available in certain courses through the CEEB Advanced Placement Program and the CEEB College Level Examination Program (CLEP). For example, credit in Math 1351 can be achieved by a score of 4 or better on an AP Calculus Exam. Entrance credit is awarded by the Admissions Office at the time of admission. Please refer to www.depts.ttu.edu/testing/uce.php for a complete list of scores accepted.

Students who do not present scores of the appropriate tests at the time of admission are not eligible for entrance credit but may elect credit by examination.

In the CLEP program, a list of the tests, passing scores, and course equivalents is as follows:

Clep Test	**Passing Score**	**TTU Course Equivalent**
College Algebra	52 And Above	Math 1320
Precalculus	50 And Above	Math 1550
Introductory Calculus	50-55	Math 1351
Introductory Calculus	56 And Above	Math 1351, 1352

In the CEEB Advanced Placement (AP) Program the following table is to be consulted:

AP

Score	**TTU Course Equivalent**
0, 1, 2, or 3	None
4 on Calculus AB	Math 1351
4 on Calculus BC	Math 1351, 1352
4 on Statistics	Math 2300

In the International Baccalaureate (IB) the following table is to be consulted:

IB

Score	**TTU Course Equivalent**
0, 1, 2, or 3	None
4, 5, 6, 7 on Math Studies SL	Math 1320
4, 5 on Math SL	Math 1550
6, 7 on Math SL	Math 1351
4 on Math HL	Math 1550
5, 6, or 7 on Math HL	Math 1351

Mathematics Placement Examination

University policy states that to be admitted to an entry-level mathematics course (0301-1351, 1420-2345), a student must meet one of the following prerequisites:

1. Students who have a sufficient high SAT Mathematics score (610 [660 for M1351] or higher) or ACT Mathematics score (26 [29 for M1351] or higher) may enroll in any of the entry-level courses.

2. Students who have collegiate credit for the appropriate prerequisite course from an accredited community college, junior college or university may enroll in the sequelled entry-level mathematics course.

3. Students who satisfactorily pass the Mathematics Placement Examination may enroll in the appropriate entry-level mathematics course.

For many students, achieving a satisfactory score on the Mathematics Placement Examination is the most direct and effective way to satisfy one of these prerequisites. The placement examination has one goal: **to place the student in the course which best matches the student's university major and the student's skill level.** The examination directs the student (i) to the course he or she wishes to take or (ii) to a course which develops the necessary prerequisite skills for the desired courses.

Initial Administration

Students matriculating to the university in a Fall semester are typically expected to take the on-line Mathematics Placement Examination prior to attending their summer new student orientation. The examination may be taken on-line twice.

Students matriculating to the university in a Spring semester (or a Summer term) are expected to take the placement examination during the week of open registration prior to the start of the semester (or during the day of open registration prior to the start of the term).

Subsequent Administrations

Students whose placement score (from the on-line administration of the Mathematics Placement Exam) do not match their expectations may retake the mathematics placement examination during the period of open registration prior to the beginning of each semester or term. The retakes of the placement examinations will be administered by a proctor from the Department of Mathematics. Students desiring to retake the placement examination should check the examination schedule
http://corpus.math.ttu.edu/cgi-bin/calweb/calweb.exe?cal=Mathematics_Placement_Examination
or contact the receptionist in Room 201 of the Mathematics Building.

Prerequisite Courses for Undergraduate Mathematics Courses at Texas Tech University

0301	None	0302	Code 2 or higher on the math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH 0301 or TSI 0202 or a grade of D or better in MATH or TSI 0302 or a grade of D or better in a college level mathematics course
1300	Code 3 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH or TSI 0302 or a grade of C of better in a college level mathematics course		
1320	Code 3 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH or TSI 0302 or a grade of C of better in a college level mathematics course	1321	Code 4 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of C of better in MATH 1320 or MATH 1420
1330	Code 3 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH or TSI 0302 or a grade of C of better in a college level mathematics course	1331	Code 4 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of C of better in MATH 1330 or MATH 1430
1351	Code 7 on the math placement exam or a or a score of at least 660 on the SATM or a score of at least 29 on the ACTM or a grade of a C or better in [MATH 1321 and Code 5 on the math placement exam] or MATH 1550 or MATH 1350	1352	1351 or consent of department
1420	Code 2 or higher on the math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH 0301 or TSI 0202 or a grade of D or better in MATH or TSI 0302 or a grade of D or better in a college level mathematics course	1430	Code 2 or higher on the math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of A or B in MATH 0301 or TSI 0202 or a grade of D or better in MATH or TSI 0302 or a grade of D or better in a college level mathematics course
1550	Code 3 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on SATM or a grade of an A in MATH or TSI 0302 or a grade of a C or better in college level mathematics course		
2300	Code 4 or higher on the math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of a C or better in a college level math course	2345	Code 4 or higher on math placement exam or a score of at least 610 on the SATM or a score of at least 26 on the ACTM or a grade of a C or better in MATH 1330 or MATH 1430
2350	1352 or consent of department	2356	1351 or 1331
2360	2350 or concurrent with 2350 or consent of department		
2370	Major of (EC or MDS) and 1320 or consent of department	2371	Major of (EC or MDS) and 1320 or consent of department
3310	2350 or consent of department		
3322	1352 or consent of department	3342	2350 or consent of department
3350	2350 or consent of department	3351	3350 or 3354 or consent of department
3354	2350 and 2360 or consent of department	3360	2360 and 3310 or consent of department
3370	2370 or consent of department	3371	1331 or 1351 or 2370 or consent of department
3372	2371 or consent of department		
3430	2350 and 2360 and consent of department	4000	consent of instructor and department
4310	3350 or 3354 or consent of department	4312	2360 or consent of department
4330	consent of instructor and department	4331	2350 and 3310 or consent of department
4342	2350 or consent of department	4343	4342 or consent of department
4350	2350 and 2360 and 3310 or consent of department	4351	4350 or consent of department
4354	3350 or 3354 or consent of department	4356	4350 or concurrent or consent of department
4360	3360 or consent of department	4362	3310 or consent of department
4370	3370 or consent of department	4371	2371 or 3371 or consent of the department

Updated: August 20, 2009

Scholarships, Awards, and Financial Support

The Mathematics and Statistics Department at Texas Tech University is fortunate to have several scholarship funds established in memory of past members of the department, in honor of current faculty and former faculty, and donors. The amount available varies, but has been averaging approximately $70,000 per year for undergraduates and $12,500 per year for graduates, with awards based on merit and/or financial need, as specified by the donor.

SCHOLARSHIPS FOR MATHEMATICS MAJORS

Scholarship Name	Eligible Students
Ronald Anderson	Graduate
H. Earl and Countess Fore Archer	Undergraduate
George Baldwin	Undergraduate
Ben Duran	Graduate
Gordon Fuller	Graduate
Rick & Sherrie Hale	Undergraduate
Emmett Hazlewood	Undergraduate
E. Richard Heineman	Freshmen
Mildred and Lonnie Langston	Undergraduate
Robert A. Moreland	Undergraduate
Morrison-Broughton	Undergraduate
Patrick Odell	Graduate
Herman Reynolds	Graduate
“dub” Rushing Family	Undergraduate
SIAM	Graduate
Monty J. Strauss	Undergraduate
Tarwater Family	Undergraduate
Ralph Underwood	Undergraduate
John T. White	Graduate

Undergraduate scholarships are administered in the department by the Scholarship Committee under the direction of Professor Monty J. Strauss. The standard university applications should be used in applying for undergraduate awards and are due by February 1. Students who apply for scholarships will be considered for all scholarships for which they are eligible and do not need to specify for which ones they wish to be considered.

In addition to the above scholarships there are two scholarship funds for the training of mathematics teachers. One is a scholarship established by Professor Derald Walling and the other was established in memory of Professor Paul Thompson.

Graduates should contact the director of graduate programs, Dr. Alex Wang, for information about applying for graduate scholarships.

SCHOLARSHIPS FOR MATHEMATICS TEACHERS

Scholarship Name	Eligible Students
Paul Thompson	Elementary Specialist
Derald Walling	Secondary

Professor Ali R. Amir-Moez has established a fund to award undergraduates for research projects.

UNDERGRADUATE RESEARCH AWARDS

Award Name	Eligible Students
A. Amir-Moez	Undergraduate

Undergraduate Degree Programs

The Director of Undergraduate Studies or Departmental Undergraduate Advisor will sign all undergraduate degree plans and certification plans. A student may opt to remain under the catalog rules which were in effect when the student initially registered. A student must have a grade of C or better for each mathematics course counted toward a major, a minor, or certification (elementary or secondary).

Students are expected to develop a degree plan upon completing 60 hours of coursework. Forms and information for developing a degree plan in mathematics are available from the Director of Undergraduate Studies or the Departmental Undergraduate Advisor in the Department of Mathematics and Statistics. The degree plan must be approved by the Director of Undergraduate Studies or the Departmental Undergraduate Advisor.

Detailed information, listed by catalog year, can be found at
http://www.depts.ttu.edu/artsandsciences/students/undergraduate/.

Mathematics Major Degree Requirements: Bachelor of Arts (B.A.)
The curriculum established for this degree is designed to provide the foundation of a liberal education through a well-rounded study of the humanities and fine arts, mathematics, and the physical, biological, and social sciences. It also provides the factual basis and the insights requisite for specialized study and professional work in these fields.

***General Degree Requirements (For a B.A. in Mathematics):**
(See the section on Undergraduate Credit by Examination for information on credit provided by test scores for these requirements.) Students must take the specified number of hours in these areas. Courses from the major and minor may be used to satisfy these requirements, but courses used to fulfill specific requirements may not be used to satisfy distribution requirement. A course may not be counted in two areas.

1. English	12 hours
2. Oral Communication	3 hours
3. Foreign Language	6-11 hours
4. Natural Science	8-11 hours
5. Technology and Applied Science	3 hours
6. Social and Behavioral Sciences	6 hours
7. American History	6 hours
8. Political Science	6 hours
9. Humanities	6 hours
10. Fine Arts	6 hours
11. Personal Fitness and Wellness	2 hours
12. Multicultural Requirement	3 hours

Major, Minor and Electives (for the B.A. in Mathematics):
Major: Twenty-one semester hours of upper level courses in mathematics are required. The following courses are required: Calculus through 2350, 2360, 3310, 3354, 3360, 4350, and one of the four courses 4343, 4351, 4354, 4360. In addition a minimum of six semester hours (not used above) must be taken from the following list: 3342, 3430, 4310, 4312, 4330, 4331, 4342, 4343, 4351, 4354, 4356, 4360, 4362, 4000.

Minor: A minimum of eighteen semester hours is required, six of which must be advanced. The minor is subject to the requirements of and must be approved by the minor department.

Elective courses: Additional courses, sufficient to bring the total to 120 semester hours, must be taken.

For the Bachelor of Arts degree, *a minimum of 40 semester hours of junior and senior work must be presented*; not more than 42 semester hours in one subject may be counted; not more than 8 hours may be counted in applied music and/or music ensemble except for students offering music as a major or minor; not more than 6 hours in P.E. activity courses may be counted as electives; not more than 24 hours in the technical or professional subjects or agriculture, business administration, engineering, and/or home economics may be counted as electives.

Mathematics Major Degree Requirements: Bachelor of Science (B.S.)

The B.S. degree permits a greater degree of specialization than that afforded by the B.A. degree. The following are the requirements for this degree. The descriptions of the requirements are the same as for the Bachelor of Arts degree (see pages 8 and 9).

1. English	12 hours
2. Oral Communication	3 hours
3. Foreign Language	6-16 hours
4. Political Science	6 hours
5. American History	6 hours
6. Natural Science	8 hours
7. Technology and Applied Science	3 hours
8. Social and Behavioral Sciences	3 hours
9. Humanities	3 hours
May be satisfied with the 12-hour English requirement.	
10. Fine Arts	3 hours
11. Personal Fitness and Wellness	2 hours
12. Multicultural Requirement	3 hours

Major, Minor, Adjunct Requirements and Electives (for the B.S. in Mathematics):

Major: Twenty-seven semester hours of upper level courses in mathematics are required. The mathematics requirements are identical with those for the B.A. degree except that two additional advanced mathematics electives are required one of which must be from 4343, 4351, 4354, 4360. The mathematics electives may be selected from the same list as given for this purpose in the section for the B.A. degree.

Minor: Candidates for the B.S. degree must choose their minor from the following: actuarial science, agricultural engineering, atmospheric science, biology, botany, chemistry, chemical engineering, civil engineering, computer science, economics, electrical engineering, exercise and sport sciences, geosciences, industrial engineering, mechanical engineering, microbiology, petroleum engineering, physics, or zoology. A minor must include 18 semester hours, 6 of which must be advanced. In particular, an engineering minor must consist of 18 semester hours in only one department. Courses counted for the minor must be approved by the minor department.

Adjunct Requirements (a special requirement by the Department of Mathematics and Statistics): Candidates for the B.S. degree must complete 8 hours of laboratory science (biology, botany, chemistry, geosciences, microbiology, physical geography, physics, or zoology) outside their minor area.

Participants in the Dual Degree Program must follow a fairly rigid program, and should consult with the directors of the undergraduate programs in both Mathematics and Computer Science as early as possible. They must also be accepted into the College of Engineering.

Electives: Additional courses must be taken which, together with the above, are sufficient to total to 126 semester hours.

The inventory of courses which can be used to fulfill various requirements changes every year, with some courses deleted and others added. Students should consult a recent Catalog, or the Director of Undergraduate Studies if they have any questions about a particular course and the general degree requirements.

Accelerated Bachelors-to-Masters

Undergraduate mathematics majors may apply for admission to the master's degree program during their junior year so they can begin taking graduate courses during their senior year. This program can result in a B.A./M.A., B.A./M.S., or B.S./M.S. depending on the needs of the student. The combined bachelor's and master's degree in mathematics differs only in the final two years; the first three years are the same as the standard B.S. in mathematics program. See either the graduate or undergraduate advisor for details.

Minor in Mathematics

A minor in mathematics for most students consists of the following:

1. MATH 1351 and 1352 and 2350
2. MATH 2360 or 3351
3. Six semester hours of mathematics at the junior-senior level, subject to approval by the Director of Undergraduate Programs, selected from the following list: 3430, 3350 or 3354 (credit may not be received for both 3350 and 3354), 4354, 3360, 4310, 4312, 4330, 4331, 4342, 4343, 4350, 4351, 4356, 4360, 4362, 4300. For Economics B.S. students, the recommended upper division courses are MATH 3354 and 4350.

For the minor and major in mathematics at least one half of the upper level mathematics courses must be taken in the Department of Mathematics and Statistics at Texas Tech University. This residency requirement will be waived by the department only in very exceptional circumstances.

Minor in Actuarial Sciences

This training for an actuary requires one to pass a series of established (society) exams, leading to the two major milestones of: *Associateship* (at least 5 exams), and *Fellowship* (several more exams). For life, health, and pension actuaries, exams are given by the Society of Actuaries (SOA). For property and casualty actuaries, the exams are administered by the Casualty Actuarial Society (CAS). Candidates will need to specialize their training early on in their career path, either SOA or CAS. In order to secure an entry-level position, a candidate is currently expected to have passed at least one of the *preliminary exams*, as well as have acquired validation through education experience *(VEE) credits* in 3 areas (required by SOA). The exams are offered at appropriate times (twice each year in the Spring and Fall) and locations (most major cities and college campuses). The VEE credits can be acquired by taking appropriate college courses.

Preliminary exams (CAS/SOA):

- 1/P (Probability)
- 2/FM (Mathematics of Finance)
- 3F-3L/MFE-MLC (Actuarial Modeling)
- 4/C (Construction and Evaluation of Actuarial Models)

VEE credits (required by SOA):

- Applied Statistical Methods
- Corporate Finance
- Economics

CAS exams 1,2, and 4 are the same as SOA exams P, FM, and C, respectively. But CAS exam 3F-3L does not correspond exactly to SOA exam MFE-MLC, so at this point the candidate may already have to choose a specialty, either SOA or CAS.

TTU offers a minor in *actuarial science*, administered by the Mathematics & Statistics Department and advised by Dr. Alex Trindade. The minor requirements can be satisfied by taking any 6 courses from the following list (boldface courses are required; ECO 2301 and AAEC 2305 cannot both be counted):

- MATH: **2356** (prereq=1351 or 1331); **4342** (prereq=2350); 4343 (prereq=4342)
- ECO: 2301 (or AAEC 2305); 2302 (prereq=2301)
- FIN: 3320 (prereq=ACCT 2300-2301, ECO 2301-2302, MATH 2345); 3322 (prereq=3320); 4329 (prereq=3320, 3323)

Notes. ECO 2301 and AAEC 2305 cannot both be counted. The ACCT 2300-2301 prerequisite for FIN 3320 is waived for MATH majors. Keep in mind that any given course cannot simultaneously be counted toward the major and the minor (i.e. there must be no overlap between the major and minor lists of courses).

As an example, a typical MATH major, after picking up all the necessary prerequisites, might satisfy the minor by taking the following (not necessarily in this order): ECO 2301, ECO 2302, MATH 2356, FIN 3320, FIN 3322, MATH 4342.

In order to fit the minor into your graduation plan, note/check carefully the prerequisites for each course, and when these courses are offered. MATH 2356 (Quantitative Theory of Interest) is a new course that will be offered for the first time in Spring 2010. Students should plan to take all of these courses, since:

- MATH 4342 covers the syllabus for Exam 1/P
- MATH 2356 & FIN 4329 cover the syllabus for Exam 2/FM
- FIN 3320 & FIN 3322 satisfy the VEE credit in Corporate Finance
- ECO 3311 & ECO 3312 satisfy the VEE credit in Economics (AAEC 3315 can be substituted for ECO 3312)
- MATH 4343 prepares students for the graduate-level courses leading to the VEE in Applied Statistical Methods. This VEE basically consists of a *regression analysis* course and a *time series* course, and can be obtained in any of the following ways:
    - STAT 5371 (regression) & STAT 5379 (time series)
    - AAEC 5307 (regression) & AAEC 6311 (time series)
    - One can also pair a regression course like: STAT 5371, AAEC 4302, AAEC 5307, or ISQS 5349, with a time series course like: STAT 5379, or AAEC 6311.

To officially obtain VEE credit (in the eyes of SOA) for a given subject, the student may have to apply for it through SOA after taking the courses. (See SOA website for details.)

Selection of Elective Courses

The department recommends that the student select a junior-senior curriculum depending on whether the student plans to go to graduate school, enter the job market, or teach in public schools. The suggested course selections are as follows.

Graduate School

The following MATH courses are recommended for those planning to enter graduate school: 3310, 3430 and/or 4330, 4360, 4351, 4356, 4310, 4312, 4342, 4343, 4362.

Industrial or Applied Job Sector

The following courses are recommended: 3430 and/or 4330, 4310, 4312, 4342, 4343, 4354. In addition, it is recommended that the student learn the computer language C++.

Secondary Certification
The 24-hour mathematics requirements for certification to teach mathematics in secondary schools are as follows:
a) 1351, 1352, 2350, 2360, 3310, and 4331
b) One of 3430 or 4371
c) One of 2300, 3342, or 4342

For the 36-hour certification, the student selects an additional 12 hours of upper level courses.

A secondary certification with mathematics as a teaching field may be obtained through the College of Arts and Sciences by completing supplementary work in education courses and in another teaching field. Advisors in the department offering the second teaching field and in secondary education should be consulted concerning specific course requirements in those areas.

Middle School Certification
The courses offered in mathematics for students intending to prepare themselves to be middle school mathematics teachers are 1320, 2370, 2371, 3370, 3371, 3372, 4370, and 4371.

Generally all students seeking certification at the middle school level will enroll in the College of Education and as MDS majors. This program calls for a specialization in one subject area, referred to as the "academic specialization."

Course Rotation of Upper Division Courses
We will try to offer upper division courses according to the following schedule:

Fall Block:			**Spring Block:**		
3310	3322	3430	3310	3322	3342
3342	3350	3354	3350	3351	3354
3360	3370	3371	3360	3372	4330
4342	4350	4354	4331	4343	4351
4371			4360	4370	

Odd Fall:	Block + 4356	**Even Spring:**	Block + 4312
Even Fall:	Block + 4362	**Odd Spring:**	Block + 4310

Odd Summer:		**Even Summer:**	
session 1:	3310 3342 3350 3371 4331	**session 1:**	3310 3342 3350 3370
session 2:	3342 3350 3360 4350 4371	**session 2:**	3342 3350 3360 4350 4370

Syllabus Guide

The following guidelines for creating a syllabus were taken, with some modifications from www.syllabusguide.ttu.edu where additional information can be found.

Faculty Information:

- Name
- Building and office number
- Phone number
- Office hours
- E-mail address (indicate your preferred way to communicate with students)

Course Information:

- Course name and number
- Meeting place and time
- Labs or Discussion sections
- Pre-requisites for the course
- Required and recommended textbooks

Course Description and Purpose:

State the intent of the course and if applicable how it contributes to the major.
State any expectations regarding the students' prior knowledge of the subject.

Course Outline:

The organization or schedule of the material to be covered. May be specific (day-by-day) or general (weekly or in units).

Expected Student Learning Outcomes:

These statements express what the student should know and be able to do (knowledge, skills and abilities) as a result of completing the course. Student leaning outcomes are provided with the course descriptions that follow in this handbook. The university Core Curriculum Committee has issued special requirements for courses in the general education core curriculum. In particular, the syllabus must indicate that the course meets the university core curriculum requirement for Mathematics. An additional statement must be provided that indicates how the expected learning outcomes for the specific course meet the Mathematics Core Curriculum student learning outcomes. If you are teaching M1300, M1320, M1420, M1321, M1330, M1430, M1331, M1351, M1352, M1550, M2300, M2345, M2350, M2360, M2370 or M2371 please use the statement of expected learning outcomes that are provided in this handbook.

Methods of Assessment of Learning Outcomes (See pages 15-16 for examples)

Criteria for Grading:

Indicate how the above methods of assessment will be used to determine the final grade in the course.

- Percent, weight, points, etc., associated with each assignment
  - Note: If the course has a common departmental final exam, then the instructor is expected to administer the common departmental final and to use grade from that final as a substantial portion of the final course grade.
- Percent, weight, points, etc., associated with absences, participation, etc.
- Tell how grades are announced – Texas Tech University Operating Policy 34.12 states that instructors may not post grades for any examinations, including final examinations, unless permission is granted by the department chairperson and a substantiated random identification procedure is in place. Leaving papers with social security numbers or TechID numbers visible for students to pick up violates confidentiality as well.
- Clarify any curve applied and how it works

- Describe any grading consequences for missing deadlines
- Explain any opportunities for extra credit and specifically how it will count toward the final grade
- Emphasize if there is any portion of the course that is required to PASS the course
- If class participation is counted in the grade, state what that means:
  - ✓ Student asking instructor questions
  - ✓ Student answering instructor questions
  - ✓ Student responding to other students' questions
  - ✓ Student initiating discussion
  - ✓ Lab participation
  - ✓ External requirements such as field trips, lecture/concert attendance
  - ✓ Discussion group participation
  - ✓ Participation in group projects

Freshmen and sophomore level courses are expected to have several exams during the semester in addition to the final exam. At least one of those exams should be administered and returned with a grade before midsemester grades are due.

Describe your expectations for preparation for class. The Texas Tech University Catalog states that students are expected to spend approximately two hours in preparation for each hour of lecture.

Class Attendance:

- Absence and tardy policy - if excessive or unexcused absences or tardiness will lower the grade in the class be very specific about how points will be deducted.
- Policy regarding make up exams
- Absence due to religious observance - The Texas Tech University Catalog states that a student shall be excused from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence. (p.50)
- Absence due to officially approved trips – The Texas Tech University Catalog states that the department chairpersons, directors, or others responsible for a student representing the university on officially approved trips should notify the student's instructors of the departure and return schedules in advance of the trip. The instructor so notified must not penalize the student, although the student is responsible for material missed. Students absent because of university business must be given the same privileges as other students (e.g., if other students are given the choice of dropping one of four tests, then students with excused absences must be given the same privilege). (p.50)
- Whether an absence is excused or unexcused is determined solely by the instructor with the exception of absences due to religious observance and officially approved trips described above. The Center for Campus Life will notify faculty, at the student's request, when a student is absent for four consecutive days with appropriate verification of a health related emergency. This notification does not excuse the student from class, it is provided as a courtesy. The service is explained as follows and can be found on the Center for Campus Life web site at: http://www.campuslife.ttu.edu/crisis/

Illness and Death Notification:

The Center for Campus Life is responsible for notifying the campus community of student illnesses, immediate family deaths and/or student death. Generally, in cases of student illness or immediate family deaths, the notification to the appropriate campus community members occur when a student is absent from class for four (4) consecutive days with appropriate verification. It is always the student's responsibility for missed class assignments and/or course work during their absence. The student is encouraged to contact the faculty member immediately regarding the absences and to provide verification afterwards. The notification from the Center for Campus Life does not excuse a student from class, assignments, and/or any other course requirements. The notification is provided as a courtesy.

Academic Integrity

Academic Misconduct:

- You may wish to quote the university's statement on academic integrity found in the Texas Tech University Catalog (p.50) and (OP 34.12):

  "It is the aim of the faculty of Texas Tech University to foster a spirit of complete honesty and a high standard of integrity. The attempt of students to present as their own any work that they have not honestly performed is regarded by the faculty and administration as a serious offense and renders the offenders liable to serious consequences, possibly suspension."

- You also may wish to include the descriptions of Cheating and Plagiarism found in the Texas Tech University Catalog: (p.50)

- It is helpful to also include interpretations of plagiarism and academic misconduct especially relevant to your discipline.

Civility in the Classroom:

- Include a statement regarding your expectations for acceptable behavior in the classroom. More information about this topic is available on-line at www.studentaffairs.ttu.edu/vpsa/publications/civility.htm

Students with Disabilities:

- Include a statement in the syllabus and make a verbal announcement at the beginning of class that students should inform you of their special needs as soon as possible. One of two university approved statements found in the Texas Tech Faculty Handbook is:

  Any student who because of a disability may require special arrangements in order to meet course requirements should contact the instructor as soon as possible to make any necessary accommodations. Student should present appropriate verification from AccessTECH. No requirement exists that accommodations be made prior to completion of this approved university procedure.

Examples of Assessment Statements and Procedures

Example 1
The expected learning outcomes for the course will be assessed through:
Exams, in-class activities, quizzes, research paper, class discussion, one-minute classroom assessment techniques, polling the class, active learning activities**.**

Example 2
Assessment of the learning outcomes will be achieved through one or more activities such as class discussion, board work, short non-graded quizzes, selected non-graded homework, and other optional activities deemed appropriate by the instructor. It is important to note that these assessments are for your learning benefit only and will NOT affect your grade. Class grades will be assigned according to the following rubric. (*Evaluation procedure follows)*.

Example 3
The assessment of students' mastery of the skills and concepts as specified in the expected learning outcomes will occur, with appropriate course grades assigned, as follows. (*Describe the method by which you will determine the final course grades: points for quizzes, exams, homework, final exam, projects, etc; as well as your policies about class attendance and makeup work.)*

Example 4
Continuous formative assessment of the progress of the course will occur via ongoing communication between the instructor and the students. To this end all students are encouraged to ask questions during class and to seek the instructor's help out of class when needed.

Other activities in support of student-instructor communication include the following:

- Use of Blackboard facilities to improve communication. (Several people do this and will be happy to share their experience with you, so ask around if you are interested in doing something with Blackboard.)
- Giving practice quizzes or exams.
- Reviewing homework.
- Observing students working in class. (group activities, students working problems on the board, etc)
- One-minute papers and/or midterm evaluations.
- Use of Learnstar (Consult B. Williams)
- Use of Webwork (Consult D. Gilliam or B. Byerly)
- Use if MyMathLab, MathXL, or Enhanced WebAssign, online homework systems associated with different publishers (Consult course coordinator)
- Requiring students who do poorly on first exam, or quiz, to schedule an appointment to discuss their performance with you in your office.
- Requiring one-on-one office interviews with all your students (probably suitable only for "smaller" classes)

Undergraduate Course Outlines

The pages that follow contain information about certain courses in the undergraduate program. Current course outlines are included for multi-section courses. Additions and changes will be made as textbook changes or revisions of course outlines are made.

Note: All the following course outlines are based on 3 meeting times a week for 50 minutes each. Each outline allows plenty of time for testing and review. Most outlines cover about 35 meeting times, not counting tests and review periods, where we usually meet 42-44 times per semester. If you have a TT class or if you are teaching during a summer session, you will have to make appropriate adjustments.

Undergraduate Course Outlines

The pages that follow contain information about certain courses in the undergraduate program. Current course outlines are included for multi-section courses. Additions and changes will be made as textbook changes or revisions of course outlines are made.

Note: All the following course outlines are based on 3 meeting times a week for 50 minutes each. Each outline allows plenty of time for testing and review. Most outlines cover about 35 meeting times, not counting tests and review periods, where we usually meet 42-44 times per semester. If you have a TT class or if you are teaching during a summer session, you will have to make appropriate adjustments.

Course Number: **Mathematics 0301**
Descriptive Title: **Essential Mathematics**
Prerequisite: **None**

About the Course: This course does not carry any credit toward any degree at Texas Tech and appears on the transcript as 0 hours attempted and 0 hours earned. A student who has not passed the TASP or received a score of 1 or less on the required math placement test is required to take this course. It is also recommended that the student with no background in algebra or who wishes to review basic arithmetic and geometric skills take this course. The purpose of the course is to prepare the student with a foundation of prerequisite skills and knowledge to successfully take MATH 0302 and review skills needed to pass the TASP.

To the Instructor: It is recommended that the instructor assign many exercises and give a test after each chapter. Emphasis on terminology, applications, and study skills for math (i.e. how to read a math textbook, how to study math, and how to prepare for math exams) in an encouraging and positive cooperative-learning environment is essential. Therefore, the instructor is advised to define all symbols and mathematical terms used. Requiring attendance through a percentage of their grade is advised at this level to prevent "gaps of knowledge" occurring in their prerequisite knowledge and skills foundation.

The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: The students will review those topics from pre-algebra that are required for success in typical pre-college algebra. In particular the students will be able to:

- Perform arithmetic operations
- Perform operations with equations and inequalities
- Graph linear functions in Cartesian coordinates and understand the concept of slope of a line
- Perform operations involving exponents
- Perform operations involving polynomials
- Understand functions and function notation
- Understand the basics of factoring

Text: *Elementary & Intermediate Algebra: Concepts & Applications* 5th Edition by Bittinger, Ellenbogen and Johnson; published by Pearson

Course Outline:

Chapter 1 (Sections 1.1-1.8).....8 days
Chapter 2 (Sections 2.1-2.7).....7 days
Chapter 3 (Sections 3.1-3.7).....7 days
Chapter 4 (Sections 4.1-4.8).....8 days
Chapter 5 (Sections 5.1-5.2).....4 days
.....34 days

Course Number: **Mathematics 0302**
Descriptive Title: **Intermediate Algebra**
Prerequisite: **B in MATH 0301/TSI 0202 or 2 on MPE or D in college-level math, 610 on SATM, or 26 on ACTM**

About the Course: This course does not carry any credit toward any degree at Texas Tech and appears on the transcript as 0 hours attempted, 0 hours earned. A student who has not passed the TASP or received a score of 2 on the required math placement test is required to take this course. This course is intended to be a thorough review of high school Algebra I, Algebra II and Geometry courses. Students must have a B or better in order to proceed to the next course. The purpose of this course is to prepare the student with a foundation of prerequisites skills and knowledge to successfully take MATH 1320 or MATH 1330 and to review skills needed to past the TASP.

The purpose of the course is to prepare the student with a foundation of prerequisite skills and knowledge to successfully take MATH 1320 or MATH 1330 and to review skills needed to pass TASP.

To the Instructor: It is recommended that the instructor assign many exercises and give a test after each chapter. Emphasis on terminology, applications, and study skills for math (i.e. how to read a math textbook, how to study math, and how to prepare for math exams) in an encouraging and positive cooperative-learning environment is essential. Therefore, the instructor is advised to define all symbols and mathematical terms used.

The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Text: *Elementary & Intermediate Algebra: Concepts & Applications* 5th Edition by Bittinger, Ellenbogen and Johnson; published by Pearson

Student Learning Outcomes: The students will review those topics from pre-college algebra that are required for success in college level mathematics. In particular the students will be able to:

- Understand relations and functions
- Factor standard polynomials
- Manipulate rational expressions and expressions involving radicals
- Solve systems of linear equations and inequalities
- Apply the quadratic formula

Course Outline:

Review of Sections 5.1-5.2	1 day
Chapter 5 (Sections 5.3-5.7)	5 days
Chapter 6 (Sections 6.1-6.6)	6 days
Chapter 7 (Sections 7.1-4.4)	4 days
Chapter 8 (Sections 8.1-8.4)	4 days
Chapter 9 (Sections 9.1-9.4)	4 days
Chapter 10 (Sections 10.1-10.8)	8 days
Chapter 5 (Sections 11.1-11.4)	4 days
	36 days

Course Number: **Mathematics 1300**
Descriptive Title: **Contemporary Mathematics**
Prerequisite: **B in MATH/TSI 0302, C in a college level math, 3 on MPE, 610 on SATM, or 26 on ACTM**

About the Course: This course is offered for students whose degree programs require no mathematics beyond the quantitative literacy intended in the Texas Tech general education mathematics and logical reasoning requirements. Topics include problem solving, elementary notions of set theory, logical statements and deductive reasoning, truth tables, exponential and linear growth, financial management, voting theory, units of measurement, and some notions of elementary geometry. While use of technology in class is encouraged, this is not a technology-based course and the students should not be expected to use a calculator in class or during examinations.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1300 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the following TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Use mathematical and logical reasoning to evaluate the validity of an argument.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

In particular the students will

- Construct simple logical expressions and arguments
- Evaluate simple algebraic expressions
- Use linear and exponential models
- Create multiple graphical representations of data
- Compute compound interest, annuities and tax payments
- Apply techniques of problem solving.

Text: *The Nature of Mathematics* Custom 11th Edition by Karl Smith, published by Cengage

Course Outline:

Chapter 1: The nature of problem solving.....3 days
Chapter 2: The nature of sets.....4 days
Chapter 3: The nature of logic.....5 days
Chapter 7: The nature of geometry (optional).....(4 days)
Chapter 8: The nature of networks and graph theory.....3 days
Chapter 9: The nature of measurement.....4 days
Chapter 10: The nature of growth.....3 days
Chapter 11: The nature of financial management.....6 days
Chapter 17: The nature of voting and apportionment.....4 days
.....32-36 days

Course Number: **Mathematics 1320**
Descriptive Title: **College Algebra**
Prerequisite: **B in MATH/TSI 0302, C in a college level math, 3 on MPE, 610 on SATM, or 26 on ACTM**

About the Course: This course is intended to provide students with the skills necessary to use tools from algebra to solve problems in a variety of contexts. Calculus bound students should be advised to take MATH 1550, rather than MATH 1320.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1320 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

In particular the students will

- Solve linear, quadratic, rational, logarithmic and exponential equations
- Graph and interpret functions
- Formulate and solve problems that involve real world applications
- Perform simple counting and probability computations

Text: *College Algebra* 5th Edition by Robert Blitzer, published by Pearson

Chapter P (assumed known) ..... 0 days
Chapter 1 (Treated as a review)..... 6 days
Three days to review sections 1.1, 1.2, and 1.3 with emphasis on section 1.3
One day on section 1.4.
One day on section 1.5 for completion of square to derive quadratic formula (assumed known)
Skip section 1.6 and spend one day on section 1.7 (review absolute value)
Chapter 2 (Treated mostly as review)..... 7 days
Four days to review sections 2.1, 2.2, 2.3, & 2.4
Three days to review sections 2.5, 2.6, & 2.7 (Skip 2.8)
Chapter 3 (Treated mostly as review) ..... 5 days
Skip section 3.7
Chapter 4 (material not covered in 0302 or SPCM 0320) ..... 5 days
Four days on sections 4.1, 4.2, 4.3, and 4.4
One day on section 4.5 (emphasize use of ln to solve equations with variable exponents)
Chapter 5 (Linear systems of equations and inequalities covered in 0302 and SPCM 0320) .. 5 days
Two days reviewing sections 5.1 and 5.2
Three days on sections 5.3, 5.4, and 5.5
Skip section 6
Chapter 6 (skip)..... 0 days
Chapter 7 (skip)..... 0 days
Chapter 8 sections 1-7 ..... 8 days
..... 36 days

Course Number: **Mathematics 1420**
Descriptive Title: **College Algebra with Review**
Prerequisites: **2 on MPE or B in 0301 or D in college-level math, 610 on SATM, or 26 on ACTM**

*About the Course***:** The purpose of this course is to allow students who are deemed to have weak algebra skills, usually by virtue of their score on the MPE, to acquire those skills as well as complete the curriculum in MATH 1320 in one semester. Instructors are encouraged to have a rigid attendance policy especially with regard to the review material. The final exam will be the same as for MATH 1320.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: See M1320.

Text: *College Algebra* 5th Edition by Robert Blitzer, published by Pearson

Chapter P ..... 6 days
Chapter 1 ..... 6 days
Three days to review sections 1.1, 1.2, and 1.3 with emphasis on section 1.3
One day on section 1.4.
One day on section 1.5 for completion of square to derive quadratic formula (assumed known)
Skip section 1.6 and spend one day on section 1.7 (review absolute value)
Chapter 2 ..... 7 days
Four days to review sections 2.1, 2.2, 2.3, & 2.4
Three days to review sections 2.5, 2.6, & 2.7 (Skip 2.8)
Chapter 3 ..... 6 days
Skip section 3.7
Chapter 4 (material not covered in 0302 or SPCM 0320) ..... 5 days
Four days on sections 4.1, 4.2, 4.3, and 4.4
One day on section 4.5 (emphasize use of ln to solve equations with variable exponents)
Chapter 5 (Linear systems of equations and inequalities covered in 0302) ..... 5 days
Two days reviewing sections 5.1 and 5.2
Three days on sections 5.3, 5.4, and 5.5
Skip section 6
Chapter 6 (skip) ..... 0 days
Chapter 7 (skip) ..... 0 days
Chapter 8 Sections 1-7 ..... 9 days
..... 44 days

Course Number: **Mathematics 1321**
Descriptive Title: **Trigonometry**
Prerequisites: **4 on MPE, 610 on SATM, or 26 on ACTM, or C in MATH 1320 or 1420**

About the Course: The purpose of this course is to prepare students to take Precalculus or Calculus as well as to prepare students for future courses within their chosen major, such as, but not limited to, Pre-Physical Therapy, Pre-Occupational Therapy, Pre-Dental, Interior Design and Construction Technology. From this course, students should acquire the skills and concepts necessary for success. Although a graphing calculator is required, it will not be a central feature of this course; we will use them to aid understanding after you have mastered the concepts.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1321 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students obtain those trigonometry skills needed for subsequent studies in pre-calculus and calculus. In particular the students will:

- understand and use the definitions of trigonometric functions
- understand and verify trigonometric identities
- understand vectors, operations, and the dot product
- graph trigonometric functions with understanding of translations, polar equations
- interpret information given by graphs including intercepts, domain, and range
- solve trigonometric equations and parametric equations
- use technology appropriately
- understand the unit circle
- understand when to use certain rules, properties, theorems, and formulas in the above learning outcomes
- model real world situations right angle trigonometry, law of sines and cosines
- integrate appropriate terminology into your everyday language when discussing mathematics
- appraise your own progress in thinking logically, increasing your mathematical confidence, and appropriate organizational skills for mathematics

Text: *Trigonometry* 9th Edition by Lial, Hornsby, and Schneider; published by Pearson

Course Outline:

Chapter 1 .....4 days
Chapter 2 .....5 days
Chapter 3 .....4 days
Chapter 4 .....5 days
Chapter 5 .....5 days
Chapter 6 .....5 days
Chapter 7 .....5 days
Chapter 8 (omit 8.4) .....5 days
.....38 days

No other topics should be omitted as they are necessary for various degree plans at the university.

Course Number: **Mathematics 1330**
Descriptive Title: **Introductory Mathematical Analysis I**
Prerequisites: **B in MATH/TSI 0302, C in a college level math, 3 on MPE, 610 on SATM, or 26 on ACTM**

About the Course: Primary emphasis is to be placed on the applications problems in the homework sets at the end of each chapter. Assume the students have and can use graphing calculators.

Student Learning Outcomes: M1330 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students obtain skills and master concepts from finite mathematics that pertain to finance and economics. Students will

- Derive and analyze linear models of supply and demand
- Derive and analyze quadratic models of profit
- Compute problems that involve compound interest
- Compute future and present values of annuities
- Solve basic probability problems, including using Bayes' formula and computing the expected value of a random variable
- Use Markov Processes to project long term trends

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Text: *Applied Mathematics* Custom Edition by Soo T. Tan, published by Cengage

Course Outline:

Chapter 2 ..... 7 days
Sections 2.1, 2.3, and 2.4 should be considered background material and covered very briefly, if at all. Section 2.5 and the business applications in 2.6 should be strongly emphasized. Do not cover completing the square; find maxima for quadratic models of revenue and profit by using the vertex formula –b/(2a).

Chapter 3 ..... 3 days
Cover 3.1 and 3.2 with particular emphasis on solving equations.

Chapter 4 ..... 7 days
Give particular attention to deciding whether a problem involves simple interest, compound interest, amortization (present value), or a sinking fund (future value). The basic formulas should be provided to the students on the exams and the final. Omit 4.4

Chapter 7 ..... 5 days

Chapter 8 ..... 6 days
Cover 8.4 only briefly if at all. Omit 8.6

Markov Chains ..... 6 days
Cover all sections. Use calculators for all matrix manipulations.

..... 34 days

This is an application intensive course. The final exam should consist primarily of business applications.

Course Number: **Mathematics 1430**
Descriptive Title: **Introductory Mathematical Analysis I with Review**
Prerequisites: **2 on MPE or B in 0301 or D in college-level math, 610 on SATM, or 26 on ACTM**

About the Course: The purpose of this course is to allow students who are deemed to have weak algebra skills, usually by virtue of their score on the MPE, to acquire those skills as well as complete the curriculum in MATH 1330 in one semester. Instructors are encouraged to have a rigid attendance policy especially with regard to the review material. The final exam will be the same as for MATH 1330.

Student Learning Outcomes: See M1330.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Text: *Applied Mathematics* Custom Edition by Soo T. Tan, published by Cengage

Course Outline:
Chapter 1 ..... 14 days
Chapter 2 ..... 8 days
Sections 2.1, 2.3, and 2.4 should be considered background material and covered very briefly, if at all. Section 2.5 and the business applications in 2.6 should be strongly emphasized. Do not cover completing the square; find maxima for quadratic models of revenue and profit by using the vertex formula –b/(2a).
Chapter 3 ..... 4 days
Cover 3.1 and 3.2 with particular emphasis on solving equations.
Chapter 4 ..... 9 days
Give particular attention to deciding whether a problem involves simple interest, compound interest, amortization (present value), or a sinking fund (future value). The basic formulas should be provided to the students on the exams and the final. Omit 4.4
Chapter 7 ..... 7 days
Cover all sections.
Chapter 8 ..... 7 days
Cover 8.4 only briefly if at all. Omit 8.6
Markov Chains ..... 7 days
Cover all sections. Use calculators for all matrix manipulations.
..... 56 days

This is an application intensive course. The final exam should consist primarily of business applications.

Course Number: **Mathematics 1331**
Descriptive Title: **Introductory Mathematical Analysis II**
Prerequisites: **C in 1330, 4 on MPE, 26 on ACTM, or 610 on SATM**

About the Course: Primary emphasis is to placed on the use of calculus concepts to solve relevant problems as represented by the applications problems in the homework sets at the end of each chapter. Assign most, if not all, the application problems in each homework set. Focus on the math needed to solve these problems. Assume the students have and can use graphing calculators.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1331 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

In particular, students obtain skills and master concepts from calculus that pertain to finance and economics. Students will

- Explain the concepts of differential and integral calculus, including limits
- Calculate derivatives, indefinite and definite integrals
- Solve problems that involve marginal cost, revenue and profit, elasticity of demand, diminishing returns, consumers' and producers' surplus Lorentz curves, and the coefficient of inequality

Text: *Applied Mathematics* Custom Edition by Soo T. Tan, published by Cengage

Course Outline:

Precalculus Review (review of topics from Math 1330) ..... 5 days
Regression ..... 3 days
Chapter 9 ..... 10 days
Chapter 10 ..... 7 days
Do not cover 10.3
Chapter 11 ..... 9 days
..... 34 days

This is an application intensive course. The final exam should consist primarily of business applications.

Course Number: **Mathematics 1351**
Descriptive Title: **Calculus I**
Prerequisites: **C in MATH 1350 or 1550 or 7 on MPE or C in 1321 with 5 on MPE or 660 on SATM or 29 on ACTM**

About the Course: The goal here is developing the student's geometric insight into the concepts of differentiation and integration, and applying these concepts to problem solving and "real world application". Do not get bogged down in proofs. Stress the relation of the concepts of limit, continuity, and differentiability to properties of graphs. Intuitive discussions and "picture arguments" are acceptable. Our majors do the ε-δ proofs in advanced calculus.

The use of technology is a prerogative of the instructor. The calculator should be used as an aid to understanding concepts. The vast bulk of the calculator use is devoted to understanding properties of the graphs of the various functions, how these graphs are affected by algebraic manipulations, such as adding functions, inverting functions, scalar multiplication of functions, and composing functions with shifts; and how derivations and integrals relate to graphs.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1351 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students will become proficient in techniques of differentiation, understand the concept of rate of change and how to use it to solve real world problems, the concept of definite and indefinite integral and their relations to area and rate of change. In particular, the students will

- Be able to explain the concept of continuous functions
- Compute instantaneous rate of change
- Compute derivatives of polynomial and transcendental functions
- Differentiation to solve related rate and optimization problems
- Compute definite and indefinite integrals

Text: *CALCULUS*, 5th Edition by Strauss, Bradley, and Smith; published by Pearson

Course Outline

Chapter 1 ..... 4 days
Chapter 2 ..... 4 days
Chapter 3 ..... 8 days
Chapter 4 ..... 8 days
Chapter 5 ..... 9 days
..... 33 days

A minimum of three one-hour exams should be given. Encourage students with graphing calculators to us them to work some of the designated "graphing exercises," e.g. 61.on pg 57, etc. Technology supplements and exercises are available from the Director of Undergraduate Program.

It is important that instructors cover all of the material required. If you discover that this will not be possible, you must inform the Director of Undergraduate Studies and course coordinator immediately.

Course Number: **Mathematics 1352**
Descriptive Title: **Calculus II**
Prerequisites: **C in 1351**

About the Course: Students should develop an understanding of the basic transcendental functions and of their importance. In particular students should have a good understanding of the meaning of the terms exponential growth and logarithmic growth, and how they relate to polynomial growth. Students should experience a variety of applications of the definite integral. Be careful not to overemphasize the mechanical techniques of integration so much as to obscure the concept of the definite integral. The main point of the antiderivative should be its use in solving differential equations. Pay sufficient attention to teaching how to use integral tables. The students should obtain a minimal working knowledge of infinite sequences and series. Finally, the student should have an introduction to vectors.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1352 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students will become proficient in techniques of integration and the use of integration to solve real world problems. They also understand the basic properties of convergent series and sequences. In particular the students will:

- Compute areas and volumes
- Solve real world problems involving selected concepts from the physical and life sciences, and economics
- Integrate by using substitution, integration by parts, and partial fractions
- Analyze the convergence of infinite series and sequences
- Perform basic vector algebra

Text: *CALCULUS*, 5th Edition by Strauss, Bradley, and Smith; published by Pearson

Course Outline

Chapter 6 .....8 days
Chapter 7 .....9 days
Chapter 8 .....10 days
Chapter 9 .....7 days
.....34 days

It is important that instructors cover all of the material required. If you discover that this will not be possible, you must inform the Director of Undergraduate Studies and course coordinator immediately.

Course Number **Mathematics 2350**
Descriptive Title: **Calculus III**
Prerequisites: **C in 1352**

About the Course: This is calculus of several variables. The concepts are extensions of the concepts of calculus I. It is necessary to remind the students of those basic concepts as the course progresses.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M2350 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students develop skills in differentiation and integration needed to solve problems in 3-dimensional space. In particular the students will master the concepts of

- tangent and normal vectors, and their geometric and physical interpretations
- partial derivatives, tangent planes, directional derivatives, and gradients, and how to compute them
- three-dimensional integration, and how to compute such integrals
- vector fields, divergence, and curl, and how to calculate them

Text: *CALCULUS*, 5th Edition by Strauss, Bradley, and Smith; published by Pearson

Course Outline

Chapter 10 .....6 days
Chapter 11 .....9 days
Chapter 12 .....10 days
Chapter 13 .....9 days
.....34 days

It is not necessary that the students memorize "Stokes" Theorem, but it should be utilized to calculate surface & line integrals.

It is important that instructors cover all of the material required. If you discover that this will not be possible, you must inform the Director of Undergraduate Studies and course coordinator immediately.

Course Number: **MATHEMATICS 1550**
Descriptive Title: **Precalculus**
Prerequisites: **A in MATH/TSI 0302, C in a college level math, 3 on MPE, 610 on SATM, or 26 on ACTM**

About the Course: The purpose of this course is to prepare students to take the Calculus sequence as well as to prepare students for future courses within their chosen major, such as, but not limited to, Engineering and Chemistry. From this course, students should acquire the skills and concepts necessary for success. Although a graphing calculator is required, it will not be a central feature of this course; we will use them to aid understanding after you have mastered the concepts.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M1550 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students develop the pre-calculus skills necessary to be successful in calculus. In particular, the students will:

- Use linear and quadratic functions
- Use rational functions, graphs, and asymptotes
- Compute exponential and logarithmic expressions
- Solve linear, quadratic, exponential and logarithmic equations
- Utilize the unit circle and basic trigonometric functions
- Graph trigonometric functions
- Solve simple trigonometric equations
- Use technology appropriately
- Integrate appropriate terminology into your everyday language when discussing mathematics.
- Appraise your own progress in thinking logically, increasing your mathematical confidence, and appropriate organizational skills for mathematics

Text: *PRECALCULUS WITH UNIT-CIRCLE GEOMETRY* 4th Edition by Cohen, Lee, and Sklar; published by Cengage

Course Outline

Appendix (A.1, B.1, B.2, B.3)	3 days
Chapter 1 (review and completing the square)	2 days
Chapter 2	3 days
Chapter 3	5 days
Chapter 4 (omit 4.3)	6 days
Chapter 5	6 days
Chapter 6	4 days
Chapter 7	5 days
Chapter 8	6 days
Chapter 9	7 days
Chapter 10 (omit 10.4 – 10.7)	3 days
Chapter 11 (omit 11.8)	7 days
Chapter 12	7 days
Chapter 13 (omit 13.1, 13.2, 13.6)	3 days
	67 days

It is important that instructors cover all of the material required. If you discover that this will not be possible, you must inform the Director of Undergraduate Studies and course coordinator immediately.

Course Number: **Mathematics 2300**
Descriptive Title: **Statistical Methods**
Prerequisites: **4 on MPE, 610 on SATM, 26 on ACTM, or C in a college level math**

About the Course: This course gives the students an introduction to some of the basic statistical methods used in practice. The following syllabus allows for 4 hourly exams and a few days for "lab-type" work with the students.

To the instructor: The final exam for non-evening sections of this course is scheduled as a common departmental final. Consequently, there is an expectation that the instructors of non-evening sections of this course will administer the common departmental final and that they will use the grade from that final as a substantial portion of the final course grade. Please refer to Common Final Exam times found at www.depts.ttu.edu/officialpublications/ClassSchedule/FinalExams.php to find the time of your scheduled final.

Student Learning Outcomes: M2300 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

The students will learn the meanings of, and computational procedures related to, the elementary statistical concepts used by the general population in decision making. In particular

- Develop proficiency in solving real-world problems
- Compute various statistical measures, including the mean, median, mode, standard deviation, variance, and quartiles
- Utilize graphical representations of data
- Solve problems involving the binomial and normal distributions
- Apply the Central Limit Theorem
- Compute and interpret confidence intervals
- Conduct and interpret hypothesis tests
- Use linear regression models

Text: *STATISTICS: The Art and Science of Learning From Data* 2nd Edition by Agresti and Franklin, published by Pearson

Course Outline

Chapter 1 - 1.1-1.3	1 day
Chapter 2 - 2.1-2.6	4 days
Chapter 3 - 3.1-3.4	4 days
Chapter 4 - 4.1-4.3 (4.4 optional)	3 days
Chapter 5 - 5.1-5.4	4 days
Chapter 6 - 6.1-6.3	3 days
Chapter 7 - 7.1-7.3	3 days
Chapter 8 - 8.1-8.3 (8.4 and 8.5 optional)	3 days
Chapter 9 - 9.1-9.4 (9.5 and 9.6 optional)	4 days
Chapter 10 - 10.1-10.4 (10.5 optional)	4 days
Chapter 11 - 11.1-11.2	2 days
	35 days

Course Number: **Mathematics 2345**
Descriptive Title: **Business Statistics**
Prerequisites: **C in MATH 1330 or 1430, 4 on MPE, 26 on ACTM, or 610 on SATM**

About the Course: The students will learn the meanings of, and computational procedures related to, the elementary statistical concepts used for making decisions in business and economics.

Student Learning Outcomes: M2345 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students will learn the meanings of, and computational procedures related to, the elementary statistical concepts used for making decisions in business and economics. In particular, students will:

- Develop proficiency in solving real-world problems
- Compute various statistical measures, including the mean, median, mode, standard deviation, variance, and quartiles
- Utilize graphical representations of data
- Solve problems involving the binomial and normal distributions
- Apply the Central Limit Theorem
- Compute and interpret confidence intervals
- Conduct and interpret hypothesis tests
- Use linear regression models
- Construct and use of control charts

Text: *Business Statistics: A First Course*, Custom Edition by: D. Levine, T. Krehbiel and M. Berenson, published by Pearson

*Course Outline (*A day consists of 50 minutes.)

Chapter 1-1.1-1.5	1 day
Chapter 2 - 2.1-2.5	3 days
Chapter 3 - 3.1-3.5	3 days
Chapter 4 - 4.1-4.2	2 days
Chapter 5 - 5.1-5.3	2 days
Chapter 6 - 6.1-6.2	2 days
Chapter 7 - 7.1-7.2	2 days
Chapter 8 - 8.1-8.4	3 days
Chapter 9 - 9.1-9.5	3 days
Chapter 10 - 10.1-10.3	3 days
Chapter 11 - 11.1-11.2	2 days
Chapter 12 - 12.1-12.7	3 days
Chapter 13 - 13.1-13.4	3 days
Chapter 14 - 14.1-14.6	3 days
Additional Chapter	2 days
	37 days

Course Number: **Mathematics 2356**
Descriptive Title: **Quantitative Theory of Interest**
Prerequisites: **MATH 1351 or 1331**

About the Course: This course covers the mathematical theory of interest. It is recommended for students who plan to take the professional examinations given by the Society of Actuaries (SOA) and the Casualty Actuarial Society (CAS). This course is required for Actuarial Science minor. Students are required to have a calculator with business capacities, for example, the Texas Instruments BA II Plus. The instructor is expected to be familiar with the calculator and to incorporate its use into the course as soon as possible.

Student Learning Outcomes: Students obtain the knowledge of key terms of financial mathematics and are proficient in the key procedures of financial mathematics. In particular the students will be able to demonstrate their ability to:

- Calculate the effective rate (or force) of interest (or discount)
- Calculate the present and future values of an annuity
- Calculate annuity payment
- Form amortization schedule or sinking fund schedule
- Determine the prices, values, and yield rates for bonds and other securities

Text: *The Theory of Interest* 3rd Edition by S. G. Kellison, published by McGraw-Hill/Irwin

Course Outline

Chapter 1 – The Measurement of Interest .....7 days
Chapter 2 – Solution of Problems in Interest .....4 days
Chapter 3 – Basic Annuities .....6 days
Chapter 4 – More General Annuities.....7 days
Chapter 5 – Amortization Schedules and Sinking Funds .....6 days
Chapter 6 – Bonds and Other Securities .....7 days
.....37 days

Course Number: **Mathematics 2360**
Descriptive Title: **Linear Algebra**
Prerequisites: **MATH 1352 or concurrent**

About the Course: It is essential that the presentation be very elementary with a great deal of attention directed to solving specific problems in order to meet with any great degree of success. This is *not* intended to be a course in *abstract mathematics*. Rigor, with proofs, is expected but all examples and applications should be concrete.

Student Learning Outcomes: M2360 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the following TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

Students develop skill in manipulating with matrices and understand their relationship to linear systems. They understand the concept of bases and vector spaces, as well as, eigenvectors and eigenspaces.
In particular, students

- perform basic vector algebra, and compute their bases
- express a linear transformation as a matrix

- perform basic matrix manipulations, and compute the determinant of a matrix
- compute eigenvalues and eigenvectors
- use the Gram-Schmidt process

Text: *Linear Algebra with Applications* 7th edition by S. J. Leon, published by Pearson

Course Outline

Chapter 1 - Sections 1-4 .....7 days
Chapter 2 - Sections 1-3 (cover Cramer's rule briefly).....3 days
Chapter 3 - Sections 1-6 .....8 days
Chapter 4 - Sections 1-3 .....6 days
Chapter 5 - Sections 1-3, 5-6.....9 days
Chapter 6 Sec.1-3 (higher order systems in Sec. 2 and exponential
of a matrix in Sec. 3 are optional) .....4 days
.....37 days

There are numerous applications; the instructor will need to be selective. The MATLAB exercises at the end of each chapter are optional, but some can, and should be done using calculators that can do matrix manipulation up to and including eigenvalues and eigenvectors (such as the TI-86 and TI-89).

Course Number: **Mathematics 3310**
Descriptive Title: **An Introduction to Proof**
Prerequisites: **MATH 2350**

About the Course: This course will teach students how to construct and organize their mathematical reasoning and develop skill for writing mathematical proofs. This is a writing intensive course.

Learning Outcomes: Students will

- Construct direct proofs
- Construct proofs by mathematical induction
- Construct proofs by contradiction
- Use the geonhole principle
- Carry out case analysis

Text: *Chapter Zero: Fundamental Notions of Abstract Mathematics* 2nd Edition by Carol Schumacher, published by Pearson

Course Number: **Mathematics 3322**
Descriptive Title: **Higher Mathematics for Engineering Technology**
Prerequisites: **MATH 1352**

About the Course: This course is for students in Engineering Technology and touches on several topics of higher mathematics with emphasis on differential equations and includes Laplace Transforms, Fourier Series and vector algebra among others. Again, these subjects are presented from the standpoint of engineering application rather than a theoretical development. Students are required to have and learn to use a TI-85 calculator for this sequence. The instructor should use the TI-85 to aid in understanding the concepts. MATH 3322 introduces some topics of higher mathematics for the engineering technology students, with emphasis of differential equations and includes Laplace transforms, Fourier series, vector algebra, complex numbers, and matrix algebra. The POLY and SIMULT packages on the TI-86 should both be used.

Student Learning Outcomes: The students will develop the necessary skills from pre-calculus, calculus, and differential equations required to be successful in their engineering technology programs.
Students will understand infinite series and differential equations. In particular, students will:

- Understand the concept of multiple integration and learn to solve real-world problems involving multiple integrals.
- Understand sequences gain proficiency in determining convergence.
- Understand series gain proficiency in determining convergence.
- Solve first order and higher order differential equations.
- Understand and become proficient using Laplace transforms.

Text: *TECHNICAL CALCULUS WITH ANALYTIC GEOMETRY* 4th Edition by Kuhfittig, published by Cengage
Reference: Schaum's Outline - ADVANCED MATH FOR ENGINEERING & SCIENTISTS

Course Outline
Chapter 9-3D Space, partial Derivatives, Multiple Integrals .....3 days
Chapter 10-Infinite Series.....9 days
Chapter 11-1st Order Differential Equations.....9 days
Chapter 12-Highest Order Differential Equations.....6 days
Chapter 13-Laplace Transforms .....9 days
.....36 days

Course Number: **Mathematics 3342**
Descriptive Title: **Mathematical Statistics for Engineers and Scientists**
Prerequisites: **MATH 2350**

About the Course: This course is designed to cover topics from mathematical statistics that are of interest to students from engineering and/or the sciences. Topics should include descriptive statistics, elementary probability, random variables and distributions, mean variance, parameter estimation, hypothesis testing, regression, and analysis of variance.

Student Learning Outcomes: Students will apply their calculus knowledge to learn the meanings of, and computational procedures relating to, basic statistical concepts used for making decisions in the sciences and engineering. In particular, students will

- Understand the need to be wary of statistical claims, common pitfalls in sampling, and misrepresentation of conclusions
- Understand the meanings of various statistical measures, including the mean, median, mode, standard deviation, variance, and quartiles
- Become familiar with various graphical representations of data and learn to recognize misleading graphs.
- Develop proficiency in real-world probability problems
- Understand the concept of a probability distribution and real-world problems involving various distributions, including binomial, normal, hypergeometric, and Poisson distributions
- Understand and apply the Central Limit Theorem
- Compute and interpret confidence intervals
- Conduct and interpret hypothesis tests
- Understand linear regression models

Text: *Probability and Statistics for Engineering and Science* Custom Edition by Devore, published by Cengage

Course Outline

Chapter 1 – 1.1-1.4 .....5 days
Chapter 2 – 2.1-2.2, 2.4-2.5 (2.3 optional) .....5 days
Chapter 3 – 3.1-3.4, 3.6 (3.5 optional) .....4 days
Chapter 4 – 4.1-4.5 .....5 days
Chapter 6 – 6.1 (6.2 optional).....1 day
Chapter 7 – 7.1-7.4 .....4 days
Chapter 8 – 8.1-8.5 .....6 days
Chapter 9 – 9.1-9.5 .....6 days
Chapter 12 – 12.1-12.5 .....As time permits
.....36 days

Chapter 5 is optional

Course Number: **Mathematics 3350, 3351**
Descriptive Title: **Higher Mathematics for Engineers and Scientists I, II**
Prerequisites: **For 3350, MATH 2350**
For 3351, MATH 3350 or 3354

About 3350: This course covers topics in ordinary differential equations. Topics to be covered include: First-order differential equations; Modeling with first-order differential equations; Higher-order differential equations; Modeling with higher-order differential equations; Laplace transform; Series Solutions of Linear Equations.

Student Learning Outcomes: (3350) The students will understand the concept of differential equations, their solutions, and applications to physical sciences and engineering. In particular the students will learn to

- recognize a differential equation and its solution
- compute solutions of first order differential equations
- compute solutions of linear differential equations
- use Laplace transforms
- recognize Fourier series
- find numerical solutions

About 3351: This course covers topics in linear algebra, systems of ordinary differential equations, Fourier series and solution of boundary value problems for partial differential equations. Topics to be covered include: Linear Algebra and Matrix Theory; Systems of linear first-order differential equations; Orthogonal Functions and Fourier Series; Boundary-Value Problems in Rectangular Coordinates; Boundary-Value Problems in Other Coordinate Systems.

Student Learning Outcomes: (3351) The students will extend their knowledge of differential equations and their solutions acquired in MATH 3350 by developing new methods to solve differential equations and by studying the concept of partial differential equations and their solutions and applications. In particular, the students learn:

- the fundamental properties of power series, and how to use them to solve linear differential equations,
- how to apply Frobenius' method
- to solve Cauchy-Euler equations
- the fundamental properties of linear systems, and their solutions
- how to solve partial differential equations by separation of variables or Fourier series
- to apply these techniques to the three classical equations: the heat, wave, and Laplace's equation

Text: *Advanced Engineering Mathematics* 3rd Edition by Dennis G. Zill and Michael R. Cullen, published by Jones & Bartlett

Course Outline (3350)

Chapter 1 – (1.1, 1.2) Introduction	2 days
Chapter 2 – (2.1-2.8) First-Order Differential Equations	9 days
Chapter 3 – (3.1-3.6, 3.8) Higher-Order Differential Equations	10 days
Chapter 5 – (5.1, 5.3) Series Solutions of Linear Equations	4 days
Chapter 4 – (4.1-4.5) Laplace Transforms	9 days
	34 days

Course Outline (3351)

Chapter 8 – (8.1-8.5, 8.8) Matrices	8 days
Chapter 10 – (10.1, 10.2) Systems of Linear Differential Equations	4 days
Chapter 12 – (12.1-12.4) Orthogonal Functions and Fourier Series	6 days
(Review table of solutions for linear DEs p. 674)	
Chapter 13 – (13.1-13.6, 13.8) Boundary-Value Problems Rectangular Coordinates	10 days
Chapter 14 – (14.1-14.3) BVP in Other Coordinate Systems	5 days
Chapter 15 – (Selected Topics) Integral Transforms	2 days
	35 days

Course Number: **Mathematics 3354, 4354**
Descriptive Title: **Differential Equations I, II**
Prerequisites: **For 3354, MATH 2350 and MATH 2360**
For 4354, MATH 3354 or MATH 3350

About 3354: This course covers topics in ordinary differential equations. Topics to be covered include: First-order differential equations; Modeling with first-order differential equations; Higher-order differential equations; Modeling with higher-order differential equations; Laplace transform; Series Solutions of Linear Equations.

Student Learning Outcomes: (3354) Students will obtain a thorough knowledge of solution techniques for first-order and for second- and higher-order constant coefficient linear homogenous and nonhomogeneous initial value problems using standard methods of undetermined coefficients and variation of parameters. In addition, the students will acquire a general understanding of how to apply the Laplace transform in solving initial value problems and convolution integral equations. Students will gain an appreciation for some of the applications of ordinary differential equations in biology and engineering.

About 4354: This course covers topics in ordinary and partial differential equations. Topics to be covered include: Systems of linear first-order differential equations; Orthogonal Functions and Fourier Series; Boundary-Value Problems in Rectangular Coordinates; Boundary-Value Problems in Other Coordinate Systems; Integral Transforms.

Student Learning Outcomes: (4354) Students will learn solution techniques for systems of ordinary differential equations. Students will also learn elements of Fourier series and how to apply these series in the solution of boundary value problems for partial differential equations, specifically, the heat equation, wave equation, and Laplace's equation in rectangular and other coordinate systems. In addition, students will obtain a general understanding of transform methods in the solution of initial and boundary value problems for partial differential equations.

Text: *Differential Equations with Boundary-Value Problems*, 7th Edition by D.G. Zill and M.R. Cullen, published by Cengage

Course Outline (3354)

Chapter 1 – (1.1, 1.2) Introduction ..... 2 days
Chapter 2 – (2.1-2.6) First-Order Differential Equations ..... 8 days
Chapter 3 – (3.1-3.2) Modeling with First-Order Differential Equations ..... 1 day
Chapter 4 – (4.1-4.4, 3.6, 4.7) Higher-Order Differential Equations ..... 9 days
Chapter 5 – (5.1) Modeling with Higher-Order Differential Equations ..... 1 days
Chapter 6 – (6.1, 6.3) Series Solutions of Linear Equations ..... 4 days
Chapter 7 – (7.1-7.5) Laplace Transforms ..... 9 days
..... 34 days

Course Outline (4354)

Chapter 8 – (8.1, 8.2) Systems of Linear Differential Equations ..... 4 days
Chapter 10 – (10.1-10.4) Plane Autonomous Systems ..... 6 days
Chapter 11 – (11.1-11.3) Orthogonal Functions and Fourier Series ..... 5 days
(Review table of solutions for linear DEs p. 416)
Chapter 12 – (12.1-12.6, 12.8) Boundary-Value Problems Rectangular Coordinates ..... 10 days
Chapter 13 – (13.1-13.3) BVP in Other Coordinate Systems ..... 5 days
Chapter 14 – (14.1-14.4) Integral Transforms ..... 5 days
..... 35 days

Course Number: **Mathematics 3360, 4360**
Descriptive Title: **Foundations of Algebra I, II**
Prerequisites: **For 3360, MATH 2360 and 3310**
For 4360, MATH 3360

About 3360: This course is intended to be *the* introduction to *abstract mathematics*, with proofs. It is also a writing intensive course.

Student Learning Outcomes: (3360) Students learn how to think and reason abstractly in the context of algebraic structures, and learn how to write correct and clear mathematical arguments in this context. Concepts to be mastered by the students include but are not limited to the following:

- Groups and group homomorphisms
- Group actions
- Rings and ring homomorphisms
- Polynomials

About 4360: This is a continuation of MATH 3360.

Student Learning Outcomes: (4360) Students learn how to think and reason abstractly in the context of algebraic structures, and learn how to write correct and clear mathematical arguments in this context. Concepts and skills to be mastered by the students include but are not limited to the following:

- Ideals and quotient rings
- Euclidean domains
- Field theory
- Galois theory; insolvability of a general quintic
- Applications (instructor's choice)

Text: *Algebra, Pure & Applied* by A. Papantonopoulou, published by Pearson

Course Outline (3360):

Chapters 1-3 & §0.3.30-38	17 days
Chapter 4 (§1-5)	5 days
Chapter 4 (§6-7) or Chapter 14	4 days
Chapter 6	4 days
Chapter 7 (§1-2)	3 days
Chapter 8 (§1-4)	6 days
	39 days

Instructor has choice of Chapter 4 §6-7 or Chapter 14, time permitting.

There will be 6-10 writing assignments. Students will be given the opportunity to rewrite at least four of the assignments, based on appropriate feedback from the instructor. In these cases, should the first submission be unsatisfactory, the second submission will count for the grade.

Course Outline (4360)

§7.3 and §8.6-8.8	6 days
Chapter 15, 16, or 17	5 days
Chapters 9-10	12 days
Chapter 5	5 days
§12.1-12.3	9 days
Chapter 11 & §12.4	5 days
§12.5	2 days
	35 days

Instructor has choice of Chapters 15, 16, or 17 or Chapter 11 and §12.4

Course Number: **Mathematics 3430**
Descriptive Title: **Computational Techniques for Science and Mathematics**
Prerequisites: **MATH 2350 and 2360**

About the Course: This course familiarizes the students with software packages used for scientific and mathematical computing, with an emphasis on problem solving. The instructor should *not* assume prior computer experience. Students are required to enroll in the accompanying lab section. This course fulfills the technology requirements for Arts & Sciences.

Student Learning Outcomes: Students reinforce their knowledge of concepts from arithmetic, algebra, number theory, calculus, and linear algebra, and learn how to use the program MAPLE to study and demonstrate these concepts. Students will become familiar with the general capabilities of a CAS, and obtain experience employing these capabilities to solve mathematical problems in the context of MAPLE. In order to communicate with the program students obviously will have to use the appropriate syntax. However, learning MAPLE syntax is never to be considered the main objective.

Text: Instructor's notes

Course Number: **Mathematics 4000**
Descriptive Title: **Selected Topics**
Prerequisites: **Approved by the Director of Undergraduate Programs**

About the Course: This course can be anything from an individual study/research course to a formal lecture course on a particular selected topic. Credit can be rewarded on a 1, 2, or 3 hour basis and it can be repeated for credit.

Student Learning Outcomes: Students will learn to apply mathematics research methodology in an attempt to solve a problem of mutual interest with an instructor.

Course Number: **Mathematics 4310**
Descriptive Title: **Introduction to Numerical Analysis I**
Prerequisites: **MATH 3350 or 3354**

About the Course: This course covers the standard topics from Numerical Analysis used to solve differential equations. Numerical integration should also be addressed, as well as interpolation.

Student Learning Outcomes: The students will learn the basic numerical procedures for solving differential equations and computing definite integrals, and apply these procedures to real world problems. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: At the discretion of the instructor, subject to approval by Director of Undergraduate Programs.

Course Number: **Mathematics 4312**
Descriptive Title: **Introduction to Numerical Analysis II**
Prerequisites: **MATH 2360**

About the Course: This is a course in numerical linear algebra.

Student Learning Outcomes: The students will learn the basic numerical procedures for solving systems of linear equations, and apply these procedures to real world problems. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: At the discretion of the instructor, subject to approval by Director of Undergraduate Programs.

Course Number: **Mathematics 4330**
Descriptive Title: **Mathematics Computing**
Prerequisites: **Consent of Department**

About the Course: This course is intended to *introduce* mathematics majors to special topics in mathematics and programming. While the students may be assumed to be advanced mathematics students, the instructor must assume they are *beginning* programming students. Students with advanced programming experience should *not* be allowed to take this course.

Student Learning Outcomes: The students will learn how computers can be used to study concepts, or solve problems related to the special topic chosen by the department for the particular semester. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: At the discretion of the instructor, subject to approval by Director of Undergraduate Programs.

Course Number: **Mathematics 4331**
Descriptive Title: **Advanced Geometry**
Prerequisites: **MATH 2350 and 3310**

About the Course: This course covers Euclidean, non-Euclidean, and projective geometries and is required for secondary teacher certification.

Student Learning Outcomes: Students master the concepts from Euclidean and non-Euclidean geometry that are taught in the typical high school geometry class. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: At the discretion of the instructor, subject to approval by Director of Undergraduate Programs

Course Number: **Mathematics 4342, 4343**
Descriptive Title: **Mathematical Statistics**
Prerequisites: **For 4342, MATH 2350**
For 4343, MATH 4342

About the Course: This is a year-long sequence covering frequency functions, moments, probability, correlation and regression, testing hypotheses, small sample distributions, analysis of variance, nonparametric methods, and sequential analysis.

Student Learning Outcomes: Applying their knowledge of Calculus the students will learn to use and understand the derivations of the basic concepts of mathematical statistics.

Text: *Mathematical Statistics with Applications* 7th Edition by Wackerly, Medenhaff, and Scheaffer; published by Cengage

Course Number: **Mathematics 4350, 4351**
Descriptive Title: **Advanced Calculus**
Prerequisites: **For 4350, MATH 2350 and 2360 and 3310**
For 4351, MATH 4350

About the Courses: This course covers sets, functions, vector fields, partial derivatives, power series, and theory of integration. Students are expected to present proofs. Math 4350 and 4351 are writing intensive courses.

Student Learning Outcomes: (4350) Students learn how to think and reason abstractly in the context of analysis of the real line, and learn how to write correct and clear mathematical arguments in this context. There will be a heavy emphasis on proofs, especially epsilon-delta proofs. Concepts and skills to be mastered by the students include but are not limited to: suprema, infima, limits of sequences, limits of functions, continuous functions, derivatives of functions on the line.

Student Learning Outcomes: (4351) Students learn how to think and reason abstractly in the context of analysis of the real line, and learn how to write correct and clear mathematical arguments in this context. There will be a heavy emphasis on proofs, especially epsilon-delta proofs. Concepts and skills to be mastered by the students include but are not limited to: L'Hospital's Rules, Taylor's Theorem, the Riemann integral, sequences of functions, infinite series, introduction to the topology of the line, introduction to Lebesgue measure and integration.

Text: *Introduction to Real Analysis* 3rd edition by Bartle and Sherbert, published by Wiley
4351 also needs Chapter 11 of *Methods of Real Analysis* by Goldberg, 2nd ed., available from CopyTech

Course Outline (4350):

Chapters 1 and Appendix B (1.1 and 1.2 should be only briefly reviewed)	3 days
Chapter 2	7 days
Chapter 3	10 days
Chapter 4	5 days
Chapter 5	8 days
Chapter 6 (§1-2)	4 days
	37 days

Course Outline (4351):

Chapter 6 (§3-4)	4 days
Chapter 7	7 days
Chapter 8	5 days
Chapter 9	4 days
Chapter 11	5 days
Chapter 11 from Goldberg	12 days
	37 days

Course Number: **Mathematics 4356**
Descriptive Title: **Elementary Functions of a Complex Variable**
Prerequisites: **MATH 4350 or concurrent**

About the Course: This is an undergraduate course in complex numbers and functions.

Student Learning Outcomes: The student will learn, and be able to derive, basic concepts related to complex numbers and functions. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: *Fundamentals of Complex Analysis for Mathematics, Science and Engineers* 3rd Edition by Saff & Snider, published by Pearson

Course Number: **Mathematics 4362**
Descriptive Title: **Theory of Numbers**
Prerequisites: **MATH 3310**

About the Course: This course covers prime numbers; modular arithmetic; theorems of Fermat, Euler, and Wilson; residues, quadratic reciprocity; and Diophantine Equations. Students should write proofs.

Student Learning Outcomes: Students learn how to think and reason abstractly in the context of number theory, derive basic concepts, and learn how to write correct and clear mathematical arguments in this context. Concepts and skills to be mastered by the students include but are not limited to the following: (Here the instructor should include a list of the particular concepts he or she obtain from his or her offering of this particular course.)

Text: *Fundamentals of Number Theory* by LeVeque, published by Dover

THE 70 SERIES DESIGNED FOR ELEMENTARY SCHOOL TEACHERS

This is a sequence of seven courses (2370, 2371, 3370, 3371, 3372, 4370, 4371) for students in elementary education.

Course Number: **Mathematics 2370**
Descriptive Title: **Elementary Analysis I**
Prerequisites: **MATH 1320 and Major of EC or MDS**

About the Course: This course is designed to provide the prospective elementary school teacher with some background in elementary analysis. Among other things, it covers number systems and coordinate geometry. It will be taught in a "cooperative learning environment" with supplemental group exercises and other materials provided to all instructor by the Director of Undergraduate Program.

Student Learning Outcomes: M2370 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Use mathematical and logical reasoning to evaluate the validity of an argument.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

The students will understand number systems with different bases, the ring and field properties of the real number system, and the description of numbers and points using the coordinate axis. In particular, the students will:

- Explain and model the arithmetic operations for whole numbers, integers, and rational numbers
- Explain and model computations with fractions, decimals, and percentages
- Explain elementary number theory related to factors, multiples, and prime numbers and apply problem solving skills to numerical applications
- Model with sequences and patterns

Text: *A PROBLEM SOLVING APPROACH TO MATHEMATICS OF ELEMENTARY SCHOOL TEACHERS* 10th Edition by Billstein, Libeskind, and Lott; published by Pearson

Course Outline

Chapter 1 (Problem Solving) .....3 days
Chapter 2 (Sets) .....5 days
Chapter 3 (Whole numbers) .....5 days
Chapter 4 (Algebraic Thinking) .....5 days
Chapter 5 (Integers).....6 days
Chapter 6 (Rational Numbers).....6 days
Chapter 7 (Decimals).....5 days
.....35 days

This should leave sufficient time for three hour exams in addition to the comprehensive final exam. There should also be some time available for discussion of such things as issues in elementary mathematics education, the NCTM standards, pedagogy in general, and use of manipulatives and technology.

Course Number: **Mathematics 2371**
Descriptive Title: **Elementary Analysis II**
Prerequisites: **MATH 1320 and Major of EC or MDS**

About the Course: This course is concerned with the basic ideas of calculus and should not be presented in a formal or rigorous manner. The approach is to be intuitive and honest but not sloppy. The ideas and concepts should be well-motivated and geometry should be used freely. Many problems involving the basic concepts should be given. Special formulas of interest only to the engineering student should not be stressed.

Student Learning Outcomes: M2371 satisfies the university core curriculum requirement in Mathematics: *"Students graduating from Texas Tech University should be able to demonstrate the ability to apply quantitative and logical skills to solve problems."* It meets the TTU general education student learning outcomes for mathematics that students will:

- Apply arithmetic, algebraic, geometric, statistical and logical reasoning to solve problems.
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically.
- Interpret mathematical and/or logical models such as formulas, graphs, tables and schematics, and draw inference from them.

In particular, students will

- compute derivatives of polynomials
- compute definite integrals with applications area

Text: *Calculus and its Applications* 9th Edition by Bittinger and Ellenbogen, published by Pearson

Course Outline

Chapter 1 .....10 days
Chapter 2 .....10 days
Chapter 3 ..... 8 days
Chapter 4 .....10 days
.....38 days

Course Number: **Mathematics 3370**
Descriptive Title: **Elementary Geometry**
Prerequisites: **MATH 2370**

About the Course: This course is designed to provide the prospective elementary school teacher with a basic background in elementary geometry. In addition it also introduces them to some basic ideas in probability and statistics. It will be taught in a "cooperative learning environment" with supplemental group exercises and other materials provided to all instructor by the Director of Undergraduate Program.

Student Learning Outcomes: Students should learn the basic concepts of Euclidean geometry, and become at ease with studying these concepts in a student centered, cooperative learning environment. These concepts include constructions, congruence and similarity, measurement, and motions and symmetries. Students should also learn the basic concepts of probability, and some basic concepts of statistics including statistical graphs and measures of central tendency and variation, and be aware of common methods of abusing statistics. (Instructor should include list of specific objectives depending on his/her conduct of the course.)

Text: *A PROBLEM SOLVING APPROACH TO MATHEMATICS OF ELEMENTARY SCHOOL TEACHERS* 10th Edition by Billstein, Libeskind, and Lott; published by Pearson

Course Outline

Chapter 11 (Intro Geometry/Basic Concepts) do not skip section 5 on networks.....4 days
Chapter 12 (Constructions/Congruence/Similarity).....6 days
Chapter 13 (Measurement).....7 days
Chapter 14 (Basic Motions/Tessellation).....6 days
Chapter 9 (Probability/Basic Concepts).....5 days
Chapter 10 (Statistics/Basic Concepts).....5 days
.....33 days

This should leave sufficient time for three hour exams in addition to the comprehensive final exam. There should also be time for class discussion of such things as the NCTM standards, pedagogy in general, and the use of manipulative and technology in particular, and possibly some class presentations.

Course Number: **Mathematics 3371**
Descriptive Title: **Elements of Finite Mathematics**
Prerequisites: **MATH 1331, 1351, or 2370**

Text: *FINITE MATHEMATICS* 9th edition by Lial, Greenwell, & Ritchey; published by Pearson

About the Course. This course is intended to introduce the prospective 5-8 teacher with topics from finite mathematics that are useful in everyday life.

Student Learning Outcomes: The student should learn how concepts from logic, mathematics of finance, probability and statistics, and combinatorics are used to solve real world problems of importance to the general population. Topics may include:

- Statements, truth tables, negations, analysis of arguments, quantifiers
- Simple and compound interest, present and future values of annuities, loan amortization
- Sets and Venn diagrams,
- Probability, conditional probability, probability distributions, expected value
- Understand Bayes' theorem and its significance
- Counting, permutation and combinations, binomial probability
- The normal distribution, normal approximation to the binomial distribution

In chapter 5, finance applications in simple and compound interest are discussed, as well as annuities and amortization. Chapter 6 is an introduction to logic. It introduces methods to analyze statements, find negations, and recognize arguments as valid or invalid. Some students respond well to the Lewis Caroll-style logic puzzles in 6.5. Chapter 7 lays the foundation for the study of probability and statistics. It reviews the fundamental aspects of set theory, including Venn Diagrams and tree diagrams. Basic probability, conditional probability and Bayes' Theorem is covered. Chapter 8 contains counting techniques, permutations, combinations, binomial probability, and probability distributions. Chapter 9 presents the rudiments of statistics, including graphical methods, measures of central tendency, measures of variation, the normal distribution, and the normal approximation to the binomial distribution. 9.1 and 9.2 may be reviewed fairly quickly, as most students will remember this material from Math 3370 and other courses.

Course Outline

Chapter 5 .....5 days
Chapter 6 .....8 days
Chapter 7 .....8 days
Chapter 8 .....7 days
Chapter 9 .....6 days
.....34 days

Course Number: **Mathematics 3372**
Descriptive Title: **Math Modeling for Teachers**
Prerequisites: **MATH 2371**

Student Learning Outcomes: This course will introduce mathematical models of simple systems in science and engineering. Examples may include growth rates in biology, biomechanical motion, financial models, and engineering fluid flow simulations. Necessary mathematical background includes exponential and logarithmic equations, matrix formulae, and differential equations. Both calculus based models and non-calculus based models will be used. Appropriate technology will be introduced and used as a simulation tool. Typical tools may include Maple, Mathematica, Logo, and Geometer's Sketchpad.

Learning Outcomes: The students will

- acquire skills needed to analyze mathematical models
- develop elementary mathematical models
- reinforce their knowledge of functions, including trigonometric functions
- develop elementary programming skills

Text: Instructor's notes, online readings, programming manuals

Course Outline:

Trigonometry review	6 days
Exponential and logarithmic equations	6 days
Differential equations	6 days
Maple programming	5 days
Technology for Geometry (Logo and Geometer's Sketchpad)	3 days
Growth models in biology and finance	6 days
Simulation models in engineering and medicine	6 days
Model wrap-up	1 day
	39 days

Course Number: **Mathematics 4370**
Descriptive Title: **Elementary Problem Solving**
Prerequisites: **MATH 3370**

About the Course: It is assumed that the students have a working knowledge of counting numbers, integers, rational numbers and, to a lesser extent, the reals, linear equations, and quadratic equations.

This course might as well be described as a ``baby" modern algebra course with a highly number theoretic orientation. To this extent divisibility, primeness, division algorithm, and modular arithmetic should be covered. Examples of groups, rings, and fields should be taken primarily from the integers, rationals, reals, and the complex number system as well as modular arithmetic. (0, 2, 4) Mod 6, under multiplication is an excellent example of a field and will focus attention on the concept of the multiplicative identity.

Student Learning Outcomes: Students will understand concepts of elementary number theory that underlie the arithmetic taught in the 5-8 classroom, including divisibility, primality, and the Fundamental Theorem of Arithmetic. Students should learn to solve more sophisticated counting problems using techniques such as the Euclidean Algorithm or Chinese Remainder Theorem. Students should learn concepts of modern algebra through comparing modular arithmetic with more familiar algebraic structures such as the integers, the rationals, and the real numbers. Students should be aware of modern applications of number theory to areas such as cryptology.

Text: Instructor's notes

Course Number: **Mathematics 4371**
Descriptive Title: **Basic Computer Literacy and Programming**
Prerequisites: **MATH 2371 or 3371**

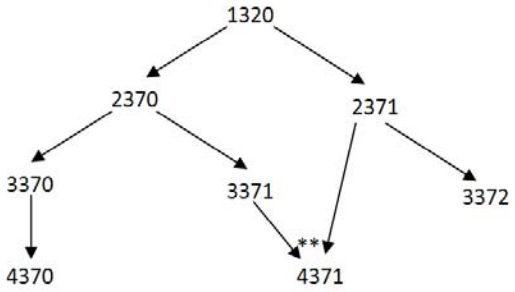
About the Course: This is a computer based, capstone course covering topics from all the previous 70-series courses in the context of the modern graphing calculator and the computer algebra system MAPLE.

Student Learning Outcomes: The students will

- develop the students' computer literacy
- get hands-on experience with computers and calculators
- develop elementary programming skills
- receive personal experience in computer-assisted instruction
- sharpen their basic mathematical skills
- learn the basics of programming with LOGO

Text: *COMPARATIVE TECHNOLOGY* by G.A. Harris

Prerequisite Flow Chart for "Elementary Math" Sequence



These prerequisites may be waived by the Department of Mathematics and Statistics, based on the student's background and demonstrated mathematical abilities.

**A student may take either 3371 or 2371 to enter 4371.

Future Scheduling of Upper Division "Elementary Math" Courses

Every Fall: 3370 and 3371
Every Spring: 3372 and 4370 and 4371
Even Summers: 3370 Summer 1 and 4370 Summer 2
Odd Summers: 3371 Summer 1 and 4371 Summer 2

Graduate Degree Programs

Master's Degree in Mathematics

The Department of Mathematics and Statistics offers the Master's Degree in Mathematics in each of the four options discussed below. The requirements listed below are in addition to the University and Graduate School requirements found in the Catalog of the Graduate School. Each student's program of study and committee must be approved by the Director of Graduate Studies in the Department of Mathematics and Statistics. The requirements listed here are to be regarded as *minimal* and the student should give very careful consideration to the selection of the particular option which is best suited to his or her needs. Work completed with a grade less than 'B' will not be accepted on a degree plan for any graduate degree in mathematics or statistics.

A. This option is a 30 hour plan leading to the degree of Master of Science. This plan calls for 24 hours of course work and at least 6 hours of the *thesis* course (MATH 6000). Of the 24 hours of course work, 18 must be in mathematics and must include *one* sequence in a core area. The core areas are: 1) Algebra, 2) Ordinary Differential Equations / Partial Differential Equations 3) Complex Analysis, 4) Probability and Statistics, 5) Real Analysis, 6) Topology, 7) Numerical Analysis. In the case of Real Analysis, 5318-5319 is not considered to be a core sequence for purposes of Option A; likewise with 5310-5311 in the area of Applied Mathematics. A minor of 6 hours in an approved area outside of mathematics is permitted. A thesis defense is required.

B. This option is a 36 hour plan leading to the degree of Master of Science. This program calls for 33 hours of course work and 3 hours of work on a departmental report (MATH 6310). Of the 33 hours of course work, 24 must be in mathematics and must include two sequences from the core areas listed in part A. A third core area is strongly recommended. A minor of 9 hours in an approved area outside mathematics is permitted. A presentation of the report and a final comprehensive examination is required.

C. This option is a 36 hour plan leading to the degree of Master of Science in Mathematics, and is designed for students desiring an emphasis in computer science. The plan calls for 18-21 hours of course work in mathematics, 12-15 hours of course work in computer science, and 3 hours of departmental report (MATH 6310). Of the 18-21 hours of mathematics course work, at least two sequences from the following list must be included:

MATH 5318-5319	(Intermediate Analysis)
MATH 5320-5321	(Complex Analysis)
MATH 5322-5323	(Real Analysis)
MATH 5324-5325	(Topology)
MATH 5326-5327	(Modern Algebra)
STAT 5328-5329	(Intermediate Mathematical Statistics)
MATH 5330, 5332	(Ordinary Differential Equations, Partial Differential Equation)
MATH 5334-5335	(Numerical Analysis)

The 12 to 15 hours of computer science course work constitute adjunct requirements (i.e., special requirements by the Department of Mathematics). These required courses must be taken from the graduate offerings in Computer Science and/or Information Systems and Quantitative Science (ISQS) in the Business College with the approval of the Director of Graduate Studies in the Department of Mathematics. The approved ISQS courses are 5338, 5341, 6337, 6339, 7338, and 7340. CS 5301 is not approved for Program credit. All other 5000-level CS courses may be used, with permission from the Graduate Advisor. A presentation of the report and a final comprehensive examination is required for completion of the program.

It is anticipated that a substantial number of students having mathematics degrees but *no background in computer science* will wish to enter this program. Such students will be required to take undergraduate leveling courses, as deemed appropriate in their individual cases, for *undergraduate credit only*. No such leveling work will be credited toward satisfying the above requirements.

D. This option is a 36 hour plan leading to the Master of Arts degree. This option is designed for persons who are teaching (or plan to teach) mathematics at the pre-university level. This plan calls for 33 hours of course work and 3 hours of work on a departmental report (MATH 6310). Of the 33 hours of course work at least 24 hours must be in mathematics. Of the seven sequences listed below, the student must complete at least three where the courses within each sequence are taken consecutively: 1) Algebra, 2) Geometry, 3) Analysis, 4) Number Theory, 5) Probability and Statistics, 6) Applied Mathematics, 7) Computer Literacy and Programming. Much of this work will be taken under the course numbers MATH 5360-5361 and 5364-5365. A minor of 9 hours in an approved area outside mathematics is permitted. Normally, work in the student's second field of certification or work towards the Professional Teacher's Certificate will be an acceptable minor area. A presentation of the report and final comprehensive examination is required.

With regard to all of the above programs, it is expected that the student's final oral defense of his/her thesis or report will be open to all who wish to attend, with scheduling to reflect this.

Master's Degree in Statistics

In order to enter the program of study leading to a Master of Science Degree in Statistics the applicant must meet the requirements of the Graduate School and of the Department of Mathematics. In addition, the applicant must satisfy the following undergraduate requirements:

a) differential and integral calculus (Calculus I, II, III),
b) linear algebra,
c) FORTRAN programming or some other high-level computer language.

The requirements b) and c) may be satisfied after admission into the program, but must be satisfied before the second year of study begins.

The degree requirements are:

1. Completion of STAT 5328-5329, Intermediate Mathematical Statistics; STAT 5373, Design of Experiments; STAT 5374, Theory of Linear Statistical Models; and STAT 5375, Statistical Multivariate Analysis. In addition, the completion of any two courses from the following list:

STAT 5372 Nonparametric Statistical Inference
STAT 5377 Statistical Sampling Theory
STAT 5378 Stochastic Processes
STAT 5379 Time Series Analysis
STAT 5386 Statistical Computing and Simulation I

2. Six hours of mathematics to be selected with the approval of the Director of Graduate Studies and the Statistics coordinator. Those students aspiring toward a Ph.D. (statistics emphasis) should take the Math 5318-5319 sequence during their first year of graduate studies.

3. One of the following two options (to be selected with the approval of the Director of Graduate Studies).
   a) Three hours in an area other than statistics, e.g., mathematics, animal science, computer science, biology, economics, engineering, psychology, or sociology. This option requires approval of the appropriate graduate advisor from the selected area.
   b) Three additional hours in Statistics (**to be selected from the Mathematics Department offerings**).

4. Either a six-hour Master's Thesis or a three-hour Master's Report with an additional three hour course to be selected from requirement 1 or 3 above. A thesis defense or a final comprehensive examination for the report is required.

NOTE: All statistics courses for the M.S. degree must be taken from the statistics offerings in the Department of Mathematics.

Doctoral Program

The following represents an outline of the Department of Mathematics policies concerning the doctoral program. These policies are supplemental to the general Texas Tech University policies as outlined in the official catalogs of the university. Specific questions concerning interpretation of these policies should be directed to the Graduate Advisor.

AREAS OF SPECIALIZATION

Each doctorate in mathematics at Texas Tech University will be based on the doctoral candidate's choice of an area of specialization from the following three broad specialty areas:

1. Applied Mathematics
2. Pure Mathematics
3. Statistics

Overall policy guidelines have been established by the Department of Mathematics with respect to work within these specialty areas.

PRELIMINARY EXAMINATIONS

The Doctoral Preliminary Examinations will be administered twice each year (in May and in August) and are offered in the seven areas corresponding to the following graduate core courses:

1. Algebra (MATH 5326-5327)
2. Complex Analysis (MATH 5320-5321)
3. Ordinary Differential Equations (MATH 5330) and Partial Differential Equations (MATH 5332)
4. Numerical Analysis (MATH 5334-5335)
5. Real Analysis (MATH 5322-5323)
6. Probability and Statistics (STAT 5328-5329)
7. Topology (MATH 5324-5325)

Each examination is four hours long with content based on important fundamental concepts in the area. Students should NOT infer that the Preliminary Examination is equivalent to a final examination over the respective core area. Rather, each examination is developed by a committee of faculty in the respective core area in consultation with the Graduate Committee. The topics over which a student can be tested are listed in the Preliminary Examination Topics List which is available from the Graduate Advisor.

At least three weeks prior to taking a Preliminary Examination the student must inform the Graduate Advisor which examinations he/she wishes to take. Up to three different examinations can be taken in each administration of the Preliminary examinations. The student must pass a total of three different examinations in four consecutive administrations of the Preliminary Examinations. This includes a requirement that at least one of the examinations must be in either Algebra, Complex Analysis, Real Analysis, or Topology. A grade of *P* (pass) or *F* (fail) will be given in each examination.

Any student who in four consecutive administrations of the Preliminary Examinations does not successfully complete the Doctoral Preliminary Examinations may not continue in the Doctoral Program in the Department of Mathematics at Texas Tech University.

QUALIFYING EXAMINATION

Each doctoral student will be required to pass a Qualifying Examination on advanced topics beyond those covered in the Preliminary Examinations. In general, the Qualifying Examination will follow the format established by the Texas Tech University Graduate Catalog. Any exceptions to this format must be agreed upon by both the student's Doctoral Advisory Committee and the Graduate Advisor.

FOREIGN LANGUAGE REQUIREMENT
Any foreign language requirement will be at the discretion of the student's dissertation advisor

AREA PROGRAMS
The following list of area programs is meant to be an outline of minimal requirements. The individual student is encouraged to supplement specified requirements with as much advanced work as possible.

Specific course requirement may be waived at the request of the student's Doctoral Advisory Committee with the consent of the Graduate Advisor.

Advanced topics seminars which contribute to the student's overall mathematical background will be offered each semester. It is expected that each student will participate in seminar work in his/her area of specialty.

Note that Math 5316, and Math 5318-5319 will not be counted toward a doctoral degree.

APPLIED MATHEMATICS
1. All of the following three sequences:
MATH 5322-5323 Functions of a Real Variable I and II
MATH 5330 Ordinary Differential Equations I and
MATH 5332 Partial Differential Equations I
MATH 5334-5335 Numerical Analysis I and II

2. At least one of the following sequences:
MATH 5320-5321 Functions of a Complex Variable I and II
STAT 5328-5329 Intermediate Mathematical Statistics I and II

3. At least six courses, different from the courses used in part 2, chosen from:
MATH 5312-5313 Control Theory I and II
MATH 5320-5321 Functions of a Complex Variable I and II
MATH 5324-5325 Topology I and II
MATH 5326-5327 Modern Algebra I and II
MATH 5331 Ordinary Differential Equations II
MATH 5333 Partial Differential Equations II
MATH 5340-5341 Functional Analysis I and II
MATH 5354-5355 Biomathematics I and II
MATH 5382-5383 Advanced Probability I and II
STAT 5328-5329 Intermediate Mathematical Statistics I and II
STAT 5378 Stochastic Processes
STAT 5379 Time Series Analysis

4. At least six additional courses which are usually related to the student's dissertation area. These courses may be listed under MATH 5342-5343 or MATH 5344-5345.

5. Twelve hours of MATH 8000

PURE MATHEMATICS
1. All of the following four sequences:
MATH 5320-5321 Functions of a Complex Variable I and II
MATH 5322-5323 Functions of a Real Variable I and II
MATH 5324-5325 Topology I and II
MATH 5326-5327 Modern Algebra I and II

2. An additional six hours in mathematics to serve a unifying role to the courses in Section 1. This requirement will usually be met by MATH 5340-5341 Functional Analysis I and II. With approval of the student's Doctoral Advisory Committee and the Graduate Advisor, other courses serving the same purpose may be acceptable.

3. Twelve hours of course work providing breadth in training. These will normally come from the following courses:
STAT 5328-5329 Intermediate Mathematical Statistics I and II
MATH 5330 Ordinary Differential Equations I
MATH 5332 Partial Differential Equations I
MATH 5334-5335 Numerical Analysis I and II

With the approval of the student's Doctoral Advisory Committee and the Graduate Advisor, other courses serving the same purpose may be acceptable.

4. At least eighteen additional hours of advanced course work to be approved by the student's Doctoral Advisory Committee and the Graduate Advisor. These courses will normally include work related to the student's area of specialization but need not be confined to that area.

5. Twelve hours of MATH 8000

STATISTICS
1. All of the following sixteen courses:

MATH 5322-5323 Functions of a Real Variable I and II
MATH 5382-5383 Advanced Probability I and II
STAT 5328-5239 Intermediate Mathematical Statistics I and II
STAT 5370 Decision Theory
STAT 5372 Nonparametric Statistical Inference
STAT 5373 Design of Experiments

STAT 5374 Theory of Linear Statistical Models
STAT 5375 Statistical Multivariate Analysis
STAT 5376 Advanced Statistical Methods
STAT 5377 Statistical Sampling Theory
STAT 5378 Stochastic Processes
STAT 5379 Time Series Analysis
STAT 5380 Advanced Mathematical Statistics I

2. At least two of the following sequences:
MATH 5320-5321 Functions of a Complex Variable I and II
MATH 5330 Ordinary Differential Equations I and
MATH 5332 Partial Differential Equations I
MATH 5334-5335 Numerical Analysis I and II

3. Twelve hours of MATH 8000

A DISSERTATION IS REQUIRED OF EVERY CANDIDATE FOR THE DOCTORAL DEGREE. THIS REQUIREMENT IS SEPARATE AND APART FROM OTHER REQUIREMENTS IN THE DOCTORAL PROGRAM. CONSEQUENTLY, SUCCESSFUL PERFORMANCE IN OTHER AREAS DOES NOT NECESSARILY GUARANTEE THE ACCEPTANCE OF A DISSERTATION. THE DISSERTATION SHOULD EMBODY A SIGNIFICANT CONTRIBUTATION TO NEW INFORMATION TO THE SUBJECT.

FINAL EXAMINATION
A final public oral examination over the student's dissertation topics is required of every candidate for the doctorate.

EACH DOCTORAL STUDENT SHOULD BECOME FAMILIAR WITH THE UNIVERSITY AND DEPARTMENTAL REQUIREMENTS AND DEADLINES FOR THE DOCTORAL DEGREE.

Graduate Course Outlines

The pages that follow contain information about certain courses in the main body of the graduate program. Recent textbooks and course content are included for some of the courses.

Course Number: **Mathematics 5310-5311**
Descriptive Title: **Principles of Classical Applied Analysis**
Text: *Applied Linear Algebra & notes from Applied Mathematics,* both by P. Oliver, published by Person

Partial differential equations, separation of variables, Fourier series, Sturm-Louiville theory, Green's functions, Laplace and Fourier transforms, calculus of variations

Course Number: **Mathematics 5316**
Descriptive Title: Applied Linear Algebra
Text: *Matrix Theory: A Second Course*, by Ortega, Pluenum Press.

Solution of linear systems, matrix inversion, vector spaces, projections, determinants, eigenvalues and eigenvectors, Jordan forms, computational methods, and applications.

Course Number: **Mathematics 5318-5319**
Descriptive Title: Intermediate Analysis
Text: *Principles of mathematical analysis, by W. Rudin, 3rd Ed.*

This sequence covers the topics of single and multivariable advanced calculus in greater depth and with more rigor than in an ordinary advanced calculus course. It forms a bridge between senior-level analysis and the more advanced graduate studies in real analysis and functional analysis. Students with a good background in basic analysis can go to 5322-5323 directly.

Learning Outcomes: Upon completion of this two-semester series, students should master concepts and theories of single and multi variable calculus, including: sets, real number system, formal definition of limits of sequences, Cauchy sequences, epsilon-delta definition of limits of functions, continuous functions, differentiation, mean value theorems, Taylor's theorem, Riemann integrals, fundamental theorems of calculus, infinite series, sequences and series of functions, linear transformation and differentiation of multi-variable functions, inverse and implicit function theorems, vector calculus, and Green's, Stokes', and divergence theorems.

Course Number: **Mathematics 5320-5321**
Descriptive Title: Functions of a Complex Variable
Text: *Functions of One Complex Variable*, by Conway, Springer-Verlag, 2nd Edition.

Geometry and analysis of the complex plane. Topology of the plane. Analytic functions and conformal mapping. Complex integration. Residue theory. Maximum Modulus Theorem and its applications. Normal families and mereomorphic functions. Analytic continuations and Riemann surfaces. Harmonic function theory.

Learning Outcomes: Upon completion of this two-semester series, students should master concepts and theories of geometry and analysis of complex plane, topology of the plane, analytic functions, conformal mapping, complex integration, residue theory, maximum modulus theorem and its applications, normal families, meromorpic functions, analytic continuations, and harmonic function theory.

Course Number: **Mathematics 5322-5323**
Descriptive Title: Real Analysis
Text: *Real Analysis and Modern Techniques,* by G. Folland, 2nd Edition

Topics covered primarily during the first semester of this course include a general development of measure, integration, convergence theorems, decomposition of measures and L^p theory. Chapters 2, 3, 5 and 6 represent the core of material covered in 5322. In 5323 basic elements of functional analysis, as well as topics in Fourier analysis and probability theory, are covered. Other topics that might be covered are selected at the instructor's discretion. The necessary auxiliary topological facts are taught as they are needed for the main developments.

Learning Outcomes: Upon completion of this two-semester series, students should master concepts and theories of outer measures, the Caratheodory extension theorem, general measures, Lebesgue integrals with respect to a measure, Lebesgue measures, Lebesgue-Stieltjes measures, product measures, convergence theorems, Fubine-Tonelli theorem, signed measures, functions of bounded variation, absolutely continuous functions, differentiation theory, differentiation of a measure, metric spaces, compactness, Banach spaces, Lp spaces, Hilbert spaces, basic Fourier analysis, bounded linear functionals, dual spaces, and bounded linear operators.

Course Number: **Mathematics 5324-5325**
Descriptive Title: Topology
Text: *General Topology*, by S. Willard.

Mathematics 5324 will deal with the basics of metric and general topology: topologies, closure, bases and refinements, continuity, topological equivalence, compactness, paracompactness, connectedness, subspaces and embeddings, and separation properties. Core theory to be covered will include the metrization theorems of Urysohn and Bing-Nagata-Smirnov, the Tietze Extension Theorem, the Tychonoff Product Theorem, and the Stone-Cech Compactification, this fundamental cluster of material to be supplemented at the instructor's discretion.

Mathematics 5325 will deal with basic topics in algebraic topology: homotopy, fundamental groups, covering spaces, homology and exact sequence analysis, and special topics at the discretion of the instructor.

Learning Outcomes: In the two-semester sequence students should develop an understanding of basic concepts and relations of general topology. The first semester covers bases, subbases, subspaces, continuity and homeomorphisms, connectedness in its various forms, compactness, separation axioms , countability properties, products, quotients and metrization theorems. The second semester further covers metric and complete metric spaces, function spaces, as well as basics of homotopy theory, including covering spaces, fundamental group, surfaces and applications.

Course Number: **Mathematics 5326-5327**
Descriptive Title: Modern Algebra
Text: *Abstract Algebra*, by Dummit and Foote.

This two-semester sequence assumes the student has had undergraduate courses in abstract algebra and linear algebra. Topics covered are groups (solvability, nilpotency, Sylow theorems, groups acting on sets), rings (ideals, factorization in commutative rings), modules (standard functions and constructions, modules over principal ideal

domains with applications to linear algebra), fields (extensions, Galois theory, structure of finite fields) and commutative algebra (localization, primary decomposition, polynomial and power series rings). Time permitting, topics in noncommutative ring theory will also be studied.

Learning Outcomes: Upon completion of this two-semester series, students should master concepts and theories of groups (solvability, nilpotency, Sylow theorems, groups acting on sets), rings (ideals, factorization in commutative rings), modules (standard functions and constructions, modules over principal ideal domains with applications to linear algebra), fields (extensions, Galois theory, structure of finite fields), and commutative algebra (localization, primary decomposition, polynomial and power series rings).

Course Number: **Statistics 5328-5329**
Descriptive Title: Intermediate Mathematical Statistics
Text: *Statistical Inference*, by George Casella, Roger Berger, 2nd Edition.

Statistics 5328: Random variables, mathematical expectation, probability density functions, cumulative distribution functions, conditional distributions, special distributions, transformation of random variables, order statistics, moment generating functions, limiting distributions, central limit theorem, stochastic convergence.

Statistics 5329: Point estimation, interval estimation, confidence intervals for means, confidence intervals for difference of means, efficiency of estimators, statistical hypotheses, uniformly most powerful tests, likelihood ratio tests, chi-square tests, noncentral chi-square, noncentral F, sufficient statistics.

Learning Outcomes: Upon completion of this two-semester series, students should master concepts and theories of random variables, mathematical expectation, probability density functions, cumulative distribution functions, conditional distributions, special distributions, transformation of random variables, order statistics, moment generating functions, limiting distributions, central limit theorem, stochastic convergence, point estimators, statistical hypotheses, uniformly most powerful tests, likelihood ratio tests, chi^2 tests, noncentral chi^2, noncentral F, and sufficient statistics.

Course Number: **Mathematics 5330-5331**
Descriptive Title: **Ordinary Differential Equations**
Text: *Nonlinear Systems, by H. Khalil, 3rd Ed.*

M5330 is regarded as the first semester of a two-semester sequence that includes M5332. M5330 is a first course in the theory of ordinary differential equations. Prerequisites are undergraduate differential equations. Mathematical maturity at the level of 5318 and 5319 is desired. The topics to be covered in the first semester include: Existence and uniqueness results for initial value problems, dependence on data, continuation of solutions and maximal intervals of existence, linear equations and systems,
oscillation theory, stability, Sturm-Liouville theory and boundary value problems, Green's functions.

M5331 is an advanced topics course in ordinary differential equations. The content is selected at the discretion of the instructor.

Learning Outcomes: Upon completion of this course, students should master concepts and theories of existence and uniqueness of initial value problems, dependence on data, continuation of solutions and maximal intervals of existence, linear equations and systems, oscillation theory, stability. Students will acquire an introductory level knowledge on basic concepts of the theory of dynamical systems, such as invariant sets, manifolds and their stability, and chaos.

Course Number: **Mathematics 5332-5333**
Descriptive Title: Partial Differential Equations
Text: *Partial Differential Equations*, Lawrence Evans

M5332 is the second semester of the two-semester sequence that includes M5330 and is designed as a first course in partial differential equations. The content includes quasi-linear and linear first order equations, classification of PDE's, hyperbolic equations, elliptic equations, and parabolic equations.

M5333 is an advanced topics course in partial differential equations. The content is selected at the discretion of the instructor.

Learning Outcomes: Upon completion of this course, students should master concepts and theories of quasi-linear and linear first order partial differential equations, classification of partial differential equations, hyperbolic equations, elliptic equations, and parabolic equations.

Course Number: **Mathematics 5334-5335**
Descriptive Title: Numerical Analysis
Text: Recommended: Concise Numerical Mathematics, by Robert Plato.

Mathematics 5334 covers computer arithmetic and error analysis; interpolation techniques; numerical differentiation and numerical quadrature; direct and iterative methods for solution of systems of linear equations.

Mathematics 5335 covers numerical solution of ordinary differential equations; solution of nonlinear systems of equations; calculation of eigenvalues and eigenvectors; special topics.

*Learning Outcomes***:** Upon completion of this two-semester series, students should become proficient in the theoretical, analytical, and computational study of numerical analysis. Students should master concepts in computer arithmetic, rounding error analysis, numerical solution of nonlinear equations in one variable, interpolation theory, numerical differentiation, numerical quadrature, numerical linear algebra, approximation theory, direct and iterative methods for solution of linear systems, computational solution of eigenvalues-eigenvectors problems, numerical solution of initial-value differential equation systems, computational solution of systems of nonlinear equations, numerical optimization, and computational solution of boundary-value problems.