Preface

Introduction to the Kentucky Edition:

This text is a minor adaptation of Professor Neal Koblitz's notes from his University of Washington Math 124 course. Professor Koblitz generously permitted their use in this extension to Kentucky of his idea of a complete calculus text for which students pay only the reproduction costs. Errors which have been introduced into the text during the adaptation process are the responsibility of the Affordable Text Project of the University of Kentucky, edited by Paul Eakin, Carl Eberhart, and Avinash Sathaye.

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Prerequisites: Topics You Should Have Studied Before Taking Ma 113. Basic High School Algebra, Plane Geometry and Trigonometry are prerequisites to MA113. If you have taken a pre-calculus course (perhaps called *advanced math* or *functions* in high school or Ma 110 *Analytic Geometry and Trigonometry* here at UK), you are prepared to take this course.

The following are a few of the ideas from basic algebra and geometry which you will encounter in MA113. The list is far from complete. You should have previously studied and understood all of them. Although you may have forgotten the details of most you should be confident that with a *very* brief review you could re-establish your ability to solve problems with these ideas.

If you have not previously encountered a significant number of the following topics, then you may want to speak to your instructor or teaching assistant. They can discuss your background and preparation with you and help you make sure that you are in the right course.

- Cartesian coordinates, coordinates of points in the plane
- slope of a line,slope of a line perpendicular to a given line
- equation of a line through two points,equation of line given point and slope
- area of circle, rectangle, triangle; surface area of sphere, cylinder, rectangular box
- volume of sphere, rectangular box, cylinder, cone
- circumference of circle, perimeter of rectangle, triangle
- quadratic formula,multiplication and "long division" of polynomials
- addition and multiplication of rational functions
- factorization of $x^2 - y^2$, $x^3 - y^3$, $x^3 + y^3$
- equation of a circle with given center and radius
- points of intersection of a circle and a line
- factor $x^2 - y^2$ and $x^3 - y^3$, expand $(a + b)^2$ and $(a + b)^3$
- absolute value, right triangle, similar triangles
- Pythagorean Theorem, law of sines, law of cosines, radian measure

You should have worked with and previously explored the graphs of functions like the following. You should be able to graph these on a graphics calculator or computer.

- x,x^2,x^3,x^2-3x+2,e^x, e^{-x}
- x^3-x, $1/x$, $1/x^2$, $x+1$, x^2+1, x^3+1
- $1/(x+1)$, $1/(x^2+1)$,$x-1$, $(x-1)^2+2$, $(x^3-1)-3$, $1/(x-1)+1$
- $1/(x^2-1)+1$, $|x|$,$|x-2|$, $\log(x)$, $\ln(x)$,e^{-x^2}
- $\sin(x)$, $\cos(x)$, $\tan(x)$

Advice for Students

The overwhelming emphasis in this course is on applications — story problems. To master story problems one needs a tremendous amount of practice — doing homework, worksheet, and practice exam problems. For this reason, this course will require much more of your time than would a high school or community college calculus course that does not have such a focus on word problems.

Here are some pointers for doing story problems:

1. Carefully read each problem twice before writing anything.
2. Assign letters to quantities that are described only in words; draw a diagram if appropriate.
3. Decide which letters are constants and which are variables. A letter stands for a constant if its value remains the same throughout the problem.
4. Using math notation, write down what you know and then write down what you want to find.
5. Decide what category of problem it is (this might be obvious if the problem comes at the end of a particular chapter, but will not necessarily be so obvious if it comes on an exam covering several chapters).
6. Double check each step as you go along; don't wait until the end to check your work.
7. Use common sense; if an answer is out of the range of practical possibilities, then check your work to see where you went wrong.

Suggestions for Using These Notes

1. Read the example problems carefully, filling in any steps that are left out (ask someone if you can't follow the solution to a worked example).
2. Later use the worked examples to study by covering the solutions, and seeing if you can solve the problems on your own.
3. Give yourself the practice midterms and finals in an exam situation (without access to material other than a single sheet of notes, and with the same time limit as on the exam).
4. The answers to homework and practice exam problems that are in the back of the notes should be used only as a final check on your work, not as a crutch. Keep in mind that sometimes an answer could be expressed in various ways that are algebraically equivalent, so don't assume that your answer is wrong just because it doesn't have exactly the same form as the answer in the back.

Formulas Used in This Course

Algebra

Completing the square: $X^2 + bX + c = (X + \frac{b}{2})^2 - \frac{b^2}{4} + c$.

Quadratic formula: roots of $aX^2 + bX + c$ are $\dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

Exponents: $a^b \cdot a^c = a^{b+c}$; $\quad \dfrac{a^b}{a^c} = a^{b-c}$; $\quad (a^b)^c = a^{bc}$; $\quad a^{1/b} = \sqrt[b]{a}$.

Geometry

Circle: circumference $= 2\pi r$; area $= \pi r^2$.

Sphere: vol $= \frac{4}{3}\pi r^3$; surface area $= 4\pi r^2$.

Cylinder: vol $= \pi r^2 h$; lateral area $= 2\pi r h$; total surface area $= 2\pi r h + 2\pi r^2$.

Cone: vol $= \frac{1}{3}\pi r^2 h$; lateral area $= \pi r\sqrt{r^2 + h^2}$; total surface area $= \pi r\sqrt{r^2 + h^2} + \pi r^2$.

Analytic geometry

Point-slope formula for straight line: $y = y_0 + m(x - x_0)$.

Circle centered at (h, k): $(x - h)^2 + (y - k)^2 = r^2$.

Ellipse with semimajor axis along x-axis and semiminor axis along y-axis: $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$.

Trigonometry

$\sin = \dfrac{\text{opposite}}{\text{hypotenuse}}$; $\cos = \dfrac{\text{adjacent}}{\text{hypotenuse}}$; $\tan = \dfrac{\text{opposite}}{\text{adjacent}}$;

$\sec = \dfrac{1}{\cos}$; $\csc = \dfrac{1}{\sin}$; $\cot = \dfrac{1}{\tan}$; $\tan = \dfrac{\sin}{\cos}$; $\cot = \dfrac{\cos}{\sin}$;

$\sin x = \cos\left(\frac{\pi}{2} - x\right)$; $\cos x = \sin\left(\frac{\pi}{2} - x\right)$;

$\sin(x + \pi) = -\sin x$; $\cos(x + \pi) = -\cos x$.

Law of cosines: $a^2 = b^2 + c^2 - 2bc\cos A$.

Law of sines: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$.

Sine of sum of angles: $\sin(x + y) = \sin x \cos y + \cos x \sin y$.

$\sin^2$ and $\cos^2$ formulas: $\sin^2 + \cos^2 = 1$; $\sin^2 x = \dfrac{1 - \cos(2x)}{2}$; $\cos^2 x = \dfrac{1 + \cos(2x)}{2}$.

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