Mathematical Software Evaluation Report:
Mathcad Plus 6.0 versus Mathematica 3.0

Steven M. Hadfield, Carl Crockett, Paul J. Simonich, Matthew G. Mcharg, and William J. Mandeville

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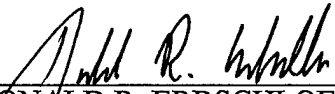
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In early 1997, the Department of Mathematical Sciences at the United States Air Force Academy conducted an evaluation to determine whether to migrate from Mathematica 2.2 to Mathematica 3.0 or to switch to Mathcad Plus 6.0 which was being successfully used by the Department of Physics. A 38-member team evaluated the suitability of both software packages in terms of user-friendliness and functionality using sample problems taken from Precalculus, Calculus I, II, and III, Differential Equations, and Engineering Mathematics as well as some advanced physics courses. This technical report is a comprehensive documentation of this evaluation describing the methodology, findings, and conclusions of this evaluation. In the end, the Department of Mathematical Sciences choose to migrate to Mathematica 3.0 due primarily to superior functionality, while the Department of Physics found that Mathcad Plus 6.0 met all of their needs and was easier to use by their students.

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This research report entitled "Mathematical Software Evaluation: Mathcad 6.0 versus Mathematica 3.0" is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author. Therefore, the views expressed in this article are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the US Government.

This report has been cleared for open publication and public release by the appropriate Office of Information in accordance with AFM 190-1, AFR 12-30, and AFR 80-3. This report may have unlimited distribution.

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DONALD R. ERBSCHLOE, Lt Col, USAF
Director of Research

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6 Feb 98
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MATHEMATICAL SOFTWARE EVALUATION REPORT

February 1997

Department of Mathematical Sciences
United States Air Force Academy

MATHEMATICAL SOFTWARE EVALUATION: MATHCAD PLUS 6.0 VS MATHEMATICA 3.0
Jan-Feb 1997

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ATTACHMENTS:

ABSTRACT

In early 1997, the Department of Mathematical Sciences at the United States Air Force Academy conducted an evaluation to determine whether to migrate from Mathematica 2.2 to Mathematica 3.0 or to switch to Mathcad Plus 6.0 which was being successfully used by the Department of Physics. A 38-member team evaluated the suitability of both software packages in terms of user-friendliness and functionality using sample problems taken from Precalculus, Calculus I, II, and III, Differential Equations, and Engineering Mathematics as well as some advanced physics courses. This technical report is a comprehensive documentation of this evaluation describing the methodology, findings, and conclusions of this evaluation. In the end, the Department of Mathematical Sciences choose to migrate to Mathematica 3.0 due primarily to superior functionality, while the Department of Physics found that Mathcad Plus 6.0 met all of their needs and was easier to use by their students.

MATHEMATICAL SOFTWARE EVALUATION: MATHCAD PLUS 6.0 VS MATHEMATICA 3.0

1. OVERVIEW

In January 1997, the Department of Mathematical Sciences undertook an evaluation of mathematical software to support our core calculus and engineering mathematics courses. A 38-member interdepartmental team including 10 members from other departments conducted the evaluation. This report documents the methodology, results, and recommendations of the evaluation.

Since the Fall 1993 semester, the Department of Mathematical Sciences has been using Mathematica versions 2.2.2 and 2.2.3 to support core calculus and engineering mathematics courses. The choice of Mathematica was the result of an extensive study done in the Spring of 1993. Since our adoption of Mathematica, we have learned much about how to use this technology both in the classroom and within the general course work. We have also experienced numerous challenges getting novice users up to speed on this high-powered program, dealing with multiple user installations, and coping with software bugs. We have heard reports from client departments that cadets are not carrying Mathematica skills forward and that, given the choice, many cadets prefer to use the Mathcad Plus program made available through the Physics Department. Finally, a new, more user-friendly version of Mathematica (Version 3.0) became available in December 1996. This new version meant that we would eventually have to upgrade to the new version to retain supportability. As a result, Col Litwhiler decided the time was right for us to reevaluate our choice of software to support our core calculus and engineering mathematics courses.

This report documents the methodology and results of this evaluation process, as well as other ancillary issues pertinent to the software package decision. Section 2 overviews the evaluation process. Section 3 reports the results of this team's evaluation focusing on both useability and functionality. Section 4 addresses key ancillary issues with the two packages that are relevant to the decision-making process. Section 5 provides pricing information on the two software packages considered. Section 6 offers suggestions for transitioning to either of the two software packages. Section 7 provides recommendations for the software package selection. Section 8 suggests some advice for the next software evaluation. Finally, Section 9 acknowledges the many individuals that contributed to this evaluation.

2. METHODOLOGY

The mathematical software evaluation process began in October 1996. At that time DFMS sent out packages to our client departments announcing the upcoming evaluation and soliciting volunteers from these other departments. We also asked for a specification of the other departments' requirements and an identification of packages they would like

us to consider (besides Mathematica Ver 3.0 and Mathcad Plus Ver 6.0). From this solicitation, we received eleven volunteers from other the departments to assist with the evaluation, but there were no additional requirements identified (in addition to those we proposed) and no other software packages were proposed to be included in the evaluation process. Major Geoff Mcharg and Capt Jody Mandeville from DFP volunteered to be major players in the process both as the advocates and trainers for Mathcad and as primary planners for the evaluation process.

The next step was to develop test suites for the evaluation process. The Fall 1996 course directors for core calculus and engineering mathematics courses developed a set of exercises that represented how we typically use a mathematical software package to support each of these courses. The specific courses are shown in Table 1. The test items were reviewed by the appropriate academic division chiefs and stated in as generic a manner as possible to avoid a bias to one package or the other. Major Geoff Mcharg also developed a set of test items representative of how DFP currently uses the Mathcad Plus program in their upper division courses. The result was seven test packages; one for each of the six mathematics courses and one for physics. These packages are included with this report as Attachments 1 through 7. We also had a generic package which client departments could customize with test items of their own making that reflected how they would use these software programs. The only client department that responded was DFEE. Their completed package is included as Attachment 8.

TABLE 1: Courses With Test Packages

Course #	Description
Math 130	Precalculus
Math 141	Calculus I
Math 142	Calculus II
Math 243	Calculus III
Math 245	Differential Equations with Matrices
Math 346	Engineering Mathematics

While the test packages were being developed, the two software package advocates: Capt Paul Simonich, DFMS (Mathematica Advocate) and Capt Jody Mandeville, DFP (Mathcad Plus Advocate), were busy preparing training materials for their respective software packages and securing the necessary copies of the software and documentation. This was very demanding and both Capt Simonich and Capt Mandeville did an outstanding job. They were very careful to coordinate their training materials to insure comparable content and scope. The Mathematica materials are included as Attachment 9 and the Mathcad Plus materials as Attachment 10.

Our experiences with Mathematica over the past three and a half years have taught us that user-friendliness is of at least equivalent importance to functionality in a mathematical software program. In order to effectively evaluate the user-friendliness perspective (from here on referred to as "useability"), we decided to use a large evaluation committee. We

also wanted as many evaluators as possible that did not have previous experience with the two software packages. To this end, we solicited the help of casual status lieutenants currently assigned to DF, CW, and AH. However we were only able to get two of these to help out; Lt Malan, DFAN, and Lt Herrera, DFBL. Some of the volunteers from other departments also helped in this regard, but the bulk of the evaluation team membership came from DFMS instructors.

The evaluation team was organized by test packages (courses) with eight evaluators on each package. Of these eight, half started on Mathematica and half on Mathcad Plus. Within these groups of four, two received training and two did not (relying only on on-line help facilities and the documentation). Determination of who received training and who did not was left largely up to individual preference. This organization of the evaluation team was purposely designed to account for and balance out as many biases as possible. Also, each course/test package had an assigned "course leader" and an alternate. These individuals would get started a few days early, make sure each test item in the package was evaluated, and serve as a primary source of assistance to the other evaluators of that course. The actual assignments of the evaluation team are included as Attachment 11.

The actual evaluation process started on 13 Jan 97 with a twenty-minute meeting of the entire evaluation team. At this meeting the assignments and test packages were provided and the process reviewed. The slides used for this meeting are included as Attachment 12. The first training sessions took place immediately following this meeting. The intent was for all the evaluators to complete their tests using the first software package prior to 21 Jan 97. On this date the second training sessions occurred. The final results were originally scheduled to be due on 29 Jan 97, but this was extended to 31 Jan 97.

3. RESULTS

Within each test package two ratings were given for each test item and for the overall package. One rating was for useability of the software (how easy was it to perform the desired function) and the other for functionality (how well the function was performed). For each rating there were ten points to be divided up between the two software programs (Mathcad Plus and Mathematica) with the better program receiving proportionally more of the points. The overall ratings for each test package were based on the included test items as well as the evaluator's perception of how well the software program would support the overall requirements for that course. The time required to perform each test item was also recorded by some of the evaluators. All of these results are reported within the test packages for each course included as Attachments 1 through 8. The overall ratings are also summarized by evaluator, in the reports included as Attachment 13. These overall ratings are also summarized in the figures and tables below. The figures present average ratings while the tables generally provide the number of evaluators that showed a preference to one program or the other (that is, they gave a rating greater than 5 points out of 10). To put these preference ratings in context, they are presented together with the total number of evaluators providing ratings in that category. For example, a result of "5/12" means that 5 of the 12 evaluators providing a rating gave a score of above 5.

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These numerical results are augmented by comments from the evaluators, which are included as Attachment 14. Many important points were raised in these comments and we have tried to summarize them in this report but we strongly recommend also going straight to the source and reading these comments directly.

The overall results of all the evaluators on all of the test packages are presented in Figure 1 and Table 2 below. There was a slight preference towards Mathematica in terms of useability and a more significant preference towards Mathematica for functionality. However there were significant differences among the courses and most of the evaluation team came from DFMS which has been using an earlier version of Mathematica for several years now. Hence a more detailed analysis is required and we shall break out the results by course, department, experience, training, and which package was tested first.
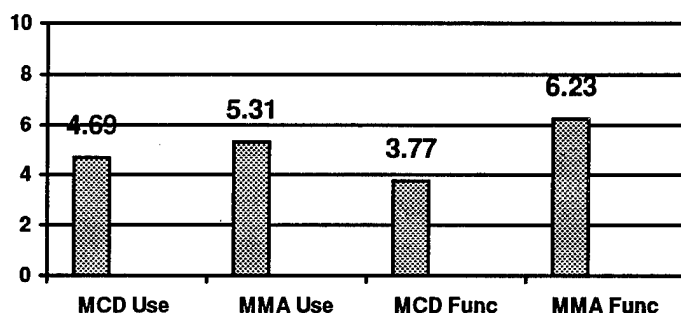
Figure 1: Overall Ratings (All Courses)

TABLE 2: Overall Evaluator Preferences

Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
17/48	24/48	4/48	36/48

The "by course" test package results are provided in Figure 2 and Tables 3 & 4. More details on these results can be found in Attachments 1 through 8 where results for each test item are reported as well as the time needed to execute each test item. Also provided below are more detailed discussions of the results from each course package.

For Math 130: Precalculus, Mathcad was rated low in both useability and functionality. The key problem was with Mathcad's plotting functions which require user specification of step size and do not provide automated "adaptive step sizes" around singularities and other extreme behaviors in the function being plotted. These problems showed up most noticeably when graphing trigonometric and rational functions. (The MathSoft representative told us that Mathcad Plus 7.0 due out late Spring 1997 will have an adaptive step size in its plotting function). The evaluators also preferred the way in which Mathematica solved equations and allowed for zooming in on regions of a plot. For more

details, see Attachment 1 and the comments by Major Bussian and Capt Brown in Attachment 13.
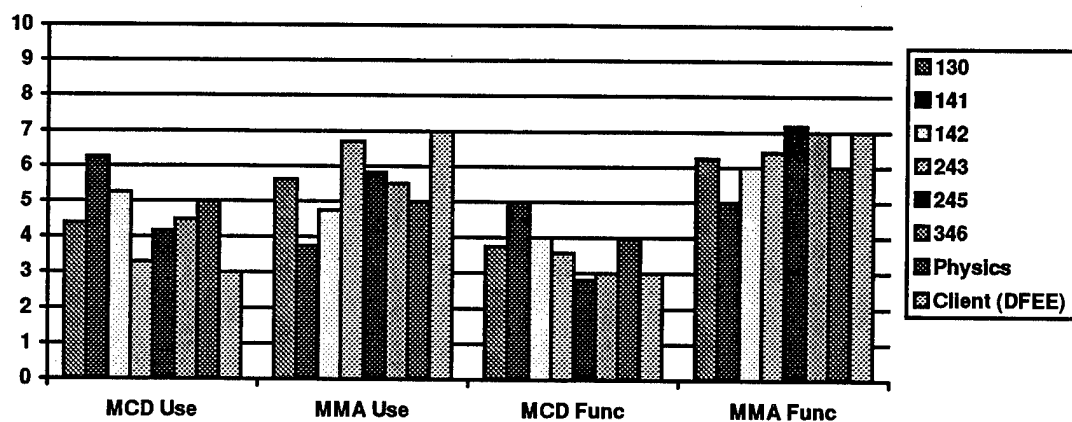
Figure 2: Overall Ratings By Course

TABLE 3: Ratings By Course

Course	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
Math 130	4.38	5.62	3.75	6.25
Math 141	6.25	3.75	5.0	5.0
Math 142	5.25	4.75	4.0	6.0
Math 243	3.29	6.71	3.57	6.43
Math 245	4.17	5.83	2.83	7.17
Math 346	4.50	5.50	3.0	7.0
Physics	5.0	5.0	4.0	6.0
Client (only DFEE)	3.0	7.0	3.0	7.0

TABLE 4: Evaluator Preferences By Course

Course	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
Math 130	1/8	6/8	1/8	5/8
Math 141	5/8	2/8	1/8	4/8
Math 142	4/8	2/8	1/8	6/8
Math 243	1/7	6/7	0/7	6/7
Math 245	1/6	4/6	0/6	5/6
Math 346	3/6	2/6	0/6	6/6
Physics	2/4	1/4	1/4	3/4
Client (only DFEE)	0/1	1/1	0/1	1/1

For Math 141: Calculus I, Mathcad was preferred for useability and tied for functionality. This was the only course for which Mathematica was not preferred for functionality. The

only functionality difference was that Mathcad could not apply L'Hopital's rule for evaluating limits where Mathematica could.

For Math 142: Calculus II, the two packages were essentially tied for useability, but Mathematica was preferred for functionality. However, the evaluators strongly preferred Mathcad for doing Taylor polynomials.

With Math 243: Calculus III, we saw a strong swing towards Mathematica primarily due to weaknesses with Mathcad's 3D plotting and the inability for Mathcad to superimpose different types of graphics upon each other (like parametric plots on top of a vector field). The makers of Mathcad, MathSoft, provided a copy of their Axum software which can be integrated into Mathcad Plus and offers significant enhancements to the 3D plotting capabilities. However, even with Axum, we found no ability to superimpose graphics of different types. The evaluators preferred Mathematica for doing parametric plots in general and also for solving systems of nonlinear equations. They preferred Mathcad for dealing with vectors and for graphing tabular data.

Similarly, Mathematica was preferred for Math 245: Differential Equations with Matrices. The primary problem was that Mathcad can not solve differential equations symbolically like Mathematica can with it's "DSolve" command. This is a major requirement for Math 245 and really hurt Mathcad. However, Mathcad was preferred for use doing Laplace transformations. Also noticed during the Math 245 evaluations was that some of the differential equations that Mathematica 2.2.3 (old version) could solve just fine could not be solved (or were solved in a less preferred manner) by Mathematica 3.0. Details are provided in Attachment 16.

In Math 346: Engineering Mathematics, the inability of Mathcad to symbolically solve systems of differential equations hurt significantly. The 3D plotting issues of Math 243 would also carry forward to Math 346 as the first block of Math 346 is an extension of Math 243. Also, Mathematica was preferred for dealing with Fourier integrals.

In the package from the Physics department, only 8 of the 14 provided test items were accomplished. The test items for this package were taken from several advanced physics courses and tended to be very difficult and time-intensive. Given less than three weeks during the start of the semester to accomplish the tests, it is not surprising that this was all that could be accomplished. Of the eight items evaluated, the programs tied on four and Mathematica was preferred on the other four. It should be noted however, that of the four evaluators that worked on this package, three had more experience with Mathematica than with Mathcad which becomes especially important with these more difficult problems.

Only one of our representatives from a client department accomplished an evaluation of client requirements. DFEE ran nine tests representative of typical equations required for use in EE classes, running the gamut from sophomore classes through senior classes. Of the nine items, the programs tied on four, MathCAD was favored on one, and

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Mathematica preferred on the remaining four. However, DFEE requirements typically do not demand the analytical capability of Mathematica for their needs. Many projects and assignments for EE classes require numerical analysis and graphing, which does not utilize the analytical evaluation capability of Mathematica and Mathcad. For numerical analysis, DFEE prefers MATLAB.

When reviewing these ratings, it is important to keep in mind that 35 of the 48 evaluations came from DFMS where Mathematica Version 2.2 has been in use for several years now and all new department members have received training in this program. Figure 3 and Table 5 below break out the overall ratings by DFMS (35 evaluations), DFP (3 evaluations), and all 13 non-DFMS evaluations (including DFP). There is a notable preference for Mathematica in the DFMS members both in terms of useability and functionality that likely results from our experience with the program. The non-DFMS members tended to slightly prefer Mathcad for useability and Mathematica for functionality.
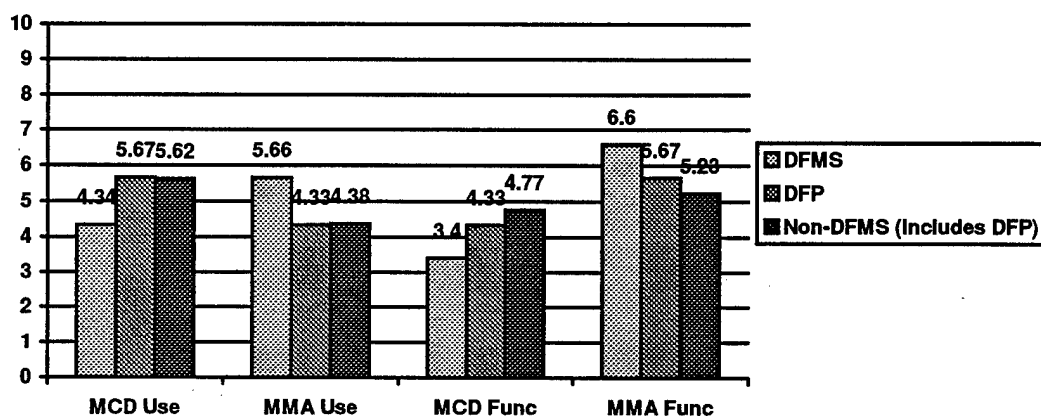
Figure 3: Overall Ratings by Department

TABLE 5: Evaluator Preferences By Department

Department	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
DFMS	10/35	21/35	1/35	30/35
DFP	2/3	0/3	1/3	2/3
Non-DFMS (Includes DFP)	7/13	3/13	3/13	6/13

One of the most important observations made was to correlate the results by experience level. Maj Mcharg and Capt Mandeville in DFP suggested this during our setting up of the evaluation process. We included items on the test packages where the evaluators would report their experience levels with each of the programs (options were "None", "Some", or "Lots"). Reported in Figure 4 and Table 6 are the overall results for those that

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reported "None" for experience with either Mathcad (MCD), Mathematica (MMA), or both.

There were five evaluators with eight evaluations that reported no experience on either program ("Both None"). Of these evaluations Mathcad got a slight nod for useability and for functionality. But these results include large deviations. Dr Lisowski of DFAS strongly preferred Mathematica while Lt Herrera of DFBL strongly preferred Mathcad. The others rated the two packages nearly equal.

Thirty-two (32) evaluations reported "None" for Mathcad, but only 12 reported "None" for Mathematica. Importantly, the preference was typically towards the program that the evaluator had more experience with which likely hindered Mathcad's showing due to the larger number of evaluators unfamiliar with it.
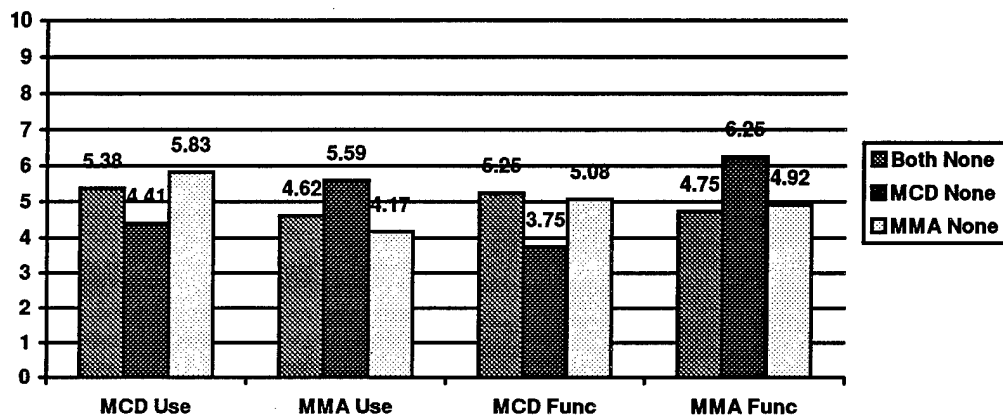
Figure 4: Overall Ratings By Experience

TABLE 6: Evaluator Preferences By Experience

Experience	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
Both None	3/8	2/8	2/8	2/8
Mathcad None	8/32	19/32	3/32	24/32
Mathematica None	7/12	2/12	3/12	4/12

Half of the evaluators received training on both programs while the other half received no training on either program. The overall results by these two categories are shown in Figure 5 and Table 7 below. They indicate a slightly higher preference for Mathematica if training was received on both packages.
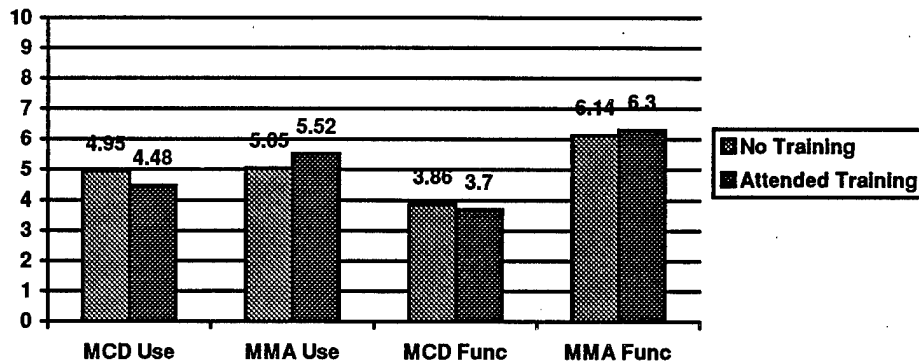
Figure 5: Overall Ratings By Training

TABLE 7: Evaluator Preference By Training

Attended Training	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
No	8/21	12/21	3/21	16/21
Yes	9/27	12/27	1/27	20/27

The last correlation was done by which program was evaluated first based on the premise that this could affect the ratings. To this end, half of the evaluators started with Mathcad and the other half with Mathematica. The overall results by this categorization are shown in Table 8 and Figure 6. In these results, Mathematica was consistently preferred but it was preferred more by those that used it first.

TABLE 8: Evaluator Preferences By First Program

First Software Package	Mathcad Useability	Mathematica Useability	Mathcad Functionality	Mathematica Functionality
Mathcad Plus	9/22	10/22	4/22	16/22
Mathematica	8/26	14/26	0/26	20/26
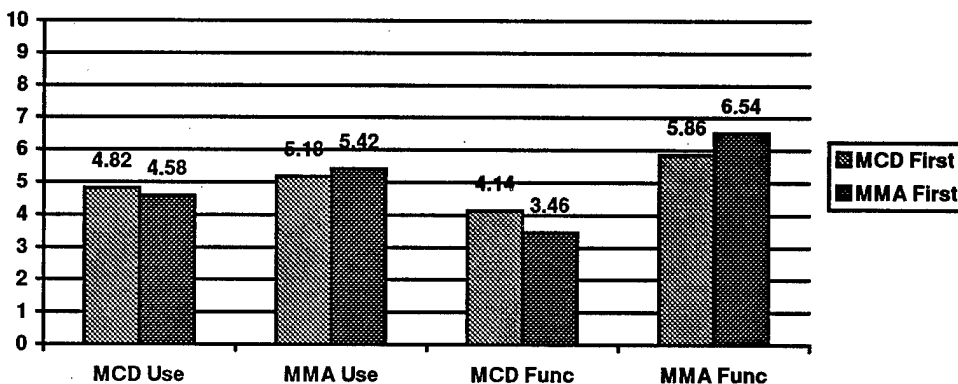
Figure 6: Overall Rating By First Program

During the evaluations, the evaluators provided comments and reports of anomalies on the two programs. Major anomalies and deficiencies are reported in Attachment 15 for Mathcad and Attachment 16 for Mathematica. Minor comments provided with the test items were accumulated and recurring themes are provided with their frequency of mention in Tables 9 (Mathcad) and 10 (Mathematica) below. In these tables, the "+" indicates a positive comment and the "-" indicates a negative comment.

TABLE 9: Comments on Mathcad Plus 6.0

	Comment	Frequency
+	Mathcad easier to learn	7
+	Liked the more visual approach	5
+	Found plotting to be easier	3
+	Preferred Mathcad's animation capability	3
+	Mathcad executed faster	3
+	Like the toolbar (speed buttons)	2
+	Can export movie files of animations	1
-	Vague help facilities	7
-	Have to specify mesh points for plotting	5
-	Too many weird keystroke sequences to remember	4
-	Lack of adaptive graphing	4
-	Weak 3D plotting	3
-	Weird programming constructs	2
-	Factoring for roots gave result as "f(x)=" vice "x="	1
-	User hostile	1
-	Default output to only 3 decimal places	1
-	Disliked scratch pad format	1

TABLE 10: Comments on Mathematica 3.0

	Comments	Frequency
+	Better help facilities	7
+	Graphics looked better	4
+	More powerful program	3
+	Can build course-specific palettes	1
-	Cryptic error messages	5
-	Multiple input modes confusing	3
-	Requires package loading for many functions, should be done automatically	3
-	Ver 3.0 did not improve user-friendliness	3
-	Ver 3.0 no longer has the handy speed buttons	2
-	Weird keystrokes to extend a matrix	1
-	Pull-down menus are not sticky (can not make them stay down)	1

4. OTHER CONSIDERATIONS

The primary emphasis of the evaluation effort was to assess the useability and functionality of the two programs on a head-to-head basis. However, there are other very significant issues that also must be factored into the selection decision. Most all of these were brought up and discussed in the extended comments from the evaluators that are included as Attachment 14. They are briefly summarized and discussed below:

A) <u>Existing Resources and Retooling</u>: DFMS has been using Mathematica for three and a half years and has devoted significant effort into developing Mathematica-based resources to support our courses. These include lesson notebooks, computer projects and exercises, and quick reference guides. These are all directly transferable to Mathematica 3.0 (but would need some minor modifications to demonstrate the new symbolic type-setting capabilities). However, a transition to Mathcad Plus 6.0 would require some significant "retooling" (term coined by Dr Judy Holdener). Table 11 below summarizes our course directors' assessment of how much time (in man-weeks) would be required to re-establish our current baseline in Mathcad.

B) <u>Software Support</u>: The makers of Mathematica, Wolfram Research, have been somewhat notorious for a lack of customer support, slowness to correct errors, and emphasis on protecting their product instead of making it easy to use. The latest evidence of this is their password mechanism to protect Mathematica Version 3.0. When you purchase Version 3.0, you get a license number. Upon installation, their software generates a "Math ID" number which is unique to your computer. You must then provide the license and Math ID numbers to Wolfram Research, via either mail, email, or phone, and they will then generate a password for your system that you must enter for the software to execute (fortunately you only need to enter this number once). Their email system to accomplish this typically takes 4 to 7 days for a response and we resorted to using the phone. The mechanism for entering these numbers is also

TABLE 11: Retooling Requirements

Courses	Resources	Time Estimates
Math 130	Course Materials	1 week
Math 141	Problem Sets	2 weeks
Math 142	Introduction/tutorial	1 week
	Lesson Notebooks	5 weeks
	Quick Ref Guides	1 week
	Projects	1 week
Math 243	Lesson Notebooks	1 week
	Computer Exerices	2 weeks
Math 245	Lesson Notebooks	4 weeks
	Computer Exercises	2 weeks
Math 346	Tutorial (new)	1 week
	Lesson Notebooks	2 weeks
	Computer Exercies	1 week

very syntax-sensitive and a misplaced space or hyphen can mess up the entire process. We have complained to Wolfram that this mechanism would be completely unacceptable for a large installation like we would have with the Cadet Wing. On 14

Feb 97, they told us via an email that they are developing an unlimited site license version that would utilize a single password for all installations (same approach that we use with the current Version 2.2.3 of Mathematica). They hope to have it available by the end of March 1997. (This was accomplished in April 1997).

C) Computer Support: Mathcad Plus 6.0 will run on any Windows 3.1 machine which makes it supportable by any of our current systems in the Cadet Wing, faculty, and labs. Mathematica 3.0 however requires Windows 95 (which means at least a 66 MHz 486 processor) as well as 120 Megabytes of storage (for a full installation). Hence, Mathematica is only practical for the Class of 2000 and later computers in the Cadet Wing. (The Class of 1999 computers could run it but they would need to have Windows 95 installed and it would stress the capacity of their 540 MB disk drives). Furthermore, only a portion (probably around half) of the faculty computers could run Mathematica 3.0 and almost none of our DFMS classroom computers would be capable. Mr Larry Bryant, DF's Director of Academic Computing, told Lt Col Crockett that all the faculty computers should be Windows 95 capable by the end of AY 97-98, although not all would be Pentiums. There are not, however, funds to upgrade the classroom computers, so some faculty would have to take non-Windows 95 machines if we are to put Windows 95 machines in the classrooms. Thus the computer support requirements for Mathematica 3.0 can be met within the next year but it will require some sacrifice. Together, the computer support issues from both the cadet and faculty sides direct us to a phased implementation spanning 2-3 years where we provided both the 2.2.3 version as well as the new 3.0 version.

D) Use In Later Courses: One of the driving reasons behind this evaluation process was complaints from client departments that the cadets were not using Mathematica in their later courses. Investigation of some of these reports found that many times the projects and assignments given to the cadets were better addressed by other software packages that were more suited to data analysis and simple graphing. So, at least in some cases, the cadets were simply using the best tool for the job. However, we admit that the DFMS focus on using Mathematica has been on supporting our course objectives. If use of the software in later courses is a real objective, we should work with our client departments to better understand how they might use the software and design our applications to better prepare the cadets to use the software later.

E) Training: Regardless of which software program is selected, we need to accept the fact that training on the selected program is essential. Both casual status Lieutenants on the evaluation committee pointed out that DFMS does not in general provide enough in-class time instruction on Mathematica. Part of the reason for this might also be that we don't spend enough time training our faculty on the program (although there as been a steady trend of more instruction provided during new instructor training). Both Mathematica and Mathcad are high powered, state-of-the-art software programs with which users will require some significant training to gain an acceptable level of proficiency. This was noted time and time again in the evaluators comments (refer to Attachment 14). If we are going to make the selected software a useable tool for the cadets, we need to more fully integrate it into our courses and require our instructors to use it during class.

F) <u>Educational Resources</u>: There are currently many textbooks and supplemental texts for using Mathematica and Maple to support courses such as those we have looked at in this study. The number of such texts for Mathcad is much smaller, although there are some new ones from McGraw-Hill just now hitting the market. Therefore, there is currently a much richer resource base to draw from for using Mathematica as compared to Mathcad.

G) <u>Status of the Software Programs</u>: Mathematica 3.0 was just released in December 1996. While it includes many new features, its true Beta testing period was short and we have found several errors with it. Also, it does have the very inconvenient password mechanism. We hope for follow-on minor releases to correct these problems but will have to deal with a stabilization period for this program. Mathcad Plus 6.0 is a more stable release, but a new version 7.0 release is planned for late Spring 1997. While this new release will have significant user-friendliness enhancements made possible by MathSoft's acquisition of Visual Sciences, this significant new version will also require a stabilization period.

5. PRICING

Wolfram Research has agreed to a site license arrangement for Mathematica 3.0 with a yearly cost of $14,430 which covers cadet and faculty use. They have also expressed that this price per year could be used for a three to four year contract. Under current arrangements this cost is divided up across the incoming class of cadets each year for a per cadet cost in the $10-$15 range. This license would only apply for use at the Academy and would not carry forward after graduation. Interested cadets and faculty/staff could purchase Mathematica 3.0 for $295 a copy. Under these arrangements we could retain access to Mathematica 2.2.3 but with limited support.

MathSoft will sell Mathcad Plus 6.0 for $25.99 per copy or bundled with the Axum data analysis and graphics program for $29.99 per copy to all incoming freshman cadets. This is a personal copy license that could also be purchased by other cadets, faculty, and staff. For those not purchasing a personal copy, there is a site license available for $16,250.00 plus an annual renewal fee of 50% of the initial cost per year for up to four years. This site license includes provisions for faculty to use the program on their home computers. However, the site license is predicated on requiring the entire incoming class to purchase the program. Hence the total cost for the software would be two to three times more for Mathcad, but the cadets would be able to retain the software after graduation.

6. TRANSITION PLANS

With either choice of mathematical software package, there will be a significant transition effort. For Mathcad Plus 6.0, the primary driver will be the time and effort required to retool resources and training materials as well as to train our faculty on the new software. For Mathematica 3.0, the challenges will be on overcoming the password problem and acquiring sufficiently powerful Windows 95 computers for the faculty and our classrooms. Plans for each of these two transitions are outlined below in Tables 12 and 13,

respectively. With either software package, we should consider adding at least one additional lab lesson to help the students get up to speed on the new program.

TABLE 12: Transition to Mathcad Plus 6.0

Semester	Activities
Spring 1997	- Make license arrangements for Mathcad Plus 6.0 - Arrange for Mathematica license for one year (AY 97-98) for transition
Summer 1997	- Retool for Math 130, 141, 142 (for Spring offering), & 152
Fall 1997	- Use Mathcad for 130, 141, & 152 - Use Mathematica 2.2.3 for 142, 243, 245, 346
Spring 1998	- Use Mathcad for 141 & 142 - Use Mathematica for 243, 245, & 346
Summer 1998	- Retool for Math 243, 245, & 346
Fall 1998	- Fully transitioned to Mathcad

TABLE 13: Transition to Mathematica 3.0

Semester	Activities
Spring 1997	- Work with Wolfram Research on password situation resolution - Arrange for Mathematica license for both versions 2.2.3 & 3.0 - Default installation will be version 2.2.3 until resolution of password (Those wishing 3.0 may load it off the net & get their own password) or install version 3.0 if password problem resolved in time - Work to acquire more Windows 95 machines for classrooms & faculty
Summer 1997	- Prepare course materials for version 2.2.3 (upward compatible to 3.0)
AY 97-98	- Retain both 2.2.3 & 3.0, move to 3.0 starting with earlier courses and moving up based on availability of Windows 95 machines for faculty and classrooms and password resolution
AY 98-99	- Retain versions 2.2.3 & 3.0
AY 99-00	- Fully transitioned to 3.0 (as all cadets will now have Windows 95)

7. RECOMMENDATIONS FOR SELECTION DECISION

With selection of either Mathcad Plus 6.0 (with Axum) or Mathematica 3.0, we in DFMS need to:

- Continue to improve how we provide training on the selected software program. We need to devote at least one and preferably more lessons to training on the program, use it consistently in the classroom, and make it an integral part of the courses by continuing to incorporate it into our course work. In order to effectively do this we need to continue to improve how we train our new and current instructors on the software to include course-specific training probably integrated into course meetings.

- Work more closely with our client departments to better understand their needs for a mathematical software package and, where possible, tailor our computer exercises to help provide the cadets with skills that they can use later. Importing and analyzing observed data comes to mind as an immediate example.

Regarding the decision of which program to select, our hope was that Mathcad was going to answer our user-friendliness problems. While it is probably preferable in user-friendliness for the new cadet, the difference is not near as profound as we hoped and, if we were to select it, there would likely be similar levels of resistance from the Cadet Wing. Mathcad also had serious deficiencies when it came to supporting our Engineering Math Division courses; Math 243, 245, and 346. Specifically, Mathcad has weak 3D plotting, can not overlay different types of graphics, and can not symbolically solve ordinary differential equations. There was quite a general agreement that Mathematica 3.0 has superior functionality. The major drawbacks to Mathematica 3.0 are the password problem, potential instabilities with the new release, the need for Windows 95 computers, and the fact that cadets don't get to keep it. The password, instability, and computer support issues can be worked. In our opinion, being able to retain the software after graduation is not a big deal as cadets will use whatever package is available at their next duty assignment.

Since Mathcad Plus does not significantly enhance user-friendliness and can not fully support our course requirements, the recommendation is for migration to Mathematica 3.0 utilizing both versions 2.2.3 and 3.0 during the transition. Exact timing of when 3.0 becomes the default program loaded on new computers would be determined based on resolution of the password problem and the acquisition of Windows 95 computers for the faculty and classrooms. However, if the password problem is not resolved by Fall 97 or there are significant stability problems with 3.0, we should look at the Mathcad Plus 7.0 release and strongly consider its adoption for the Class of 2002 computers.

8. RECOMMENDATIONS FOR NEXT EVALUATION

Several "lessons learned" became apparent after finishing this evaluation. The most significant of these was that the criteria of "user-friendliness" was evaluated by more "sophisticated" users than the first and second year cadets that will be the primary users of the software. Several key members of the evaluation team were concerned that our experienced members may have chosen the package they were most familiar with when judging the user friendliness issue. Since most of the evaluators were familiar with Mathematica, the possibility exists that the results in this key criteria are not what would be found if novice users were polled.

We suggest that in the future faculty members evaluate the functionality and novice users (preferably younger cadets) do the evaluation of user-friendliness. Another suggestion was to use the competing software programs in different sections of a course or to give the cadets the option and see which they prefer. Obvious problems of money and cadet time exist with both of these possibilities, but both offer the possibility of a more accurate assessment of the user-friendliness issue.

It was also suggested that if cadets are used for the evaluation, the support of core courses continues to be separated from the support of the more advanced courses and that

appropriate groups of cadets be used for each of these two categories. Furthermore, the more cadets that can be involved, the better the assessment would be.

We suggest that when having relatively inexperienced users evaluating user-friendliness, the evaluators start with a template of a worked problem and then ask the cadets to modify the template to solve a different, but related problem. Then they could be asked to solve an entirely different problem from scratch.

A second area of suggestion was on the amount and length of test problems. Especially for evaluating user-friendliness, it was suggested that a significantly smaller set of problems could be used and that the level of difficulty could be eased back on some of the problems. Perhaps the faculty evaluators could use an initial larger set of problems while addressing functionality and then develop a smaller set of easier problems to pass on to the cadet evaluators looking at user-friendliness. Capt Matt Santoni also suggested that we could do a more rigorous job of tracking time-on-task for working the exercises and use this as a measure of user-friendliness.

Finally, Capt Mandeville suggests that a decision matrix be developed prior to the evaluation. The decision matrix would assign a priori weights to the various criteria. The evaluation scores would then have these weights applied for determination of final comparative scorings.

9. ACKNOWLEDGMENTS

This evaluation is the result of the efforts of many very talented and gifted individuals that have an amazing capacity for teamwork and selfless dedication to a common objective. Starting at the top, Lt Col Carl Crockett initiated and structured the overall evaluation. He provided tremendous advice and counsel but also gave us freedom to explore. Major Steve Hadfield (DFMS) organized, planned, and directed the evaluation. Maj Geoff Mcharg (DFP), Capt Jody Mandeville (DFP), and Capt Paul Simonich (DFMS) worked extensively starting from the initial planning all the way through the execution and analysis. Maj Mcharg coordinated with MathSoft for all the Mathcad Plus resources, provided numerous sanity checks of our test plans and organization, developed the physics test package, and suggested numerous improvements to our plans. Capt Mandeville was our Mathcad Plus 6.0 expert and advocate. He researched Mathcad extensively and developed and presented an excellent training session on that program. Capt Simonich served as our Mathematica 3.0 expert and advocate. He developed an exceptional training package for Mathematica, spearheaded the effort to get Mathematica 3.0 running on our systems, and provided much input and sage advice on the planning of this effort. In addition to all their other contributions, Maj Mcharg, Capt Mandeville, and Capt Simonich also served as evaluators for our hardest test packages.

One of the most valuable features of this evaluation was the extensive support received from our sister departments. In total we had ten volunteers from other departments participate as evaluators. They all did wonderful jobs and provided some of our most

valuable results. These individuals are: Maj Ken Gurly (DFP), Capt Zoe Hale (DFEE), Lt Marc Herrera (DFBL), Dr Ron Lisowski (DFAS), Lt Mark Malan (DFAN), Capt Jody Mandeville (DFP), Maj Geoff Mcharg (DFP), Capt Brian Mork (DFC), Capt Matt Santoni (DFEG), and Major Paul Waters (DFEM).

The rest of the evaluators came from DFMS with an enthusiastic teamwork response that is quite common place in the DFMS family. The volunteers from DFMS were Lt Cols Steve Heinecke and Barry Sarnacki; Majors Ralph Boedigheimer, Eric Bussian, Tim Cooley, Michele Gaudreault, Steve Hadfield, Deb Hall, Marie Revak, Jim Rutledge, and Rich Schooff; Doctors Judy Holdener and Brad Kline; and Capts Jeff Barrows, Cindy Brown, Bob Clasen, Todd Cusick, Patti Egleston, Neil Huber, Bruce Maddox, Tim Mueller, Harry Newton, Dave Pendergraft, Paul Simonich, John Trujillo, Dave Tuteral, Rob Wolverton, and Bob Young. Mr Larry Bryant from DF provided significant assistance along the way especially working with Wolfram Research. Capt Bob Young, the DFMS OCM, also provided tons of assistance insuring that the necessary computing resources were in place to include loading Windows 95 on several machines and securing new Pentium 166s for our timing and baseline testing.

Attachments:
1. Math 130 Test Package with Results
2. Math 141 Test Package with Results
3. Math 142 Test Package with Results
4. Math 243 Test Package with Results
5. Math 245 Test Package with Results
6. Math 346 Test Package with Results
7. Physics Test Package with Results
8. DFEE Client Test Package with Results
9. Mathematica Training Materials
10. Mathcad Training Materials
11. Evaluation Committee Assignments
12. Kick-Off Meeting Briefing Slides
13. Overall Rating Reports
14. Evaluator's Extended Comments
15. Mathcad Plus 6.0 Anomalies and Deficiencies Report
16. Mathematica 3.0 Anomalies and Deficiencies Report

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 130 PRECALCULUS TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS ARE INCLUDED>
DEPT:
PHONE:

ATTENDED TRAINING:	Yes		No
COMPUTER USED FOR TESTING:	486		Pentium
COMPUTER CLOCK SPEED:	33MHz	100MHz	133MHz _____
OPERATING SYSTEM:	Windows 3.1		Windows 95
MATHCAD EXPERIENCE:	None	Some	Lots
MATHEMATICA EXPERIENCE:	None	Some	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support this course both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.38	5.62	3.75	6.25

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: 130.1

Plot the polynomial function $f(x) = x^4 - 4x^2 + 3$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.86	5.14	4.29	5.71

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (2,2,2,5) -> 2.75
MMA TIMES (3,2,13,5) ->5.75

TEST ITEM: 130.2

Plot the rational function $(x-1)/(x+2)$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.14	5.86	3.86	6.14

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (7,3,4,2) -> 4
MMA TIMES (3,1,1,2) -> 1.75

TEST ITEM: 130.3

Plot $sin(x)$, $cos(x)$, $tan(x)$, $sec(x)$, $csc(x)$ and $cot(x)$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.57	5.43	2.71	7.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (33,6,5,5) -> 12.25
MMA TIMES (15,1,3,2) -> 5.25

TEST ITEM: 130.4

Plot $y = 3 \sin(2x + Pi/2) - 1$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.14	4.86	3.86	6.14

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (3,1,2,2) -> 2
MMA TIMES (4,1,2,2) -> 2.25

TEST ITEM: 130.5

Simplify $(\cot(x)*\sec(x))/\csc^2(x)$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.71	5.29	5.57	4.43

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,5,2,10,3) -> 5
MMA TIMES (2,2,5,3) -> 3

TEST ITEM: 130.6

Factor and solve for the roots of the polynomial: x^3-x^2+x-1.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.67	5.33	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,13,3,32,20) -> 14.6
MMA TIMES (2,2,3,5) -> 3.0

TEST ITEM: 130.7

Set $v=x^2+3x+1$, then express $v^2+2v+\sin(v)$ in terms of x.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.57	7.43	3.71	6.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (6,5,10,20) -> 10.25
MMA TIMES (2,5,3,1) -> 2.75

TEST ITEM: 130.8

Define the function $f(s) = \cos(s)*\sin(1-s)$ and find $f(2)$ and $f(x+h)$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.86	5.14

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (6,2,10,10) -> 7
MMA TIMES (2,2,3,8) -> 3.75

TEST ITEM: 130.9

Evaluate the following expressions out to 5, 15, and 50 decimals and time the computation:

$$\tan(\frac{\pi}{6}), \qquad \sin(\frac{\pi}{24}), \qquad 1\Big/\cot(\frac{\pi}{12})$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	3.71	6.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (4,4,3,5) -> 4
MMA TIMES (4,2,4,5) ->3.75

TEST ITEM: 130.10

Solve the following equations for x:

$$x^{20} + x^{15} - 26x^{10} + x^4 - x^3 + 1 = 0$$

$$2\cos(x) - e^x = 0$$

$$x^4 + 3x^3 - 2x^2 + 10x + 1050 = 0$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.71	6.29	4.29	5.61

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (44,25,15,15) ->24.75
MMA TIMES (10,4,10,6) ->7.5

TEST ITEM: 130.11

Evaluate the expression: $\tan^{-1}(\frac{y}{x})$ for (x,y) pairs: (1,3), (-1,3), (1,-3), (-1,-3).

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.29	6.71	3.0	7.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (6,2,5,1) ->3.5
MMA TIMES (3,2,5,6) ->4

TEST ITEM: 130.12

Use the software to plot $f(x) = x^3-3x^2+1$ and $g(x)=1-x^3$ on the same axes. Solve f(x)=g(x) by solving algebraically and by zooming in (visual inspection).

COMMENTS: Once plotted it must be easy to change the range and domain, so students can zoom in on points of interest on the graph.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.71	4.29	4.86	5.14

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (32,15,3,8,5) ->13.6
MMA TIMES (10,3,7,2) ->5.5

TEST ITEM: 130.13

Use the software to plot the function $f[x] = x^2 +50000/x$ and find the minimum or maximum of a function without the use of calculus.

COMMENTS: Find minimum by zooming and by use of some type of "Findmin" command

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.67	7.33	1.83	8.17

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (19,15,15,7) ->14
MMA TIMES (3,5,2,6) ->4

TEST ITEM: 130.14

Use animation to show the change in plots of functions as we change the degree of the polynomial. (show x, x^3 , x^5 , x^7 ,... and similar for even functions)

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.8	5.2	2.6	7.4

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15,30,8) ->17.7
MMA TIMES (9.30,7) -> 15.3

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 141 CALCULUS I TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS INCLUDED>		—
DEPT:		
PHONE:		

ATTENDED TRAINING:	Yes	No		
COMPUTER USED FOR TESTING:	486	Pentium		
COMPUTER CLOCK SPEED:	33MHz	100MHz	133MHz	____
OPERATING SYSTEM:	Windows 3.1	Windows 95		
MATHCAD EXPERIENCE:	None	Some	Lots	
MATHEMATICA EXPERIENCE:	None	Some	Lots	

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support this course both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.25	3.75	5.0	5.0

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: 141.1

$$v(t) = 5 \times 10^3 \ln\left(\frac{3.6 \times 10^4}{3.6 \times 10^4 - 100t}\right) - 39t$$

1. Integrate this equation over t=0 to 60.
2. Solve v(60).
3. Take the derivative of v(t).
4. Plot v(t). Label all axes. Use grid-lines and a frame.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.43	4.57	5.71	4.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,11,5,30) -> 19
MMA TIMES (5,30,3,90) -> 32

TEST ITEM: 141.2

$$v(t) = \ln(3710.4\pi(t+1)) + \sin\left(\frac{t}{55}\right)$$

1. Plot v(t). Label all axes. Use grid-lines and a frame.
2. Find the roots of v(t).
3. Find the antiderivative of v(t).
4. Integrate v(t) over t=0 to 539.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.42	4.58	4.57	5.43

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (11,5,25) -> 13.7
MMA TIMES (30,3,180) ->71

ATTACHMENT 2

TEST ITEM: 141.3

Compute the following:

$$\lim_{x \to -1} \frac{x^2 - 1}{x + 1}, \qquad \lim_{x \to -2} \frac{x^3 + 8}{x + 2}, \qquad \lim_{x \to 0} \frac{3(1 - \cos(x))}{x}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.5	4.5	5.5	4.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,5,15,2,3) -> 7
MMA TIMES (12,5,2,2) -> 5.25

TEST ITEM: 141.4

Compute the first derivatives of the following functions:

$$f(x) = x^2 - 3x - 3x^{-2}$$

$$f(x) = \frac{1}{\sqrt[3]{x^2}}$$

$$f(x) = (3x - 2x^2)(3x - 3x^{-2})$$

$$f(x) = \frac{1 - \cos(x)}{\sin x}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.33	4.67	5.5	4.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15,13,3,2) -> 8.25
MMA TIMES (15,3,2) ->6.67

ATTACHMENT 2

TEST ITEM: 141.5

Given the following complex numbers:

$$z1 = 4 + 5i \qquad z2 = -2 + 3i \qquad z3 = 1 - 4i$$

1. Evaluate z1 + z2.
2. Evaluate z2 * z3.
3. Evaluate z1 / z3.
4. Convert z2 to the polar form.
5. Raise z3 to the 4th power.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.57	4.43	5.67	4.33

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (25,10,5) ->13.3
MMA TIMES (20,4,15) -> 13

TEST ITEM: 141.6

1. Convert the following points from Cartesian coordinates (x,y) to polar coordinates (r,theta):

(1,1) (2,1) (-3,2) (0,4) (-5,0) (0,0)

2. Convert the following points from polar coordinates (r,theta) to Cartesian coordinates (x,y):

(5,Pi/4) (3,5*Pi/6) (-2,Pi/3)

3. Use a polar plotting function to plot the graphs of :

$r = 3$, $r = 2\cos(\text{theta})$, $\text{theta} = Pi/4$, $r\cos(\text{theta}) + 6 = 0$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.8	5.2

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15,120,5,60) ->50
MMA TIMES (20,5,120) ->48.3

ATTACHMENT 2

TEST ITEM: 141.7

Given the following vectors:

$$v1 = <1, 3, -2> \quad v2 = <2, -4, 5> \quad v3 = <4, 0, -3>$$

1. Compute the dot product of v1 and v2.
2. Compute v1 + 3*v2 - v3.
3. Compute the cross product of v1 and v2.
4. Plot the vectors: v1, v3, and v1+v3 on the same plot.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.6	5.4	5.8	4.2

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (34,10) -> 22
MMA TIMES (8,30) -> 19

ATTACHMENT 2

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 142 CALCULUS II TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS ARE INCLUDED>		
DEPT:		
PHONE:		
ATTENDED TRAINING:	Yes	No
COMPUTER USED FOR TESTING: 486		Pentium
COMPUTER CLOCK SPEED:	33MHz 100MHz 133MHz _____	
OPERATING SYSTEM:	Windows 3.1	Windows 95
MATHCAD EXPERIENCE:	None Some	Lots
MATHEMATICA EXPERIENCE:	None Some	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support this course both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.25	4.75	4.00	6.00

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

ATTACHMENT 3

TEST ITEM: 142.1

$$f(x) = 3x^3 - x^2 - 10x \qquad\qquad g(x) = -x^2 + 2x$$

1) Find the antiderivatives for $f(x)$ and $g(x)$.

2) Find the area of the region between $f(x)$ and $g(x)$ from $x=-2$ to $x=2$.

3) Graph both functions and fill in the area between $f(x)$ and $g(x)$ from $x=-2$ to $x=2$.
   Label both graphs, the x- and y-axis, and include a title at the top.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.29	4.71	4.29	5.71

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (60,7,10,30) ->26.75
MMA TIMES (10,4,60,27) -> 25.25

TEST ITEM: 142.2

Find the area under the curves 1/x and $1/x^2$ from x=1 to infinity.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.57	4.43	5.29	4.71

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,1,5) ->5.3
MMA TIMES (2,1,2) -> 1.7

TEST ITEM: 142.3

Find the antiderivatives:

$$\int \sec(x)\,dx, \qquad \int \ln(x)\,dx, \qquad \int \frac{dx}{(1+x^2)}, \qquad \int \frac{dx}{t^2 + 2t - 3}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,4,5) -> 4.7
MMA TIMES (5,3,5) -> 4.3

ATTACHMENT 3

TEST ITEM: 142.4

Evaluate the definite integrals both symbolically and numerically:

$$\int_{\pi/6}^{\pi/3} \sec x\, dx, \qquad \int_{\pi/6}^{\pi/3} \frac{1}{1+x^2}\, dx, \qquad \int_{1}^{2} \ln(x)\, dx, \qquad \int_{1}^{4} \sqrt{t^2 + 2t - 3}\, dt$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.86	4.14	5.71	4.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,3,5) -> 6
MMA TIMES (5,4,7) -> 5.3

TEST ITEM: 142.5

Evaluate the indefinite integral and check the result by differentiation.

$$\int \left[3e^x + 2 - \frac{5}{x} + \sec^2(x) - 4x^3 \right] dx$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.29	4.71	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,2,5,5) -> 5.5
MMA TIMES (5,2,5,6) -> 3.75

TEST ITEM: 142.6

Evaluate the definite integral $\int_{1}^{x} \frac{t^2}{t^2 + 1}\, dt$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.14	4.86	4.71	5.29

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,5,1) -> 5.3
MMA TIMES (2,2,5,2) -> 2.75

TEST ITEM: 142.7

Find the volume of the solid formed by revolving $f(x) = x^2$ from $x=0$ to $x=2$ about the
x-axis.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (2,3,5,1) -> 2.75
MMA TIMES (2,3,5,1) -> 2.75

TEST ITEM: 142.8

Evaluate the limits: $\quad \lim_{x \to 0} \dfrac{e^x - (1-x)}{x} \qquad \lim_{x \to \infty} \dfrac{e^x}{x} \qquad \lim_{x \to \infty} x^{1/x}$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.57	4.43	5.42	4.58

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,2,5,2) -> 9.75
MMA TIMES (5,2,5,3) -> 3.75

TEST ITEM: 142.9

a) Use the Trapezoidal Rule to approximate $a(x) = 2x^3 + 4x^2 + 5$ from $x=-2$ to $x=2$ for
$n=4$. Plot $a(x)$ and draw the 4 trapezoids on the same graph.

b) Use Simpson's Rule to approximate $a(x)$ from $x=-2$ to $x=2$ for n equals 4.
   Plot $a(x)$ and draw the two second degree polynomials on the same graph.

c) Run an animation results of Part a with $n=1$ to $n=20$.

d) Run an animation like Part c, but use rectangles instead of trapezoids.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.25	5.75	4.0	6.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (60) -> 60
MMA TIMES (10,6,45) ->20.3

ATTACHMENT 3

TEST ITEM: 142.10

Generate the following picture if $f(x) = 2\sin(x) + \cos(2x)$.
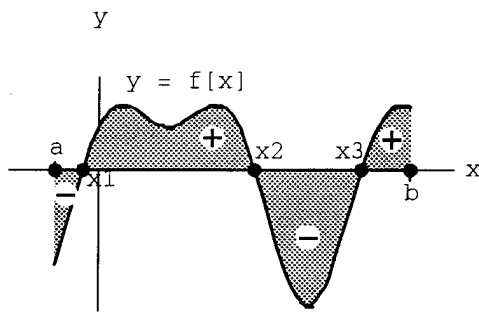
MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.5	6.5	2.75	7.25

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (none)
MMA TIMES (10,2) -> 6

TEST ITEM: 142.11

Generate a solid when $f(x) = \sqrt{x}$ and $g(x) = 1$ from $x=1$ to $x=7$ are rotated around the x-axis.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.75	5.25	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,2) -> 16
MMA TIMES (10,2) -> 6

TEST ITEM: 142.12

Find the Taylor polynomial of $h(x) = e^{x^2}$ to the 6th order centered at $c=0$ and $c=5$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.17	3.83	6.0	4.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,1,5) -> 12
MMA TIMES (10,2,12) -> 8

TEST ITEM: 142.13

Run a Taylor polynomial simulation for $g(x) = \cos(x)$ for c=0 from the 1st order to the 20th order.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.25	3.75	5.25	4.75

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (none)
MMA TIMES (10) -> 10

TEST ITEM: 142.14

Evaluate the arc lengths specified below:

1. $x = 4\cos(2t)$, $y = 4\sin(3t)$ for t from 0 to 2 Pi.

2. $y = x^{3/2}$ from (1,1) to (4, 8).

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.17	4.83	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,2,10) -> 7.3
MMA TIMES (10,2,7) -> 6.3

TEST ITEM: 142.15

Attempt to evaluate the following integrals over singularities:

$$\int_{-1}^{1}\frac{1}{x}dx, \qquad \int_{-1}^{1}\frac{1}{x^2}dx, \qquad \int_{-2}^{2}\frac{1}{x^2-1}dx$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,2,4) -> 12
MMA TIMES (15,2,3) -> 6.67

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 243 CALCULUS III TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS ARE INCLUDED>		
DEPT:		
PHONE:		
ATTENDED TRAINING: Yes	No	
COMPUTER USED FOR TESTING: 486	Pentium	
COMPUTER CLOCK SPEED: 33MHz 100MHz	133MHz ____	
OPERATING SYSTEM: Windows 3.1	Windows 95	
MATHCAD EXPERIENCE: None	Some	Lots
MATHEMATICA EXPERIENCE: None	Some	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:
Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support this course both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.29	5.62	3.75	6.25

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: 243.1

Find the gradient of $f(x,y) = xy \cos(x^2)$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.0	6.0	4.17	5.83

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15,3,10) -> 9.3
MMA TIMES (14,3,6) -> 7.7

TEST ITEM: 243.2

Plot the vector field $\mathbf{F} = x\,\mathbf{i} + y^2\,\mathbf{j}$ and then superimpose on it a circle of radius 3 centered at the origin.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.16	7.84	1.83	8.17

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (60,14,35) -> 36.3
MMA TIMES (14,4,15) -> 11

TEST ITEM: 243.3

Plot the two vectors <3,4> and <-1,2> on the same graph with both starting at the origin. Then plot them such that <-1,2> starts at the tip of <3,4>.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.2	7.8	1.8	8.2

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15) -> 15
MMA TIMES (9,5,15) -> 9.7

TEST ITEM: 243.4

Generate the graph of $z = f(x,y) = 3x^2 + 5y^2$ from two different viewpoints.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.14	7.86	3.5	6.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,1,12) -> 7.7
MMA TIMES (2,5,2,10) -> 6.3

TEST ITEM: 243.5

Create the contour plot of $z = 3x^2 + 5y^2$ and then superimpose the gradient field on the contour plot.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.6	7.4	1.6	8.4

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (27,30,27,20) -> 26
MMA TIMES (12,5,3,20) -> 10

TEST ITEM: 243.6

Graph the parametric equations $x = 2 \sin t$, $y = 5 \cos t$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.6	7.4	4.75	5.25

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (6,7,6,2) -> 5.25
MMA TIMES (1,5,1,2) ->2.25

TEST ITEM: 243.7

Animate the graph in number 243.6 so that the direction of motion is shown.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.5	6.5	6.0	4.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (25,7,25,12) -> 17.25
MMA TIMES (10,4,10) -> 8

TEST ITEM: 243.8

Find the volume of the solid bounded above by $z = 12 - x^2 - 2y^2$ and below by the xy-plane.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.67	5.33

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,10,5,3) -> 5.75
MMA TIMES (4,5,4,5) -> 4.5

TEST ITEM: 243.9

Find the partial derivatives of $f(x,y) = 3xy^3 - 5x^2y + y - 6$ and graph them.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.86	6.14	4.83	5.17

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,20,3,12) -> 11.25
MMA TIMES (4,8,1,8) -> 5.25

TEST ITEM: 243.10

Find the roots of the equation $2x^3 - 6x^2 + 7x - 10 = 0$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.8	5.2	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (3,8,5) -> 5.3
MMA TIMES (1,8,5) -> 4.7

TEST ITEM: 243.11

Plot the function $x^2 + y^2 + z^2 = 16$ and its tangent plane at the point (0,0,4) on the same graph.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.0	8.0	2.0	8.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,5) -> 5
MMA TIMES (10,10,4,15) -> 9.75

TEST ITEM: 243.12

Generate 2000 random numbers on the square $0 \leq x \leq 1$, $0 \leq y \leq 1$ and plot them.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.25	5.75	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,10,5) -> 8.3
MMA TIMES (2,20,8,15) -> 11.25

TEST ITEM: 243.13

Calculate the dot product of <2,0,-3> and <-7,3,5>.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.67	4.33	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (2,5,2,2) -> 2.75
MMA TIMES (1,1,1,2) -> 1.2

TEST ITEM: 243.14

Calculate the cross product of <1,5,-2> and <-3,6,8>.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.0	4.0	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (1,1) -> 1
MMA TIMES (1,1,2) -> 1.3

TEST ITEM: 243.15

Plot the plane 3x + 5y - z = 2 and its upward pointing normal on the same graph.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

ATTACHMENT 4

TEST ITEM: 243.16

Solve the system of equations:

$$3x + y - z = 5$$
$$x + 2y + 3z = 8$$
$$-2x + y + 2z = 2$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.17	6.83	4.6	5.4

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15,7,15,8) -> 11.25
MMA TIMES (2,3,1,3) -> 2.25

TEST ITEM: 243.17

Integrate $f(x,y,z) = x^2 - y + 3z$ over the solid that lies above $z = x^2 + y^2$ and below $z = 9$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.75	4.25	5.25	4.75

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (3,3,5) -> 3.7
MMA TIMES (3,5,3,7) -> 4.5

TEST ITEM: 243.18

Animate the graph $f(x,t) = t \cos(xt)$ as t goes from 0 to 10.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.33	7.67	5.33	4.67

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,10) -> 10
MMA TIMES (3,3) -> 3

TEST ITEM: 243.19

Plot the vector field $\vec{F}(x,y) = y^2\hat{i} + 2x^2\hat{j}$ together with the flow line (or an approximation thereof) passing through the point (1,2).

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.0	7.0	0.0	10.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (2) -> 2
MMA TIMES (7) -> 7

TEST ITEM: 243.20

Enter the following table of data:

	3.00	3.50	4.00	4.50
20	2.65	2.59	2.51	2.43
40	4.14	4.05	3.94	3.88
60	5.11	5.00	4.97	4.84
80	5.35	5.29	5.19	5.07
100	5.79	5.77	5.60	5.53

Plot the data in 3-space.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
8.0	2.0	6.0	4.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,15) -> 10
MMA TIMES (15,10) -> 12.5

TEST ITEM: 243.21

Plot the vector field $\vec{F}(x,y,z) = z\hat{i} + x\hat{j} + y\hat{k}$ in 3-space.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: 243.22

Plot five level surfaces of the function $f(x, y, z) = x^2 + y^2 - z^2$ and animate the resulting plots.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 245 DIFFERENTIAL EQUATIONS & MATRICES
TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica
on Useability and Functionality. For each of these two ratings divide up 10 points between the two
packages in a manner proportional to each package's merits. Also include any comments on the test case
and its results that you deem appropriate. Also please complete the background information block that
follows:

NAME: <RESULTS ARE INCLUDED>		
DEPT:		
PHONE:		
ATTENDED TRAINING:	Yes	No
COMPUTER USED FOR TESTING: 486		Pentium
COMPUTER CLOCK SPEED:	33MHz 100MHz 133MHz _____	
OPERATING SYSTEM:	Windows 3.1	Windows 95
MATHCAD EXPERIENCE:	None Some	Lots
MATHEMATICA EXPERIENCE:	None Some	Lots

SUGGESTION: *Print and save the results produced from running these
test cases. These will help you compare the form and accuracy of the results
from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time
you spend on each test item using each packages and report these times in
the "Comments" block of the test item. This will help us to better "size"
exercises and projects that we come up with later using whichever package
is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each
of the two packages to support this course both in terms of useability and functionality
using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.17	6.71	3.57	6.43

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: 245.1

If $A = \begin{bmatrix} 3 & 4 \\ 8 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 5 & 10 \\ -2 & -5 \end{bmatrix}$, find $(AB)^T$ and $B^T A^T$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.5	4.5	4.75	5.25

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (11,5,15,6) ->9.25
MMA TIMES (20,5,5,5) -> 8.75

TEST ITEM: 245.2

Solve the given system of equations:

$$x_1 + 2x_2 + \quad + \quad x_4 = 0$$
$$4x_1 + 9x_2 + x_3 + 12x_4 = 0$$
$$3x_1 + 9x_2 + 6x_3 + 21x_4 = 0$$
$$x_1 + 3x_2 + x_3 + 9x_4 = 0$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.25	4.75	3.75	6.25

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (34,5,5) -> 14.7
MMA TIMES (12,20,7) -> 13

TEST ITEM: 245.3

Find the determinant of the following matrix:

$$\begin{bmatrix} 2 & 2 & 0 & 0 & -2 \\ 1 & 1 & 6 & 0 & 5 \\ 1 & 0 & 2 & -1 & 1 \\ 2 & 0 & 1 & -2 & 3 \\ 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.5	4.5	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (16,5,10,2) -> 8.25
MMA TIMES (9,5,4,2) -> 5

TEST ITEM: 245.4

Find the eigenvalues and eigenvectors of the following matrix:

$$\begin{bmatrix} 2 & -1 & 0 \\ 5 & 2 & 4 \\ 0 & 1 & 2 \end{bmatrix}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.75	5.25	4.25	5.75

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (4,5,5,5,3) -> 4.4
MMA TIMES (2,5,2,2,4) -> 5

ATTACHMENT 5

TEST ITEM: 245.5

Solve the following 1st order ODE:

$$(y - x^2 y)y' = (y + 1)^2$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.0	8.0	1.0	9.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10) -> 10
MMA TIMES (10) -> 10

TEST ITEM: 245.6

The population P(t) at any time in a suburb of a large city is governed by the initial-value problem

$$\frac{dP}{dt} = P(10^{-1} - 10^{-7} P) \qquad P(0) = 5000$$

where t is measured in months. What is the limiting value of the population? At what time will the population be equal to one-half of this limiting value?

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.5	7.5	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10) -> 10
MMA TIMES (10) -> 10

TEST ITEM: 245.7

Use Euler's method to obtain a four-decimal approximation to y(0.5). First use (*a*) h = 0.1 and then (*b*) h = 0.05.

$$y' = x^2 + y^2 \qquad y(0) = 1$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
1.5	8.5	3.5	6.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,45) -> 37.5
MMA TIMES (30,5) -> 17.5

TEST ITEM: 245.8

Use the Runge-Kutta method with $h = 0.1$ to obtain a four-decimal approximation to y(0.5).

$$y' = x + y^2 \qquad y(0) = 0$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.0	4.0	5.0	5.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30,10) -> 20
MMA TIMES (30,4,20) -> 18

TEST ITEM: 245.9

Solve the following 2nd order ODE:

$$2y'' - 2y' + y = 0$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
0.0	10.0	0.0	10.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15) -> 15
MMA TIMES (15,3) -> 9

TEST ITEM: 245.10

Solve the following 3rd order ODE:

$$y''' + 6y'' - 34y = 0$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
0.0	10.0	0.0	10.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5) -> 5
MMA TIMES (5) -> 5

TEST ITEM: 245.11

Solve the following 2nd order ODE:

$$4y'' - 4y' + y = e^{x/2}\sqrt{1-x^2}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
0.0	10.0	0.0	10.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5) -> 5
MMA TIMES (5,2) -> 3.5

TEST ITEM: 245.12

A mass of 1 slug is attached to a spring whose constant is 5 lb/ft. Initially the mass is released 1 ft below the equilibrium position with a downward velocity of 5 ft/s, and the subsequent motion takes place in a medium that offers a damping force numerically equal to 2 times the instantaneous velocity.

    (a) Find the equation of motion if the mass is driven by an external force equal to

$$f(t) = 12 \cos 2t + 3 \sin 2t \ .$$

    (b) Graph the transient and steady-state solutions on the same coordinate axes.

    (c) Graph the equation of motion.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
2.0	8.0	1.0	9.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (15) -> 15
MMA TIMES (15,10,5) -> 10

TEST ITEM: 245.13

Find the Laplace transform for $f(t) = t^2 - e^{-9t} + 5$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.5	3.5	5.33	4.67

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10,10) -> 10
MMA TIMES (10,3) -> 6.5

TEST ITEM: 245.14

Find the inverse Laplace transform for $F(s) = \dfrac{1}{(s^2+1)(s^2+4)}$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6.5	3.5	6.67	3.33

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (2) -> 2
MMA TIMES (2) -> 2

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
MATH 346 ADVANCED ENGINEERING MATH TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS ARE INCLUDED>			
DEPT:			
PHONE:			
ATTENDED TRAINING:	Yes	No	
COMPUTER USED FOR TESTING:	486	Pentium	
COMPUTER CLOCK SPEED:	33MHz 100MHz	133MHz _____	
OPERATING SYSTEM:	Windows 3.1	Windows 95	
MATHCAD EXPERIENCE:	None	Some	Lots
MATHEMATICA EXPERIENCE:	None	Some	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support this course both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.5	5.5	3.0	7.0

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: 346.1

Find the eigenvalues and eigenvectors for the following system:

$$\frac{dx}{dt} = 6x - y$$

$$\frac{dy}{dt} = 5x + 4y$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.83	5.17	4.33	5.67

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (5,5,1) -> 3.7
MMA TIMES (15,5,2) -> 7.3

TEST ITEM: 346.2

Solve the following system for $x(t), y(t),$ and $z(t)$.

$$\frac{dx}{dt} = -4x + y + z$$

$$\frac{dy}{dt} = x + 5y - z$$

$$\frac{dz}{dt} = y - 3z$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
0.8	9.2	0.5	9.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (45) -> 45
MMA TIMES (30,6,2) -> 12.7

ATTACHMENT 6

TEST ITEM: 346.3

Solve the following inhomogeneous system for x(t) and y(t).

$$\frac{dx}{dt} = 6x + y + 6t$$

$$\frac{dy}{dt} = 4x + 3y - 10t + 4$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
0.8	9.2	0.5	9.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (None)
MMA TIMES (8,5,2) -> 5

TEST ITEM: 346.4

For a spring-mass-damper system with a mass of *m = 1*, a spring constant of *k=4*, a damping constant of *β = 5* and initial conditions of *x(0) = -2, x'(0) = -3*, generate a graphic which shows a phase plane plot relating the position and velocity of the mass at any time *t*. Also attempt to plot the eigenvectors and a parametric solution for the mass and velocity. Include these in your phase plane plot.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.25	6.75	2.25	7.75

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30) -> 30
MMA TIMES (60) ->

TEST ITEM: 346.5

Expand the following function in a Fourier Sine Series. Generate properly labeled plots of the expansion for *n = 1, 5, 10, and 50* terms.

$$f(x) = \begin{cases} -1, & -\pi < x < 0 \\ 1, & 0 \le x < \pi \end{cases}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.33	5.67

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (90) -> 90
MMA TIMES (15) -> 15

TEST ITEM: 346.6

For the following solution to the heat equation:

$$u(x,t) = \sum_{n=1}^{\infty} \frac{2}{n\pi}\left(1 - \cos\left(\frac{n\pi}{2}\right)\right) \sin\left(\frac{n\pi x}{L}\right) \exp\left(\frac{-kn^2\pi^2 t}{L^2}\right)$$

generate a properly labeled 3D plot of $u(x,t)$ assuming *k=1.3, L=3, t=1,* and *n=50.* Also generate a properly labeled contour plot of the same solution. Note this solution represents the heat distribution for position and time given that the ends of the bar are held at zero degrees and the initial temperature distribution across the bar is:

$$f(x) = \begin{cases} 1, & 0 < x < L/2 \\ 0, & L/2 < x < L \end{cases}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.0	6.0	3.33	6.67

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (10) -> 10
MMA TIMES (20) -> 20

TEST ITEM: 346.7

Find the Fourier series of the following function for the given interval. Generate a properly labeled plot for the case where $n = 50$.

$$f(x) = \begin{cases} 0, & -2 < x < 0 \\ x, & 0 \le x < 1 \\ 1, & 1 \le x < 2 \end{cases}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.67	5.33

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30) -> 30
MMA TIMES (20) -> 20

TEST ITEM: 346.8

Generate an animation that will demonstrate the impact of including additional terms in the Fourier Series expansion of $f(x) = x^2$ for the interval of $0 \le x < \pi$. The animation should start with $n = 1$ and go up to at least $n = 15$.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.67	5.33

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (25) -> 25
MMA TIMES (20) -> 20

TEST ITEM: 346.9

Find and plot the Fourier Integral representation of the given function:

$$f(x) = \begin{cases} 0, & x < -1 \\ -1, & -1 < x < 0 \\ 2, & 0 < x < 1 \\ 0, & x > 1 \end{cases}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.33	6.67	2.33	7.67

MCD TIMES (None)
MMA TIMES (None)

ATTACHMENT 6

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
PHYSICS DEPARTMENT TEST SUITE

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: <RESULTS ARE INCLUDED>		
DEPT:		
PHONE:		
ATTENDED TRAINING:	Yes	No
COMPUTER USED FOR TESTING: 486		Pentium
COMPUTER CLOCK SPEED:	33MHz 100MHz	133MHz ____
OPERATING SYSTEM:	Windows 3.1	Windows 95
MATHCAD EXPERIENCE:	None Some	Lots
MATHEMATICA EXPERIENCE:	None Some	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

REQUEST: *If you don't mind, please try to keep track of how much time you spend on each test item using each packages and report these times in the "Comments" block of the test item. This will help us to better "size" exercises and projects that we come up with later using whichever package is selected.*

OVERALL ASSESSMENT:

Once you've completed the exercises in this package, please rate the overall ability of each of the two packages to support physics courses both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	4.0	6.0

COMMENTS: For each exercise, time-on-task (minutes) are reported as:
MCD TIMES (reported times) -> average
MMA TIMES (reported times) -> average

TEST ITEM: PHYSICS.1 Plot the interference and diffraction patterns for a double slit experiment and the diffraction pattern for a single slit experiment.

Interference: $I(y) = I_0 \cos^2\left(\dfrac{\pi d}{\lambda L} y\right)$

Diffraction: $I(y) = I_0 \left[\dfrac{\sin\left(\dfrac{\pi d}{\lambda L} y\right)}{\dfrac{\pi d}{\lambda L} y}\right]^2$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.25	5.75	4.25	5.75

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (40,10,10,60) -> 30
MMA TIMES (8.10,20,20) -> 14.5

TEST ITEM: PHYSICS.2 A wave pulse traveling to the right along the x axis is represented by the following wave function: $y(x,t) = \dfrac{4}{2 + (x - 4t)^2}$. Plot the waveform at t=0,1, and 2 seconds. Animate the waveform between 1 and 5 seconds.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.5	4.5	4.75	5.25

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (35,15,40) -> 30
MMA TIMES (8.40,15) -> 21

TEST ITEM: PHYSICS.3 Data analysis - Generate a set of data representing a gamma spectrum. The peaks should be modeled as Gaussians, and have an amplitude of approximately 100 counts with width of ~50 bins. The two peaks should be separated by not more than 1.5 times the sum of their standard deviations. Account for "background" by adding a quadratic which is largest at smaller bin numbers and does not exceed 20% of the amplitudes of the peaks. Add the effect of counting statistics by replacing each count with a random number drawn from a Poisson distribution with the mean being the count value. Finally, fit the same functions to the "data" by using a nonlinear least squares fitting routine. Compare original parameters, fitted parameters, and estimates of parameters uncertainties. Graph the data with error bars on the data points, and the best fit line superimposed on the graph. Output the data to an ASCI file in tab delimited format to three significant figures.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.0	6.0	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (60) -> 60
MMA TIMES (60) -> 60

TEST ITEM: PHYSICS.4 Data analysis. The measured distribution function from a retarding potential analyzer can be shown to have the following form. Fit the measured data in the attached file to the function. $g(E_0, E, kT, A, Io) := \frac{1}{2} \cdot \left(1 - erf\left(\frac{\sqrt{E} - \sqrt{E_0}}{\sqrt{kT}}\right)\right) \cdot A - Io$

Here E_0 is the parallel drift energy of the plasma, and kT is the thermal energy of the plasma. Report the fitted parameters, and the associated uncertainties in those parameters.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
4.0	6.0	4.5	5.5

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30) -> 30
MMA TIMES (60) -> 60

TEST ITEM: PHYSICS.5 The damped, driven pendulum is usually solved for small angle. Instead, solve the problem for large angles; i.e. given the equation of motion

$\ddot\theta + a\dot\theta + \omega_o^2 \sin\theta = b\cos(\omega t)$ solve for $\theta(t)$. Include Lyapunov exponent, phase plot diagrams, and Poincare sections. Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
1.0	9.0	1.0	9.0

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.6 Solve the equations of motion for a charged particle in electric and magnetic fields, i.e. given the general equation of motion $m\vec{a} = q(\vec{E} + \vec{v} \times \vec{B})$. Find $\vec{r}(t)$, plot the motion in 3D for the case of perpendicular electric and magnetic fields, vary the input velocity in angle with respect to the magnetic field.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
1.0	9.0	1.0	9.0

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.7 A Helmholtz coil is a convenient way of producing a relatively uniform magnetic field along the axis of two coils separated by distance s and of radius R. The magnetic field in this case can be shown by the cadet to be;

$$B(z) = \frac{\mu_o I}{2} R^2 \left(\frac{1}{\left[\left(\frac{s}{2} - z \right)^2 + R^2 \right]^{\frac{3}{2}}} + \frac{1}{\left[\left(\frac{s}{2} + z \right)^2 + R^2 \right]^{\frac{3}{2}}} \right)$$

a. Show that $\left. \dfrac{\partial B}{\partial z} \right|_{z=0} = 0$

b. Determine s such that $\left. \dfrac{\partial^2 B}{\partial z^2} \right|_{z=0} = 0$.

Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3.33	6.67	3.0	7.0

COMMENTS: (PLEASE INCLUDE TIME USED)
MCD TIMES (30) -> 30
MMA TIMES (15) -> 15

TEST ITEM: PHYSICS.8 Find the position as a function of time and angle $r(\theta, t)$, for a planet in orbit with eccentricity $\varepsilon = 0.1$ and a semi-major axis of $a = 1$. Plot the answer for $0 \le t \le \dfrac{\tau}{2}$, where τ is the normalized year of the orbit.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.9 Find the group velocity $v_g = \dfrac{\partial \omega}{\partial k}$ of a whistler wave. The pertinent dispersion relation is the right hand electromagnetic wave parallel to B_o. The dispersion relation for this wave is $n^2 = \dfrac{c^2 k^2}{\omega^2} = 1 - \dfrac{\omega_p^2/\omega^2}{1 - \left(\omega_c/\omega\right)}$. Here ω_c and ω_p are constants. Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.10 A grounded rectangular box with sides of 0.06 m wide by 0.04 m tall, has a thin plate 0.02 m tall centered within the rectangle of unit potential. There are three point charges of charge +1,+2,-3 located at (x, y) points $(1,3), (3,3.5), (2.5,1)$. Solve Poisson's equation in 2D rectangular coordinates everywhere with in the box using the relaxation method. Graph the results as an equipotential map of the box and the charges. Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

ATTACHMENT 7

TEST ITEM: Physics.11 A particle is in the ground state of a one-dimensional box of length L. At time $t = 0$ the box is instantaneously expanded to a length of $2L$. If the energy of the particle is measured soon after this expansion, what value of energy is most likely to be found? Construct a time dependent wave function and graph this for several steps in time. Note: Present solution from software package in following form. Initial

wave function $\psi(x,0) = \sqrt{\dfrac{2}{L}} \sin\left(\dfrac{\pi x}{L}\right)$ $0 \le x \le L$, new eigen states are

$\phi_n(x) = \sqrt{\dfrac{1}{L}} \sin\left(\dfrac{n\pi x}{2L}\right)$ $0 \le x \le 2L$. Express $\psi(x,0) = \sum_n b_n \phi_n(x)$, where

$b_n = \int_0^L \psi(x,0)\phi_n(x)dx$. Probability is $P_n(x) = |b_n|^2$, with new Energy eigen states

$E_n = n^2 \dfrac{\hbar^2 \pi^2}{2m(2L)^2}$. Print out several coefficients, and probabilities. Time dependent wave

functions $\psi(x,t)$ are given by $\psi(x,t) = \sum_n b_n \phi_n(x)e^{-i\omega_n t}$ where $\omega_n = \dfrac{E_n}{\hbar}$. Graph 3-4 time

dependent wave functions, picking Δt appropriate to ω_n. Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

ATTACHMENT 7

TEST ITEM: PHYSICS.12   For an electron in a finite potential well with

$$\rho^2 = \frac{2ma^2|V|}{\hbar^2} = \left(\frac{7\pi}{4}\right)^2$$ and width $2a = 10^{-9}$ m, determine the bound energy levels and

graph the eigen states. Note: Present solution from software package in following form.
There are four possible solutions, two symmetric and two anti-symmetric. The symmetric
eigen states satisfy the transcendental equations $\xi \tan \xi = \eta$ and $\xi^2 + \eta^2 = \rho^2$. The odd
eigen states satisfy $\xi \cot \xi = -\eta$ and $\xi^2 + \eta^2 = \rho^2$. Solve for η, and the energy level is

$E = -\dfrac{\eta^2}{\rho^2} V$. The symmetric eigen functions are given by;

$$\phi_s(x) = \begin{cases} A\cos(ka)e^{k'(x+a)} & x \le -a \\ A\cos(kx) & -a \le x \le a \\ A\cos(ka)e^{-k'(x-a)} & x \ge a \end{cases}$$ where $k = \dfrac{\xi}{a}$ and $k' = \dfrac{\eta}{a}$. Find A from $\int_{-\infty}^{\infty} |\phi|^2 dx = 1$

and the anti-symmetric eigen functions are; $\phi_s(x) = \begin{cases} -B\cos(ka)e^{k'(x+a)} & x \le -a \\ B\cos(kx) & -a \le x \le a \\ B\cos(ka)e^{-k'(x-a)} & x \ge a \end{cases}$.

Comment the solution so that it could be handed in for grading by the instructor.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.13 Create a "pulsed" wave train that is two seconds long with a frequency of 5 Hz. Sample this wave train at 100 Hz. Center this wave train around zero inside a window that is 20 seconds long. Take the Fourier transform of this pulsed wave form and compare it to the Fourier transform of a wavetrain that is continuous through the 20 seconds. Generate new wave forms with 2 and seven pulses, all of the same width, and separated by one half second. Compare the Fourier transform of these wave train to the initial pulse. Next generate wave trains with seven pulses and frequencies of 10 and 20 Hz. Compare the Fourier transform of the seven pulse trains at different frequencies to each other. By varying the pulse train parameters, find the narrowest central frequency peak you can.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.0	5.0	3.0	7.0

COMMENTS: (PLEASE INCLUDE TIME USED)

TEST ITEM: PHYSICS.14 Solve a set of coupled differential equations to arrive at physical parameters that apply to the pumping rate and collisional lifetime for a CO_2 laser system. A data file will be provided for the power output of the laser as a function of time. The equations can be formally solved within a non linear fit for the parameters of interest. A "by hand" fit that gets close to the data is acceptable. The differential equations follow:

$$\frac{d\phi}{dt} = \sigma(n_2 - n_1) - \frac{\phi}{\tau_c} + \xi\frac{n_2}{\tau_2}$$

$$\frac{dn_1}{dt} = -\frac{n_1}{\tau_1} - \frac{n_2}{\tau_{1c}} + \sigma(n_2 - n_1)\phi$$

$$\frac{dn_2}{dt} = r(t) - \frac{n_2}{\tau_2} - \frac{n_2}{\tau_{2c}} - \sigma(n_2 - n_1)\phi$$

The calculated variables are:

$$r(t, r_0, \tau_p, \alpha, \beta, \gamma) = \alpha r_0 \left(\frac{t}{\tau_p}\right)^\beta e^{-\frac{\gamma t}{\tau_p}}$$

$$r_0(\sigma, \tau_{1c}, \tau_c) = \frac{1}{\sigma \tau_{1c} \tau_c}$$

$$\sigma(\Delta f) = \frac{ch}{\sqrt{2\pi}\lambda d\Delta f}B$$

The constants are:

$$A = 0.3$$

$$\xi = 10^{-6}$$

$$B = \frac{c^3 A}{8\pi h f^3}$$

$$\tau_2 = \frac{1}{A}$$

$$\tau_1 = \tau_2$$

$$\tau_c = \frac{2d}{c(1-R)}$$

$$R = 0.85$$

$$\tau_{RT} = \frac{2d}{c}$$

$$h = 6.62 \bullet 10^{-34}$$

$$c = 2.99 \bullet 10^{8}$$

$$\lambda = 10.6 \bullet 10^{-6}$$

$$f = \frac{c}{\lambda}$$

$$\tau_c = 5.7 \bullet 10^{-8}$$

The free parameters, along with initial guesses are:

$$\tau_{1c} = 10^{-6}$$

$$\alpha = 2$$

$$\beta = 0.5$$

$$\gamma = 1$$

$$\tau_{2c} = 4\tau_{1c}$$

$$\tau_{1c} = 10^{-6}$$

$$\Delta f = 8 \bullet 10^{6} \bullet 50$$

$$\tau_p = 3.5 \bullet 10^{-4}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
None	None	None	None

COMMENTS: (PLEASE INCLUDE TIME USED)

ATTACHMENT 7

MATHEMATICAL SOFTWARE PACKAGE EVALUATION
CLIENT DEPARTMENT EVALUATIONS

Perform each of the test exercises described in this document and rate both MathCAD and Mathematica on Useability and Functionality. For each of these two ratings divide up 10 points between the two packages in a manner proportional to each package's merits. Also include any comments on the test case and its results that you deem appropriate. Also please complete the background information block that follows:

NAME: Capt Hale		
DEPT: DFEE		
PHONE: 34211		
ATTENDED TRAINING:	Yes	(No)
COMPUTER USED FOR TESTING:	(486)	Pentium
COMPUTER CLOCK SPEED:	(33MHz) 100MHz	133MHz ___
OPERATING SYSTEM:	Windows 3.1	(Windows 95)
MATHCAD EXPERIENCE:	(None) Some	Lots
MATHEMATICA EXPERIENCE:	None (Some)	Lots

SUGGESTION: *Print and save the results produced from running these test cases. These will help you compare the form and accuracy of the results from the two packages.*

If you know of a better package for a particular test, please state so in the "COMMENTS" block and distribute the 10 points for both useability and functionality across the three packages (your preferred package, MathCAD, and Mathematica).

OVERALL ASSESSMENT:			

Once you've completed whatever exercises you thought appropriate, please rate the overall ability of each of the two packages to support your department both in terms of useability and functionality using the same scheme as with the individual test exercises.

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3	7	3	7

COMMENTS: Dislike intensely The way greek letters entered into MathCAD.
Like Mathematica equation entry.
Love the on-line help. Find
ʒ Mathematica symbology
(ie Sin vs (64)Sin) Annoying. ~~ATTACHMENT 8~~
Mathematica's ALWAYS slow... but seems to get There.

TEST ITEM: 1 *(Please write in a brief description of the test).*

Evaluation of modified, zero order Bessel function

$$J_0(x) = \int_0^{2\pi} \frac{1}{2\pi} e^{x\cos\theta} \, d\theta$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3	9 7	0	10

COMMENTS: MathCAD : No closed form found - 70 seconds
Mathematica : Start 2:00 pm assumes Re[x]>0,
Express function in 3.0 minutes

TEST ITEM: 2 *(Please write in a brief description of the test).*

$$\int_0^\infty \int_{x\sqrt{28}}^{60} \frac{1}{\sqrt{2}\,x} \, e^{-z^2/2} \, \frac{1}{\Gamma} \, e^{-\delta/\Gamma} \, dz \, d\gamma = \frac{1}{2}\left(1 - \sqrt{\frac{\Gamma}{1+\Gamma}}\right)$$

real + positive

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3	9 7	0 1	5

COMMENTS: MathCAD → no solution
Mathematica (start 1:31 end 1:58 → assumes real,
positive roots

TEST ITEM: 3 *(Please write in a brief description of the test).*

$$\frac{1}{2i}\left(e^{ix} - e^{-ix}\right)$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
8 5	5 5	10	0

COMMENTS: MathCAD - 14 seconds to simplify
Mathematica won't give the output of sin
at all.

65

TEST ITEM: 4 *(Please write in a brief description of the test).*

$$1 + 2 \sum_{n=1}^{\infty} \left(\frac{z}{z^*} \right)^n = \frac{z^* + z}{z^* - z}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
6 5	8 5	1	8 - 9

COMMENTS: MathCAD couldn't solve it...
Mathematica has NICE help features
... 4 minutes to answer

TEST ITEM: 5 *(Please write in a brief description of the test).*

$$\int_{-\infty}^{\infty} \left(\frac{e^{isx}}{k^2 + x^2} \right) dx = \frac{2 \pi i \, e^{-ks}}{2ik} = \frac{\pi}{k} e^{-ks}$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
7 4	8 6	3	7

COMMENTS: No closed form found in MathCAD)
Mathematica → a form of the answer,
8 minutes later

TEST ITEM: 6 *(Please write in a brief description of the test).*

$$\int \cot u \, du = \ln |\sin u| + C$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
9 5	9 5	9 5	5

COMMENTS: MathCAD: 4.4 seconds. Answer has no absolute value has
29 sec   " "

66

TEST ITEM: 7 *(Please write in a brief description of the test).*

$$\int \tan u \, du = \ln|\sec u| + C$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
5.5 6	8 4.5	8 5	8 5

COMMENTS: Answer in MathCAD is $-\ln\cos u$, no ll. Close! 8s
" " Mathematica " , no ll. ~ 43s

TEST ITEM: 8 *(Please write in a brief description of the test).*

$$\int u \sin u \, du = \sin u - u\cos u$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
3 4.5	8 5.5	5	5

COMMENTS: MathCAD wouldn't evaluate w/o (sin u) (useless mathematically);
correct answer (wow): 18 seconds
Mathematica: 57 seconds

TEST ITEM: 9 *(Please write in a brief description of the test).*

$$\int e^{au} \sin bu \, du = \frac{e^{au}}{a^2+b^2}\left(a\sin bu - b\cos bu\right)$$

MathCAD useability	Mathematica useability	MathCAD functionality	Mathematica functionality
8 6	7 7	8 4.5	7 5.5

COMMENTS: MathCAD doesn't extract unless simplified (8s)
Mathematica: 1 min 16 sec → and NOT the Ø
not useful format

67

X:\df \dfms\mmatrain\mmatrain.nb

Software Search

Mathematica Training

■ Basic Concepts of Operation

■ Online Help

■ Key Functions

Attachment 9

Software Search

Mathematica Training

■ Basic Concepts of Operation

FrontEnd ⟺ **Kernal**

The Stack

Sintax or Palettes

■ Online Help

Accessing Help On-Line

Tour of Mathematica

Getting Started

Atch 9

■ Key Functions

■ Defining and Evaluating Functions

```
In[1]:= f[x_] := x^2 + √x
       f[π]
       oldf[x_] := x^2 + Sqrt[x]
       oldf[Pi]
       % // N
```

Out[2]= $\sqrt{\pi} + \pi^2$

Out[4]= $\sqrt{\pi} + \pi^2$

Out[5]= 11.6421

```
In[6]:= g[x_, y_] := Cos[x + y]
       g[π, 5]
       g[π, 5] // N
```

Out[7]= $-\text{Cos}[5]$

Out[8]= -0.283662

Atch 9

■ Solving Equations

In[11]:= `Solve[a x² + b x + c == 0, x]`

Out[11]= $\left\{ \left\{ x \to \dfrac{-b - \sqrt{b^2 - 4\,a\,c}}{2\,a} \right\}, \left\{ x \to \dfrac{-b + \sqrt{b^2 - 4\,a\,c}}{2\,a} \right\} \right\}$

In[9]:= `Solve[{x² + y² == 9, y == x}, {x, y}]`
`Plot[{√(9 - x²), -√(9 - x²), x}, {x, -3, 3},`
`    AspectRatio -> 1, AxesLabel -> {x, y}];`

Out[9]= $\left\{ \left\{ x \to -\dfrac{3}{\sqrt{2}},\ y \to -\dfrac{3}{\sqrt{2}} \right\}, \left\{ x \to \dfrac{3}{\sqrt{2}},\ y \to \dfrac{3}{\sqrt{2}} \right\} \right\}$

Atch 9
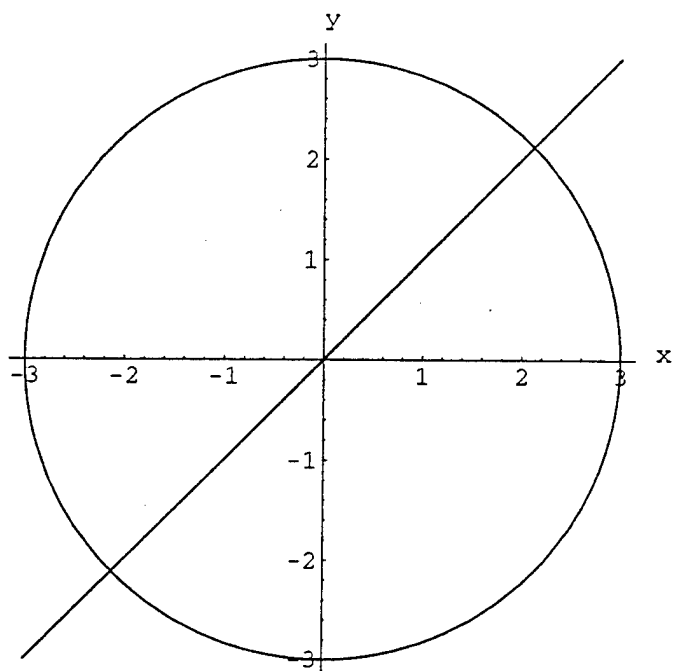
■ Graphics

In[12]:= `Plot[e^{2x}, {x, 0, 2}, AxesLabel -> {x, y}];`
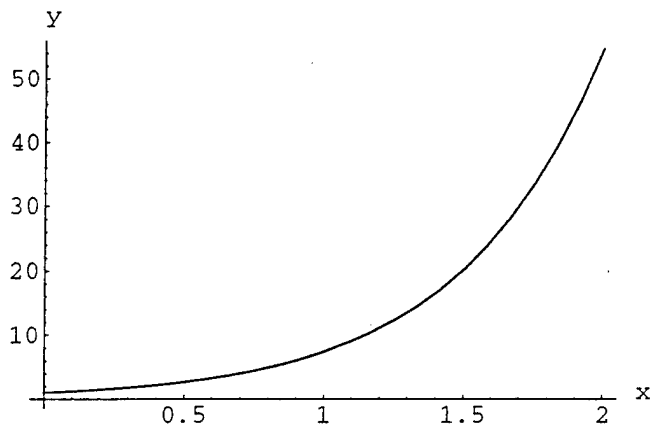
In[13]:= `Plot[Sin[1/x], {x, -1, 1}, Frame -> True,`

$$\text{FrameLabel} \to \left\{x, \ \text{Sin}\left[\frac{1}{x}\right]\right\},$$

`PlotLabel -> "My Pretty Plot"];`
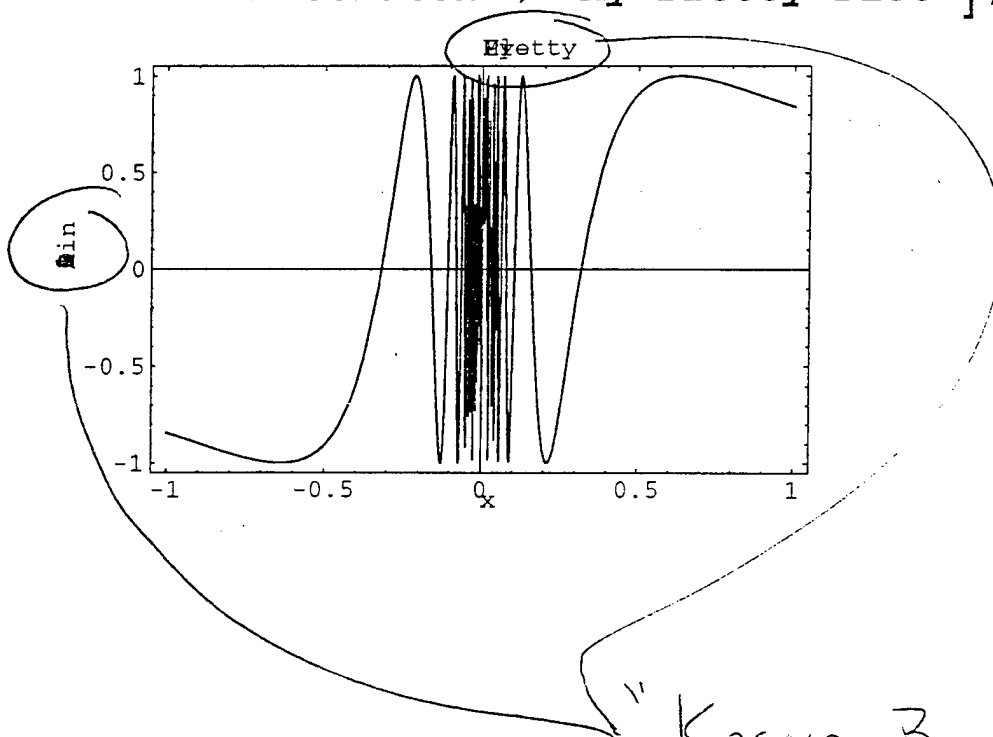
"Known Bugs"
(Being Worked On)
72

Atch 9

```
In[14]:= Plot3D[Sin[Cos[2 y] + Sin[2 x]],
        {x, 0,  π}, {y, 0, π},
        AxesLabel -> {"x", "y", "z"},
        PlotLabel -> "Wavy Plot",
        PlotPoints -> 35];
```


"Known Bug"

Atch 9
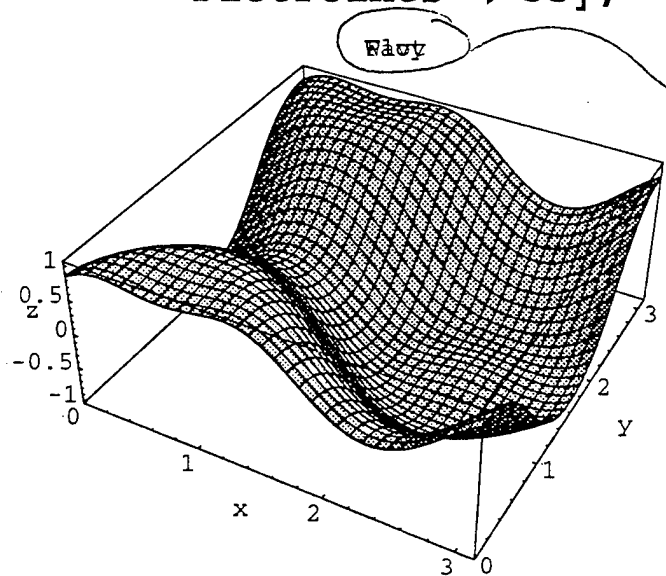
■ Differentiation

In[15]:= `position[x_] := 5 x^2 + 3 x + 6`
`Print["Position is ", position[x]]`
`Print["Velocity is ", position'[x]]`
`Print["Acceleration is ", position''[x]]`
`5 x^2 + 3 x + 6 // TraditionalForm`

General::spell1 : Possible spelling
 error: new symbol name "position" is
 similar to existing symbol "Position".

Position is $6 + 3 x + 5 x^2$

Velocity is $3 + 10 x$

Acceleration is 10

Out[19]//TraditionalForm=
$$5 x^2 + 3 x + 6$$

In[20]:= `f[x_, y_] := e^{-2 x} Cos[3 y]`
∂_x `f[x, y]`
∂_y `f[x, y]`
$\partial_{x,x}$ `f[x, y]`

Out[21]= $-2 E^{-2 x} Cos[3 y]$

Out[22]= $-3 E^{-2 x} Sin[3 y]$

Out[23]= $4 E^{-2 x} Cos[3 y]$

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Atch 9

∎ Integration

In[34]:= `F[x_] := -k x`

`Print["Work = ", ` $\int_0^{10}$ `F[x] dx]`

Work = - 50 k

In[36]:= $\int_0^{\pi}$ `e`^{x} `dx // N`

Out[36]= 22.1407

In[37]:= $\int$ `Cos[x] dx`

Out[37]= Sin[x]

In[38]:= $\int_0^{2\pi} \int_0^R$ `r dr dθ`

Out[38]= π R^2

In[41]:= $\int_0^1$ `Cos[x`^{2}`] dx`

`NIntegrate[Cos[x^2], {x, 0, 1}]`

Out[41]= $\sqrt{\dfrac{\pi}{2}}$ `FresnelC`$\left[\sqrt{\dfrac{2}{\pi}}\right]$

Out[42]= 0.904524

Atch 9

■ Iteration

In[49]:= $\text{Myfunction}[x\_] := \dfrac{1}{\sqrt{1+x}}$

$\text{Nest}[\text{Myfunction}, x, 5]$

Out[50]= $\dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1+x}}}}}}}}}}$

In[60]:= $t = x;$

$\text{Do}\left[t = \dfrac{1}{\sqrt{1+t}}, \{5\}\right]; t$

Out[60]= $\dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1 + \dfrac{1}{\sqrt{1+x}}}}}}}}}}$

In[66]:= $t = 100; \text{Do}[\text{Print}[t]; t = \text{Sqrt}[t] // N, \{5\}]$

100

10.

3.16228

1.77828

1.33352

76

Atach 9

■ Printing

Set Page Breaks

Screen Style

Printing Style

Print All or Some

Atch 9

■ Importing Data Sets

In[1]:= **mylist = ReadList["c:\Temp\plasma2.prn", Number, RecordLists -> True]**

Out[1]= {{39.7, 424, 440, 448, 470}, {34.4, 445, 460, 456, 460}, {29.9, 449, 460, 455, 442},
{25., 431, 422, 444, 422}, {20., 430, 422, 419, 403}, {15., 382, 371, 376, 381},
{9.7, 342, 341, 337, 339}, {8.9, 333, 337, 330, 337}, {8., 326, 336, 339, 334},
{7., 327, 328, 331, 326}, {6., 329, 327, 338, 340}, {5., 353, 352, 350, 353},
{4., 379, 383, 384, 385}, {3., 415, 415, 412, 413}, {2., 435, 438, 439, 438}}

In[2]:= **Pressure =**
Table[mylist[[n, 1]], {n, 1, Length[mylist]}];
Voltage3 = Table[mylist[[n, 3]], {n, 1, Length[mylist]}];
VvsP = Table[{Pressure[[n]], Voltage3[[n]]}, {n, 1, Length[mylist]}];
ListPlot[VvsP, PlotRange -> {{0, 40}, {320, 450}},
PlotStyle -> PointSize[0.02], AxesLabel -> {"pressure", "voltage3"}];
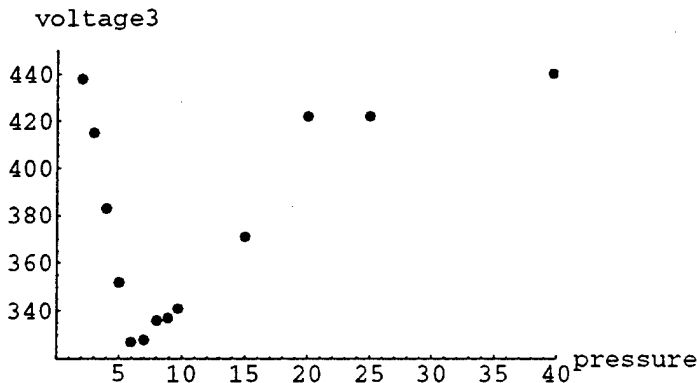
In[3]:= **Needs["Statistics`DescriptiveStatistics`"]**
pressuremeans = Table[Mean[Table[mylist[[n, i]], {i, 2, 5}]], {n, 1, Length[mylist]}]
stddevs =
Table[StandardDeviation[Table[mylist[[n, i]], {i, 2, 5}]], {n, 1, Length[mylist]}]

Out[4]= $\{\frac{891}{2}, \frac{1821}{4}, \frac{903}{2}, \frac{1719}{4}, \frac{837}{2}, \frac{755}{2}, \frac{1359}{4}, \frac{1337}{4}, \frac{1335}{4}, 328, \frac{667}{2}, 352,$
$\frac{1531}{4}, \frac{1655}{4}, \frac{875}{2}\}$

Out[5]= $\{\sqrt{\frac{1099}{3}}, \frac{\sqrt{201}}{2}, \sqrt{\frac{181}{3}}, \frac{\sqrt{433}}{2}, \sqrt{\frac{385}{3}}, \sqrt{\frac{77}{3}}, \frac{\sqrt{\frac{59}{3}}}{2}, \frac{\sqrt{\frac{139}{3}}}{2}, \frac{\sqrt{\frac{371}{3}}}{2},$
$\sqrt{\frac{14}{3}}, 5\sqrt{\frac{5}{3}}, \sqrt{2}, \frac{\sqrt{\frac{83}{3}}}{2}, \frac{3}{2}, \sqrt{3}\}$

78

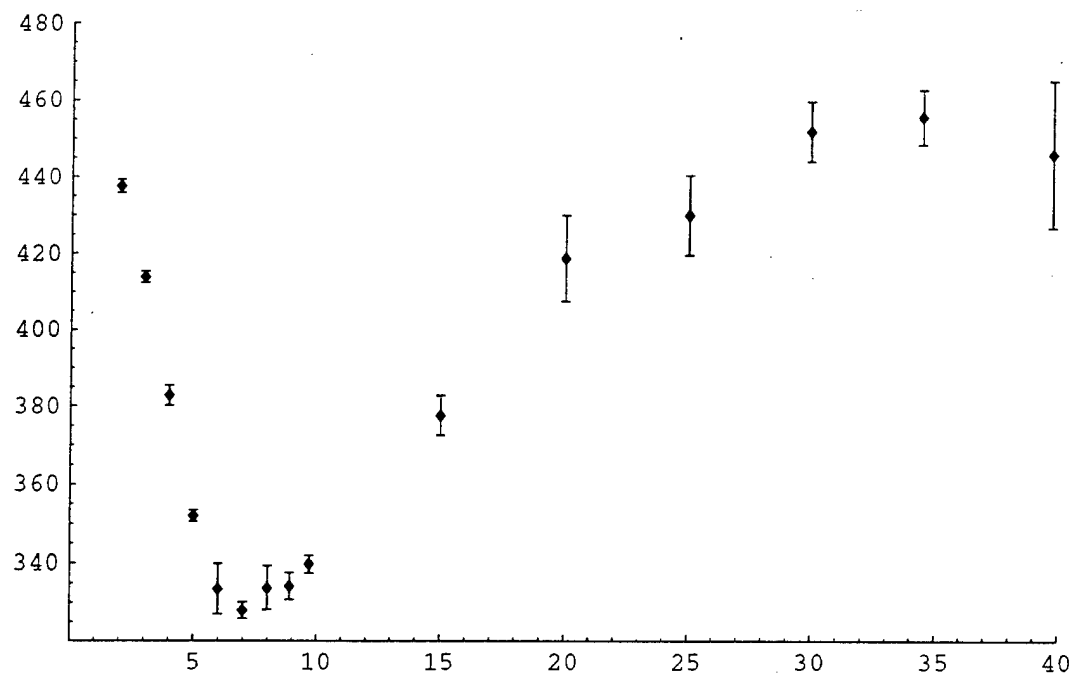*Atch 9*

```
In[6]:= Needs["Graphics`MultipleListPlot`"]
        PressMeanStdDevs = Table[{{Pressure[[n]], pressuremeans[[n]]},
          ErrorBar[{-stddevs[[n]], stddevs[[n]]}]}, {n, 1, Length[mylist]}]
        MultipleListPlot[
        PressMeanStdDevs, PlotRange -> {{0, 40}, {320, 480}}, PlotStyle -> PointSize[0.02]];
```

$Out[7]=$ $\left\{\left\{\left\{39.7, \frac{891}{2}\right\}, \text{ErrorBar}\left[\left\{-\sqrt{\frac{1099}{3}}, \sqrt{\frac{1099}{3}}\right\}\right]\right\}, \left\{\left\{34.4, \frac{1821}{4}\right\},\right.\right.$

$\text{ErrorBar}\left[\left\{-\frac{\sqrt{201}}{2}, \frac{\sqrt{201}}{2}\right\}\right]\right\}, \left\{\left\{29.9, \frac{903}{2}\right\}, \text{ErrorBar}\left[\left\{-\sqrt{\frac{181}{3}}, \sqrt{\frac{181}{3}}\right\}\right]\right\},$

$\left\{\left\{25., \frac{1719}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{\sqrt{433}}{2}, \frac{\sqrt{433}}{2}\right\}\right]\right\},$

$\left\{\left\{20., \frac{837}{2}\right\}, \text{ErrorBar}\left[\left\{-\sqrt{\frac{385}{3}}, \sqrt{\frac{385}{3}}\right\}\right]\right\},$

$\left\{\left\{15., \frac{755}{2}\right\}, \text{ErrorBar}\left[\left\{-\sqrt{\frac{77}{3}}, \sqrt{\frac{77}{3}}\right\}\right]\right\},$

$\left\{\left\{9.7, \frac{1359}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{\sqrt{\frac{59}{3}}}{2}, \frac{\sqrt{\frac{59}{3}}}{2}\right\}\right]\right\},$

$\left\{\left\{8.9, \frac{1337}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{\sqrt{\frac{139}{3}}}{2}, \frac{\sqrt{\frac{139}{3}}}{2}\right\}\right]\right\},$

$\left\{\left\{8., \frac{1335}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{\sqrt{\frac{371}{3}}}{2}, \frac{\sqrt{\frac{371}{3}}}{2}\right\}\right]\right\}, \left\{\left\{7., 328\right\}, \text{ErrorBar}\left[\left\{-\sqrt{\frac{14}{3}}, \sqrt{\frac{14}{3}}\right\}\right]\right\},$

$\left\{\left\{6., \frac{667}{2}\right\}, \text{ErrorBar}\left[\left\{-5\sqrt{\frac{5}{3}}, 5\sqrt{\frac{5}{3}}\right\}\right]\right\}, \left\{\left\{5., 352\right\}, \text{ErrorBar}\left[\left\{-\sqrt{2}, \sqrt{2}\right\}\right]\right\},$

$\left\{\left\{4., \frac{1531}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{\sqrt{\frac{83}{3}}}{2}, \frac{\sqrt{\frac{83}{3}}}{2}\right\}\right]\right\}, \left\{\left\{3., \frac{1655}{4}\right\}, \text{ErrorBar}\left[\left\{-\frac{3}{2}, \frac{3}{2}\right\}\right]\right\},$

$\left\{\left\{2., \frac{875}{2}\right\}, \text{ErrorBar}\left[\left\{-\sqrt{3}, \sqrt{3}\right\}\right]\right\}\right\}$

Atch 9

■ Key Functions Used in Test Packages

★ Evaluating Limits

In[11]:= $\text{Limit}\left[\text{Sin}\left[\dfrac{1}{x}\right],\ x \to \infty\right]$

Out[11]= 0

★ Computing Gradients

In[12]:= `Needs["Calculus`VectorAnalysis`"]`
`Grad[5 x^2 y^3 z^4, Cartesian[x, y, z]]`

Out[13]= $\{10\,x\,y^3\,z^4,\ 15\,x^2\,y^2\,z^4,\ 20\,x^2\,y^3\,z^3\}$

Atch 9

★ Plotting Vector Fields

```
In[14]:= Needs["Graphics`PlotField`"]
         PlotVectorField[{y, x}, {x, -2, 2}, {y, -2, 2}];
```

Atch 9
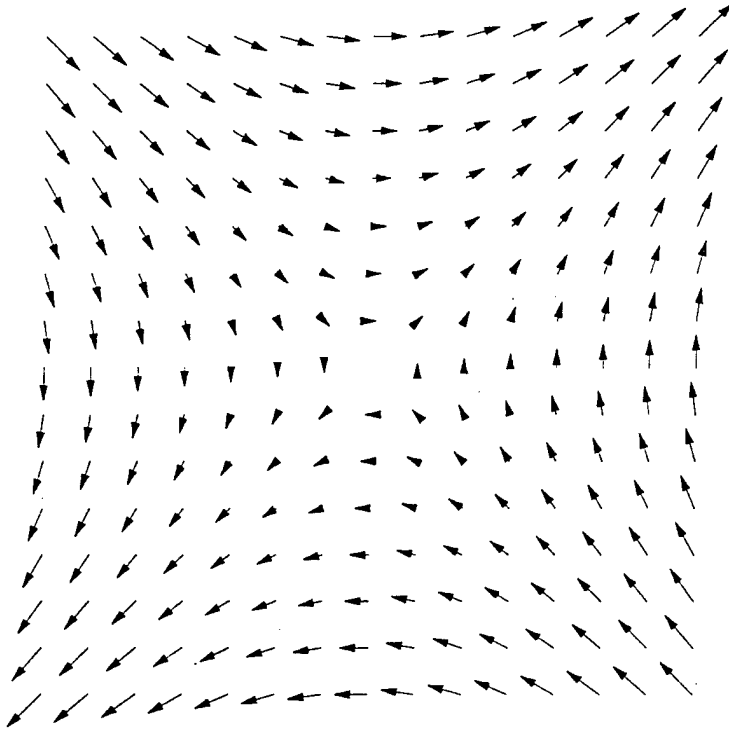
★ Plotting Level Curves (Contour Maps)

In[16]:= `ContourPlot[2 x`^{2}` + 3 y`^{3}`, {x, -π, π}, {y, -π, π}];`
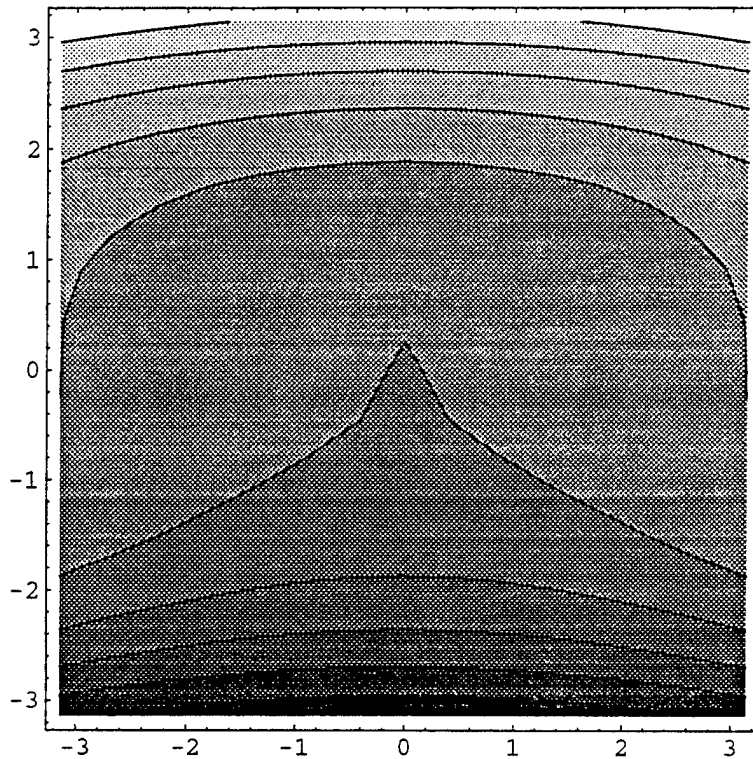
★ Generating Random Numbers

In[10]:= `Table[Random[Integer, {0, 100}], {n, 1, 10}]`

Out[10]= `{13, 14, 15, 36, 80, 13, 75, 78, 82, 0}`

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Atch 9

★ Parametric Plots and Phase Plane Plots

```
In[24]:= Needs["Graphics`Graphics`"]
        ParametricPlot[
          {3 Cos[t], 3 Sin[t]}, {t, 0, 2 Pi},
          AspectRatio -> 1 ];
```
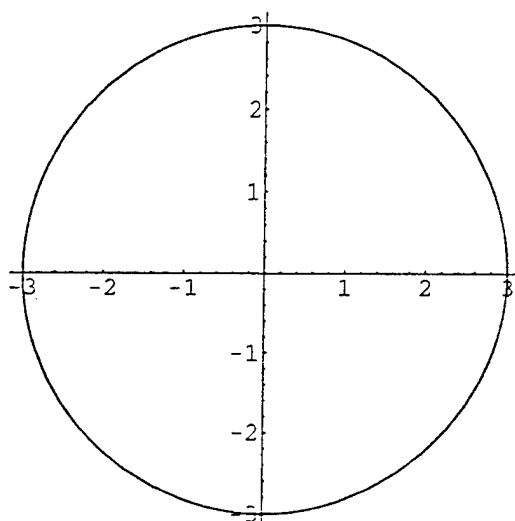


```
In[38]:= Needs["Graphics`Graphics`"]
        ParametricPlot[
          {2 Cos[t], 3 Sin[2 t]}, {t, 0, 2 Pi},
          AspectRatio -> 1 ];
```


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Atch 9

In[40]:=

```
Clear[A]
A:={{0,1},{-4,-5}}    (* INPUT "A" MATRIX *)
Print["Eigenvalues are ",Eigenvalues[A]]
Print["Eigenvectors are ",eigvec=Eigenvectors[A]]
(* Generates a plot of the two eigenvectors *)
eigvecplot:=Plot[{eigvec[[1,2]]/eigvec[[1,1]] x,
                eigvec[[2,2]]/eigvec[[2,1]] x},
                {x,-5,5},PlotRange->{-5,5},
                PlotStyle->RGBColor[1,0,0],
                DisplayFunction->Identity];

(* Generates a phase plane plot *)
Needs["Graphics`PlotField`"]
phase[x_,y_]:={A[[1,1]]x+A[[1,2]] y,
             A[[2,1]]x+A[[2,2]]y}
phaseplot:=PlotVectorField[phase[x,y],{x,-5,5},{y,-5,5},
                Axes->True,PlotPoints->20,
                DisplayFunction->Identity];

(* Generates a plot of x[t] & y[t] w.r.t. time *)
ivp=DSolve[{xx'[t]==A[[1,1]]xx[t]+A[[1,2]]yy[t],
            yy'[t]==A[[2,1]]xx[t]+A[[2,2]]yy[t],
            xx[0]==2,yy[0]==2}, (* INITIAL CONDITIONS*)
            {xx[t],yy[t]},t];
xpart:=ivp[[1,1,2]]
ypart:=ivp[[1,2,2]]
Plot[{xpart,ypart},{t,0,5},
        PlotStyle->{RGBColor[1,0,0],RGBColor[0,1,0]},
        PlotLabel->"xpart in Red, ypart in Green",  (*LABELS*)
        AxesLabel->{" time"," "}];

(* Generates a parametric plot of the solution *)
paraplot=ParametricPlot[{xpart,ypart},{t,0,3},
        PlotRange->{-5,5},
        PlotStyle->RGBColor[0,0,1],
        DisplayFunction->Identity];

(* Shows all three plots together *)
Show[eigvecplot,phaseplot,paraplot,AspectRatio->1,
        Frame->True,FrameLabel->{"xpart","ypart"},  (*LABELS*)
        DisplayFunction->$DisplayFunction,
        PlotRange->{{-5,5},{-5,5}}];
```
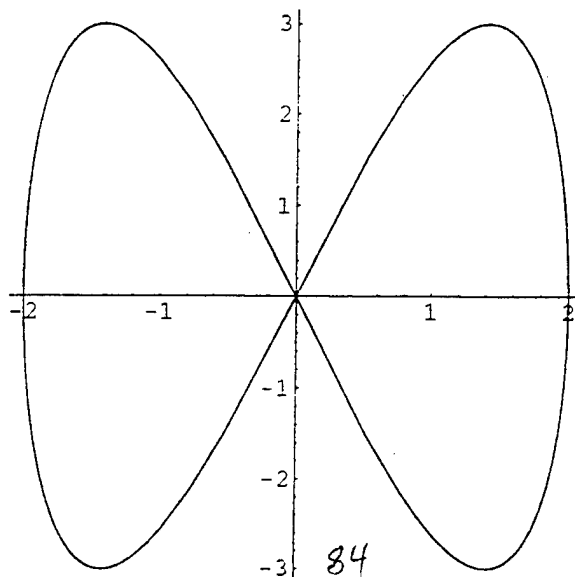
Eigenvalues are {-4, -1}

Eigenvectors are {{-1, 4}, {-1, 1}}

xpart in Red, ypart in Green
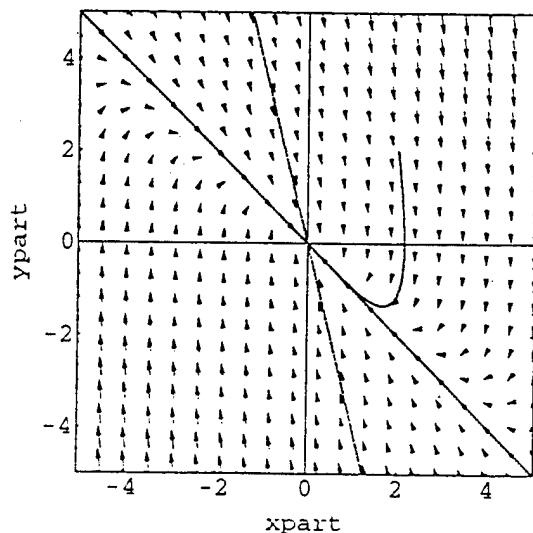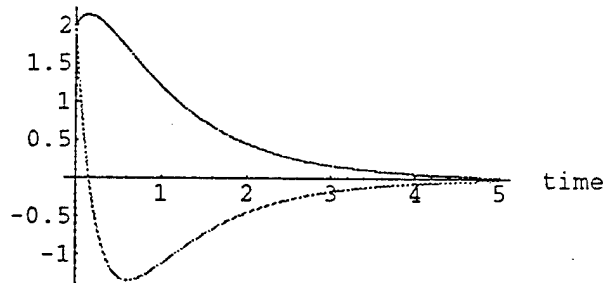
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Atch 9

★ Defining and Operating on Matrices

CTRL , Add a column

CTRL RET Add a row

In[72]:= $A := \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{pmatrix}$

$B := \begin{pmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{pmatrix}$

In[74]:= **Det[A]**

Out[74]= -3

In[76]:= **Inverse[A] // MatrixForm**

Out[76]//MatrixForm=
$$\begin{pmatrix} -\frac{2}{3} & -\frac{4}{3} & 1 \\ -\frac{2}{3} & \frac{11}{3} & -2 \\ 1 & -2 & 1 \end{pmatrix}$$

In[77]:= **A . B**

Out[77]= {{30, 24, 18}, {84, 69, 54}, {141, 116, 91}}

Atch 9

★ **Finding Eigenvalues and Eigenvectors**

In[80]:= $\mathbf{A} := \begin{pmatrix} 1 & 2 \\ 4 & 5 \end{pmatrix}$

In[81]:= **Eigenvalues[A]**

Out[81]= $\left\{ 3 - 2\sqrt{3},\ 3 + 2\sqrt{3} \right\}$

In[82]:= **Eigenvectors[A]**

Out[82]= $\left\{ \left\{ \frac{1}{2}\left(-1-\sqrt{3}\right),\ 1 \right\},\ \left\{ \frac{1}{2}\left(-1+\sqrt{3}\right),\ 1 \right\} \right\}$

In[85]:= **Eigensystem[A] // TableForm**

Out[85]//TableForm=

$3 - 2\sqrt{3}$	$3 + 2\sqrt{3}$
$\frac{1}{2}\left(-1-\sqrt{3}\right)$	$\frac{1}{2}\left(-1+\sqrt{3}\right)$
1	1

Atch 9

★ Solving ODE's and Systems of ODE's

In[90]:= `DSolve[{F == m x''[t], x[0] == Xo, x'[0] == Vo},`
`x[t], t]`

Out[90]= $\left\{\left\{x[t] \rightarrow \dfrac{F\,t^2}{2\,m} + t\,Vo + Xo\right\}\right\}$

In[94]:= `DSolve[{x'[t] == -4 x[t] + y[t] + z[t],`
`y'[t] == x[t] + 5 y[t] - z[t],`
`z'[t] == y[t] - 3 z[t]},`
`{x[t], y[t], z[t]}, t] //`
`TraditionalForm`

Out[94]//TraditionalForm=

$$\{\{x(t) \rightarrow 10\,e^{-4t}\,c_1 + e^{-3t}\,c_2 + e^{5t}\,c_3,\ y(t) \rightarrow 8\,e^{5t}\,c_3 - e^{-4t}\,c_1,$$
$$z(t) \rightarrow e^{-4t}\,c_1 + e^{-3t}\,c_2 + e^{5t}\,c_3\}\}$$

Atch 9

★ Laplace and Inverse Laplace Transforms

In[98]:= `Needs["Calculus`LaplaceTransform`"]`
`LaplaceTransform[`
`  Sin[t] DiracDelta[3 t - π], t, s]`

Out[99]= $\dfrac{E^{-\frac{\pi s}{3}}}{2\sqrt{3}}$

In[101]:= `InverseLaplaceTransform[`$e^{\frac{a}{s}+b}$`, s, t]`

Out[101]= $E^{b}\left(\dfrac{\sqrt{a}\ \text{BesselI}[1, 2\sqrt{a}\sqrt{t}]}{\sqrt{t}} + \text{DiracDelta}[t]\right)$

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Atch 9

★ Generating Fourier Series

```
In[102]:= Needs["Calculus`FourierTransform`"]
       f[x_] := π - x
       p := π
       n := 5
       FourierTrigSeries[f[x], {x, 0, p}, n]
       Plot[{%, f[x]}, {x, 0, p},
         PlotStyle -> {RGBColor[1, 0, 0], RGBColor[0, 0,
          PlotLabel -> "f(x) in blue, fourier in red"
           ];
```

$$Out[106]= \frac{\pi}{2} + Sin[2\,x] + \frac{1}{2} Sin[4\,x] + \frac{1}{3} Sin[6\,x] + \frac{1}{4} Sin[8\,x$$

$$\frac{1}{5} Sin[10\,x]$$

ExLn bluéourièn red

Atch 9
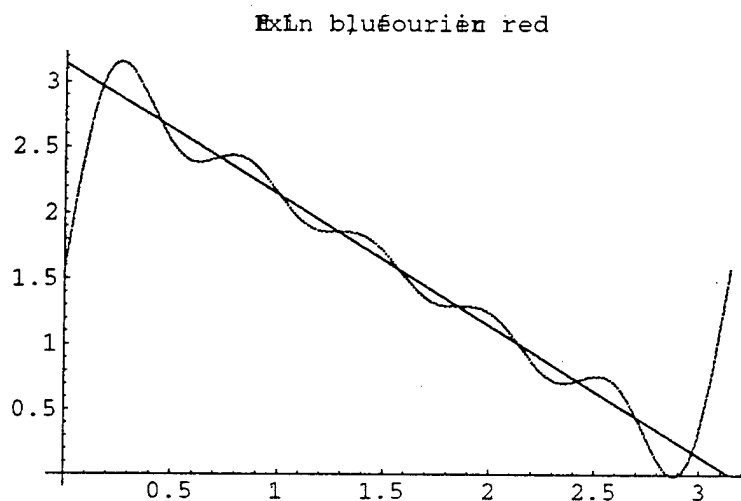
⋆ Fourier Integrals

```
In[21]:= Remove[A,B,f,g,alpha]
        f[x_]:=-1
        g[x_]:=2
        A[α_]=Integrate[f[x]Cos[α x], {x,-1,0}]+
                Integrate[g[x]Cos[α x], {x,0,1}]
        B[α_]=Integrate[f[x]Sin[α x], {x,-1,0}]+
                Integrate[g[x]Sin[α x], {x,0,1}]
        f[x_]=1/Pi Integrate[A[α]Cos[α x]+
                        B[α]Sin[α x],
                            {α,0,∞}];
        Plot[f[x],{x,-3,3}];
```

Out[24]= $\dfrac{\text{Sin}[\alpha]}{\alpha}$

Out[25]= $\dfrac{3}{\alpha} - \dfrac{3\,\text{Cos}[\alpha]}{\alpha}$

Atch9
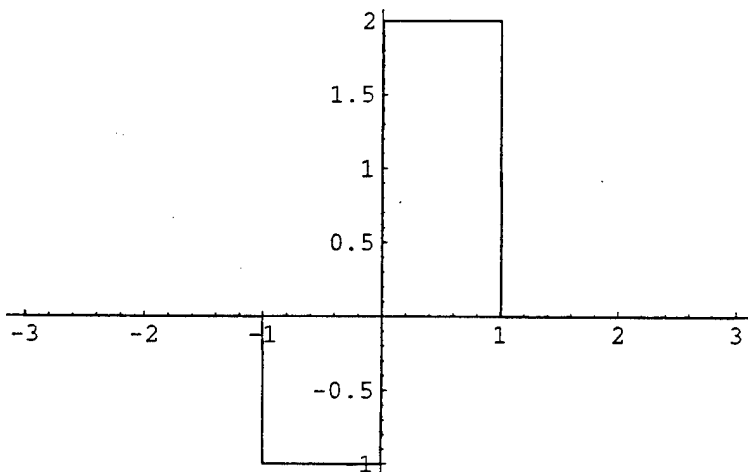
Software Search
Mathcad Training

- Basic Concepts

- Online Help/Tutorial

- Key Functions

Basic Concepts

- Everything appears in familiar math notation

- What you see is what you get

- Enter equations with the keyboard or via the palettes

- Numerical or symbolic calculations can be specified

- **Mathcad knows only what is physically above it in the worksheet**

Online Help/Tutorial

- Accessing on-line help

- Starting the Tutorial

- Running the program (R:\WINMCAD\MCAD.EXE)

ATCH W

Defining and Evaluating Functions

$f(x) := x^2 + \sqrt{x}$

$f(\pi) = 11.642$

$f(\pi) \rightarrow \pi^2 + \sqrt{\pi}$

$g(x, y) := \cos(x + y)$

$g(\pi, 5) = -0.284$

Solving for a variable

$a \cdot x^2 + b \cdot x + c$ has solution(s)

$$
\begin{bmatrix}
\dfrac{1}{(2 \cdot a)} \cdot \left(-b + \sqrt{b^2 - 4 \cdot a \cdot c} \right) \\
\dfrac{1}{(2 \cdot a)} \cdot \left(-b - \sqrt{b^2 - 4 \cdot a \cdot c} \right)
\end{bmatrix}
$$

select x and use symbolic variable solve.

ATCH 10

Solving Systems of equations symbolically

Given

$$x^2 + y^2 = 9$$

$$y = x$$

$$\text{Find}(x, y) \rightarrow \begin{pmatrix} \dfrac{-1}{2} \cdot \sqrt{9} \cdot \sqrt{2} & \dfrac{1}{2} \cdot \sqrt{9} \cdot \sqrt{2} \\ \dfrac{-1}{2} \cdot \sqrt{9} \cdot \sqrt{2} & \dfrac{1}{2} \cdot \sqrt{9} \cdot \sqrt{2} \end{pmatrix}$$

use control . for the
symbolic equals sign

Solving Systems of equations numerically

$$x := 1 \quad y := 1$$

guess values

Given

$$x^2 + y^2 = 9$$

$$y = x$$

$$\text{Find}(x, y) = \begin{pmatrix} 2.121 \\ 2.121 \end{pmatrix}$$

ATCH 10

Graphics

$$x := -3, -2.99 .. 3$$

$$\frac{\sqrt{9 - x^2}}{}$$

$$\frac{-\sqrt{9 - x^2}}{}$$

$$\frac{x}{}$$
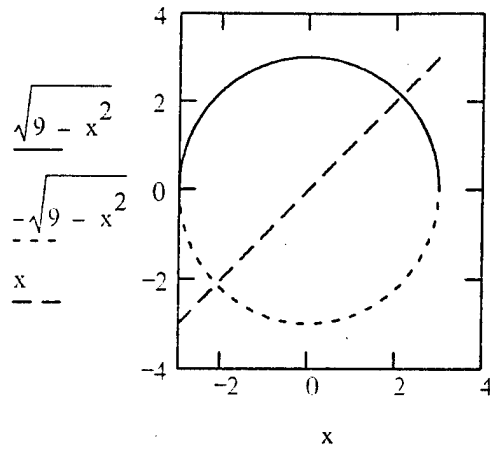
Use trace to read off values

Plot of exp(2x)

function

$$\frac{e^{2 \cdot x}}{}$$

x
x-value

ATCH 10
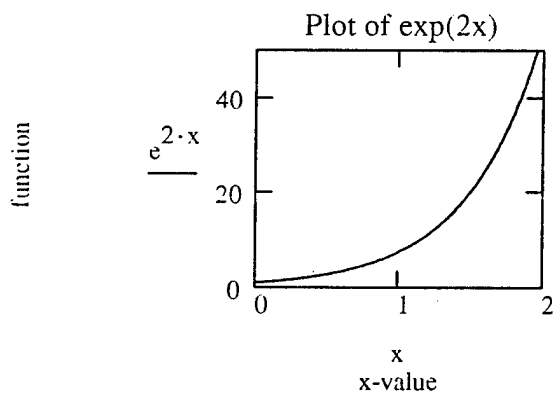
Plotting a function which is not well behaved

$\text{points} := 1000 \qquad i := 0 \mathinner{.\,.} 2 \cdot \text{points} \qquad x_i := \dfrac{1}{4000} + \dfrac{i - \text{points}}{\text{points}}$

$f(x) := \sin\left(\dfrac{1}{x}\right)$
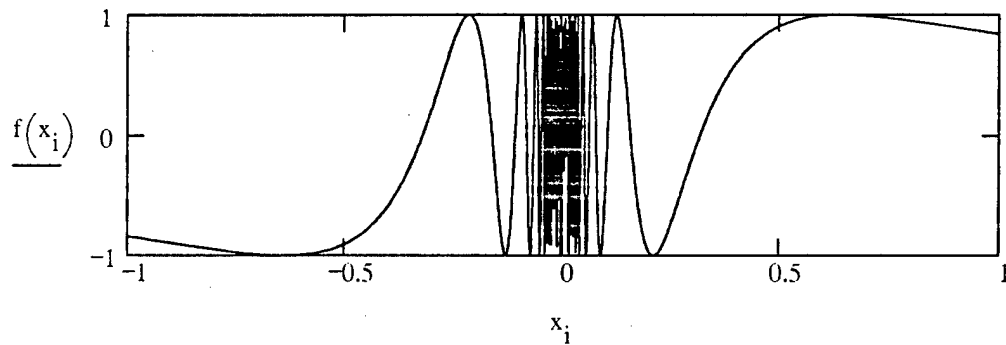
Surface Plot

N := 30

i := 0 .. N   j := 0 .. N $x_i := -1 + .1 \cdot i$ $y_i := -1 + .1 \cdot i$

$M_{i,j} := \sin\left(\cos\left(2 \cdot y_j\right) + \sin\left(2 \cdot x_i\right)\right)$

M

Animation

x := -5, -4.9 .. 5

ATCH 10
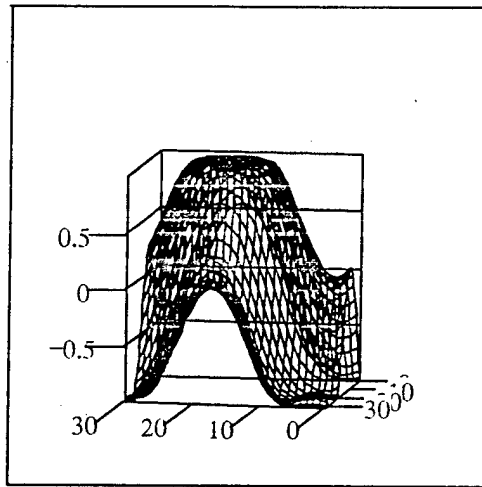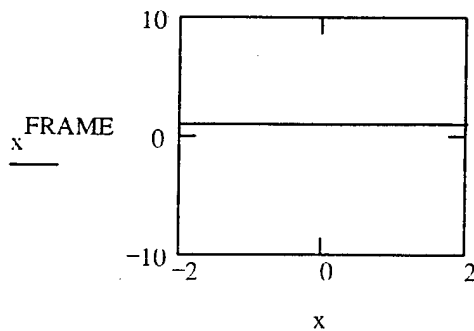
Contour Plot

N := 30

i := 0..N   j := 0..N x_i := -1 + .1·i y_i := -1 + .1·i

$M_{i,j}$:= $\sin\left(\cos(2·y_j) + \sin(2·x_i)\right)$

M

Atch10
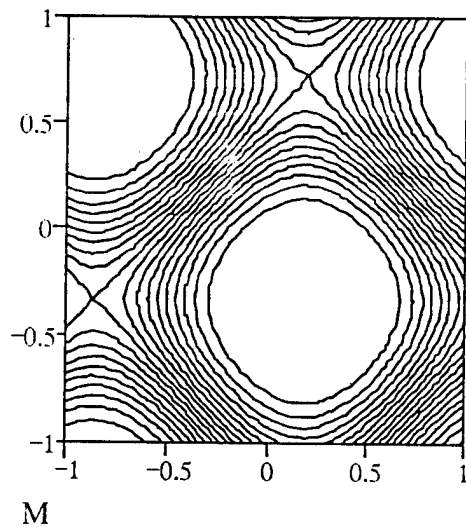
Differentiation

Position

$5 \cdot x^2 + 3 \cdot x + 6$

select variable and use symbolic-differentiate on variable

Velocity

$10 \cdot x + 3$

Acceleration

10

Function with two variables

$e^x \cdot \cos(y)$

with respect to x $\quad \exp(x) \cdot \cos(y)$

with respect to y $\quad -\exp(x) \cdot \sin(y)$

$\dfrac{d^2}{d\,y^2}\, e^x \cdot \cos(y)$ simplifies to $\quad -\exp(x) \cdot \cos(y)$ symbolic-simplify

Atch 10

Integration

$$\int_0^{10} -k \cdot x \ dx \ \text{yields} \quad -50 \cdot k$$

$$\int_0^{\pi} e^x \ dx \ = 22.141 \qquad\qquad\qquad \text{numerically}$$

$$\int_0^{\pi} e^x \ dx \ \text{yields} \quad \exp(\pi) - 1 \qquad\qquad \text{symbolically}$$

$$\int \cos(x) \ dx \ \text{yields} \quad \sin(x)$$

$$\int_0^{2 \cdot \pi} \int_0^{R} r \ dr \ d\theta \ \text{yields} \quad R^2 \cdot \pi$$

$$\int_0^1 \cos\left(x^2\right) \ dx \ = 0.905 \qquad \int_0^1 \cos\left(x^2\right) \ dx \text{yields} \quad \frac{1}{2} \cdot \sqrt{2} \cdot \sqrt{\pi} \cdot \text{FresnelC}\left(\frac{\sqrt{2}}{\sqrt{\pi}}\right)$$

Atch 10

Iteration

$N := 5$

$t_0 := 100$

$i := 1 .. N - 1$

$t_i := \sqrt{t_{i-1}}$

$$t = \begin{bmatrix} 100 \\ 10 \\ 3.162 \\ 1.778 \\ 1.334 \end{bmatrix}$$

$$\text{Function}(x) := \cfrac{1}{\sqrt{1 + \cfrac{1}{\sqrt{1 + \cfrac{1}{\sqrt{1 + \cfrac{1}{\sqrt{1 + \cfrac{1}{\sqrt{x}}}}}}}}}}$$

$\text{Function}(5) = 0.754$

$$\text{MyFunction}(x) := \begin{vmatrix} 1 & \text{if } x = 1 \\ \cfrac{1}{\sqrt{1 + \text{MyFunction}(x - 1)}} & \text{otherwise} \end{vmatrix}$$

$\text{MyFunction}(5) = 0.755$

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Importing Data

data := READPRN(file)

$$\text{data} = \begin{pmatrix} 10 & 10 \\ 20 & 15 \\ 30 & 30 \end{pmatrix}$$

$\text{data}_{1,1} = 15$

$$\text{data}^{<1>} = \begin{pmatrix} 10 \\ 15 \\ 30 \end{pmatrix}$$

$$\text{submatrix}(\text{data}, 1, 2, 0, 1) = \begin{pmatrix} 20 & 15 \\ 30 & 30 \end{pmatrix}$$

Use associate the name
to map file to variable

103

Atch10

Key Functions

Limits

$$\lim_{x \to \infty} \sin\left(\frac{1}{x}\right) \text{ simplifies to } 0$$

Gradients

Plotting Vector Fields

$N := 10$

$m := 0 .. N \qquad n := 0 .. N$

$x_m := -1 + .2 \cdot m \quad y_m := -1 + .2 \cdot m$

$X_{m,n} := x_m \qquad Y_{m,n} := y_n$

Y, X

Atch 10
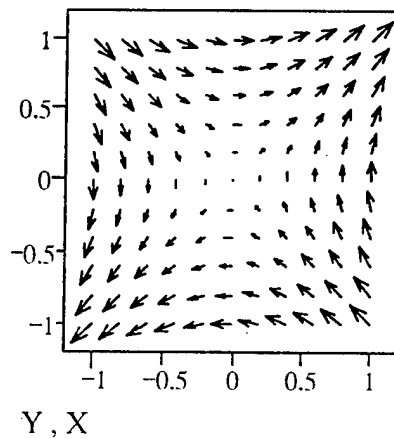
Defining and Operating on Matrices

$$A := \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{pmatrix}.$$

$$B := \begin{pmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{pmatrix}$$

$$|A| = -3$$

$$A^{-1} = \begin{pmatrix} -0.667 & -1.333 & 1 \\ -0.667 & 3.667 & -2 \\ 1 & -2 & 1 \end{pmatrix}$$

$$A \cdot B = \begin{pmatrix} 30 & 24 & 18 \\ 84 & 69 & 54 \\ 141 & 116 & 91 \end{pmatrix}$$

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Atch 10

Finding Eigenvalues and Eigenvectors

$$A := \begin{pmatrix} 1 & 2 \\ 4 & 5 \end{pmatrix}$$

$$\text{eigenvals}(A) = \begin{pmatrix} -0.464 \\ 6.464 \end{pmatrix}$$

$$\text{eigenvecs}(A) = \begin{pmatrix} 0.807 & 0.344 \\ -0.591 & 0.939 \end{pmatrix}$$

Atch 10

Laplace and Inverse Laplace Transforms

$\sin(t) \cdot \text{Dirac}(3 \cdot t - \pi)$ has Laplace transform $\quad \dfrac{1}{6} \cdot \exp\left(\dfrac{-1}{3} \cdot s \cdot \pi\right) \cdot \sqrt{3}$

$\dfrac{s}{s+a}$ has inverse Laplace transform $\quad -a \cdot \exp(-a \cdot t) + \text{Dirac}(t)$

Archie

Parametric Plot

$$x(t) := 2 \cdot \cos(t) \quad y(t) := 3 \cdot \sin(2 \cdot t) \quad i := 0 .. 100 \quad t_i := \frac{2 \cdot \pi}{100} \cdot i$$

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Atch W
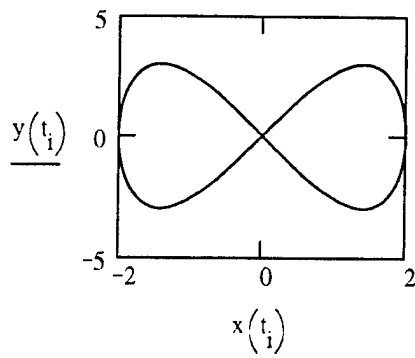
Generating Fourier Series

$$f(x) := \pi - x \quad n := 0 .. 10 \qquad L := \frac{\pi}{2}$$

$$s_n := \frac{1}{L} \cdot \int_0^{2 \cdot L} f(x) \cdot \sin\left(\frac{n \cdot \pi \cdot x}{L}\right) dx \qquad c_n := \frac{1}{L} \cdot \int_0^{2 \cdot L} f(x) \cdot \cos\left(\frac{n \cdot \pi \cdot x}{L}\right) dx \qquad c_0' := \frac{c_0}{2}$$

s_n

0
1
0.5
0.333
0.25
0.2
0.167
0.143
0.125
0.111
0.1

c_n

1.571
$1.038 \cdot 10^{-12}$
$1.383 \cdot 10^{-12}$
$1.037 \cdot 10^{-12}$
$1.475 \cdot 10^{-12}$
$1.037 \cdot 10^{-12}$
$1.383 \cdot 10^{-12}$
$1.037 \cdot 10^{-12}$
$1.499 \cdot 10^{-12}$
$1.037 \cdot 10^{-12}$
$1.383 \cdot 10^{-12}$

$$ft(x) := \sum_n \left(c_n \cdot \cos\left(\frac{n \cdot \pi \cdot x}{L}\right) + s_n \cdot \sin\left(\frac{n \cdot \pi \cdot x}{L}\right) \right)$$

Atch 10

$$i := 0..100 \quad x_i := i \cdot \frac{\pi}{100}$$

$$\frac{f(x_i)}{ft(x_i)}$$
- - - -

$$x_i$$

Atch 10
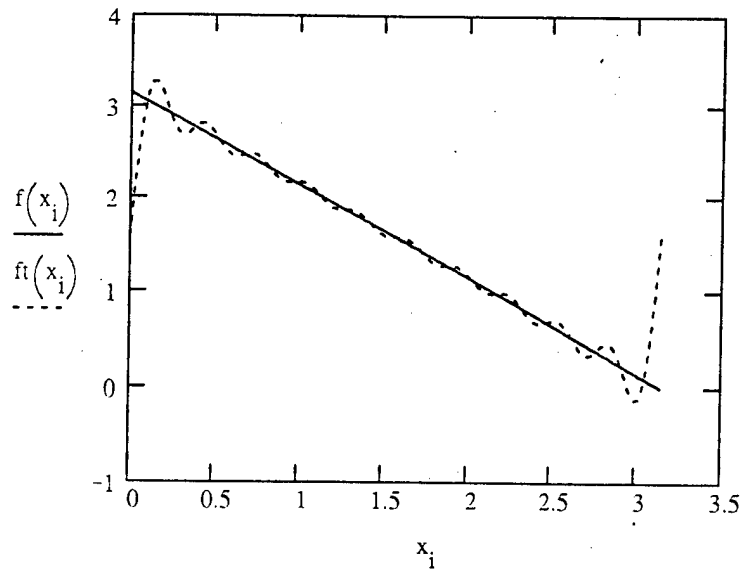
MATHEMATICAL SOFTWARE EVALUATION
COMMITTEE ASSIGNMENTS

**   *Indicates course leader*
*   *Indicates alternate course leader*
(T)   *Indicates will attend the training sessions*

Left column (shaded) will do Mathcad the first week (13-20 Jan) and Mathematica during the second week (21-28 Jan). Right column (unshaded) will do Mathematica first, then Mathcad.

MATH 130 EVALUATION	
Lt Col (sel) Boedigheimer (T)	Lt Malan (T)
Capt Clasen (T)	Capt Brown (T)
Lt Col (sel) Bussian *	Capt Cusick **
Lt Herrera	Maj (sel) Newton

MATH 141 EVALUATION	
Capt Egleston (T) *	Capt Huber (T)
Maj Hall (T)	Capt Santoni (T)
Lt Herrera	Capt Barrows **
Capt Mork	Col Litwhiler

MATH 142 EVALUATION	
Maj Hall (T)	Maj Rutledge (T)
Maj Revak (T)	Capt Maddox (T) *
Capt Tuteral	Col Litwhiler
Capt Pendergraft **	Capt Barrows

MATH 243 EVALUATION	
Maj Schooff (T)	Capt Huber (T)
Capt Young (T)	Lt Col Heinecke (T)
Maj Cooley **	Dr Holdener
Capt Wolverton	Dr Kline *

MATH 245 EVALUATION	
Capt Young (T)	Lt Malan (T)
Dr Lisowski (T)	Lt Col Sarnacki (T)
Capt Mueller **	Capt Trujillo *
Lt Col (sel) Bussian	Maj Gaudreault

MATH 346 EVALUATION	
Dr Lisowski (T)	Maj Waters (T)
Maj Mcharg (T)	Maj Hadfield (T)
Maj Bergeron	Capt Simonich *
Capt Wolverton **	Maj Gaudreault

PHYSICS EVALUATION	
Maj Mcharg (T) **	Maj Waters (T)
Maj Gurley (T Mathcad only)	Capt Mandeville (T) *
Maj Cooley	Capt Simonich
Maj Bergeron	

CLIENT DEPARTMENTS	
Capt Mork (DFC)	Capt Hale (DFEE)
Dr Lisowski (DFAS)	Capt Santoni (DFEG)
Lt Col Cain (DFC)	Maj Waters (DFEM)
Lt Herrera (DFBL)	Lt Malan (DFAN)

ATTACHMENT 11

DFMS Mathematical Software Evaluation

PURPOSE: To determine whether Mathematica Ver 3.0 or Mathcad Ver 6.0 better satisfies the technology needs of our core calculus & engineering math courses and provides a useful capability for later technical courses focusing on both functionality and useability.

Evaluation Structure

- Course-oriented with a "course leader" to insure all objectives are tested and provide a first level of assistance
- Comparison rating scheme dividing 10 functionality points and 10 useability points between the two packages
- Specific course objectives and an overall rating for each course

Evaluation Structure (cont)

- Separate test package for Physics & an open one for client department reps (*NOTE: clients can include a 3rd s/w)
- Half get training & half don't
- Half start on MMA & half on Mathcad
- Save & print results, record time used
- Explore and give general impressions

Where To Go For Help

- On-line help
- Mathcad manuals & MMA Getting Started's in 6D20C (please use sign-outs, for short times), MMA textbook is on-line
- Then, course leaders & others in course
- Finally, the software package advocates
  - » Mathcad: Capt Jody Mandeville, x2394
  - » MMA: Capt Paul Simonich, x3099

Key Dates

- 13 Jan: 1205-1225 Overview & pizza
- 13 Jan: 1230-1350 First training
  - MMA in Room ____, Mathcad in Room 2D26
- 13-20 Jan: Run tests on 1st package
- 21 Jan: 1230-1350 Second training
  - MMA in ____, Mathcad in 2D26
- 21-28 Jan: Run tests on 2nd package
- 29 Jan: Turn in results to Maj Hadfield

Analysis Plans

- Averages and favored counts of "Overall" ratings for each package and all math, physics, client packages together (also break out no exposure)
- Averages and favored counts each item
- Correlations with training, experience, order, ...
- Your comments and time used data

Evaluator	Training	MCD experience	MMA experience	Started with	Dept
Capt Barrows	N	N	S	MMA	DFMS
Capt Brown	Y	S	S	MMA	DFMS
Capt Clasen	Y	N	S	MCD	DFMS
Capt Cusick	N	N	S	MMA	DFMS
Capt Egleston	Y	N	S	MCD	DFMS
Capt Hale	N	N	S	MMA	DFEE
Capt Huber	Y	S	S	MMA	DFMS
Capt Maddox	Y	N	S	MMA	DFMS
Capt Mandeville	Y	S	L	MMA	DFP
Capt Mork	N	S	N	MCD	DFC
Capt Mueller	N	N	S	MCD	DFMS
Capt Newton	N	N	S	MMA	DFMS
Capt Pendergraft	N	N	L	MCD	DFMS
Capt Santoni	Y	N	N	MMA	DFEG
Capt Simonich	Y	S	L	MMA	DFMS
Capt Trujillo	N	N	L	MMA	DFMS
Capt Tuteral	N	N	L	MCD	DFMS
Capt Wolverton	N	N	S	MCD	DFMS
Capt Young	Y	N	S	MCD	DFMS
Dr Holdener	N	S	L	MMA	DFMS
Dr Kline	N	N	L	MMA	DFMS
Dr Lisowski	Y	N	N	MCD	DFAS
Lt Col Sarnacki	Y	N	S	MMA	DFMS
Lt Herrera	N	N	N	MCD	DFBL
Lt Malan	Y	N	N	MMA	DFAN
Maj Gurley	Y	N	L	MCD	DFP
Major Boedigheimer	Y	N	S	MCD	DFMS
Major Busslan	N	N	S	MCD	DFMS
Major Cooley	N	L	S	MCD	DFMS
Major Gaudreault	N	S	S	MMA	DFMS
Major Hadfield	Y	S	L	MMA	DFMS
Major Hall	Y	N	S	MCD	DFMS
Major Mcharg	Y	S	N	MCD	DFP
Major Revak	Y	N	N	MCD	DFMS
Major Rutledge	Y	S	N	MMA	DFMS
Major Schooff	Y	N	S	MCD	DFMS
Major Waters	Y	S	N	MMA	DFEM

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Simonich	PHYSICS	3.00	7.00	3.00	7.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Bussian	MATH 130	1.00	9.00	0.00	10.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

Avg(MCD use): 4.69　　Avg(MMA use): 5.31　　Avg(MCD func): 3.77　　Avg(MMA func): 6.23

Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Newton	MATH 130				
Capt Newton	MATH 142				
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Col Heinecke	MATH 243				
Lt Col Sarnacki	MATH 245				
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Bussian	MATH 130	1.00	9.00	0.00	10.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

— Heinecke   130

— Herra   141

Avg(MCD use) : 4.57   Avg(MMA use) : 5.43   Avg(MCD func) : 3.64   Avg(MMA func):li 6.36

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Atch 13

Evaluator	Training	MCD experience	MMA experience	Started with	Dept.
Capt Barrows	N	N	S	MMA	DFMS
Capt Brown	Y	S	S	MMA	DFMS
Capt Clasen	Y	N	S	MCD	DFMS
Capt Cusick	N	N	S	MMA	DFMS
Capt Egleston	Y	N	S	MCD	DFMS
Capt Hale	N	N	S	MMA	DFEE
Capt Huber	Y	S	S	MMA	DFMS
Capt Maddox	Y	N	S	MMA	DFMS
Capt Mandeville	Y	S	L	MMA	DFP
Capt Mork	N	S	N	MCD	DFC
Capt Mueller	N	N	S	MCD	DFMS
Capt Newton	N			MMA	DFMS
Capt Pendergraft	N	N	L	MCD	DFMS
Capt Santoni	Y	N	N	MMA	DFEG
Capt Simonich	Y	S	L	MMA	DFMS
Capt Trujillo	N	N	L	MMA	DFMS
Capt Tuteral	N	N	L	MCD	DFMS
Capt Wolverton	N	N	S	MCD	DFMS
Capt Young	Y	N	S	MCD	DFMS
Dr Holdener	N	S	L	MMA	DFMS
Dr Kline	N	N	L	MMA	DFMS
Dr Lisowski	Y	N	N	MCD	DFAS
Lt Col Heinecke	T			MMA	DFMS
Lt Col Sarnacki	Y	N	S	MMA	DFMS
Lt Malan	Y	N	N	MMA	DFAN
Maj Gurley	Y	N	L	MCD	DFP
Major Boedighelmer	Y	N	S	MCD	DFMS
Major Bussian	N	N	S	MCD	DFMS
Major Cooley	N	L	S	MCD	DFMS
Major Gaudreault	N	S	S	MMA	DFMS
Major Hadfield	Y	S	L	MMA	DFMS
Major Hall	Y	N	S	MCD	DFMS
Major Mcharg	Y	S	N	MCD	DFP
Major Revak	Y	N	N	MCD	DFMS
Major Rutledge	Y	S	N	MMA	DFMS
Major Schooff	Y	N	S	MCD	DFMS
Major Waters	Y	S	N	MMA	DFEM

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

Avg(MCD use) : 5.62   **Avg(MMA use) :** 4.38   **Avg(MCD func) :** 4.77   **Avg(MMA func):li** 5.23

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Simonich	PHYSICS	3.00	7.00	3.00	7.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Bussian	MATH 130	1.00	9.00	0.00	10.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00

Avg(MCD use) : 4.34   Avg(MMA use) : 5.66   Avg(MCD func) : 3.40   Avg(MMA func):li 6.60

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Atch 13

Evaluator	Course package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00

Avg(MCD use) : 5.67   Avg(MMA use) : 4.33   Avg(MCD func) : 4.33   Avg(MMA func):li 5.67

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Atch13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00

3   2   2   2

Avg(MCD use) : 5.38   Avg(MMA use) : 4.63   Avg(MCD func) : 5.25   Avg(MMA func):li 4.75

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Bussian	MATH 130	1.00	9.00	0.00	10.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00

8   19   3   24   32

Avg(MCD use) : 4.41   Avg(MMA use) : 5.59   Avg(MCD func) : 3.75   Avg(MMA func):li 6.25

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Atch 13

Evaluator	Course package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

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7   2   3   4

Avg(MCD use) : 5.83   Avg(MMA use) : 4.17   Avg(MCD func) : 5.08   Avg(MMA func): 4.92

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Bussian	MATH 130	1.00	9.00	0.00	10.00

Avg(MCD use) : 4.38   Avg(MMA use) : 5.63   Avg(MCD func) : 3.75   Avg(MMA func): 6.25

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Atch13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00

Avg(MCD use) : 6.25   Avg(MMA use) : 3.75   Avg(MCD func) : 5.00   Avg(MMA func):li 5.00

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Atch 13

Evaluator	Course package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00

Avg(MCD use) : 5.25　　Avg(MMA use) : 4.75　　Avg(MCD func) : 4.00　　Avg(MMA func):li 6.00

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Atch 13

Evaluator	Course package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00

Avg(MCD use) : 3.29   Avg(MMA use) : 6.71   Avg(MCD func) : 3.57   Avg(MMA func):li 6.43

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Atch B

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00

Avg(MCD use) : 4.17   Avg(MMA use) : 5.83   Avg(MCD func) : 2.83   Avg(MMA func):li 7.17

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

Avg(MCD use) : 4.50   **Avg(MMA use) :** 5.50   **Avg(MCD func) :** 3.00   **Avg(MMA func):li** 7.00

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Simonich	PHYSICS	3.00	7.00	3.00	7.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00

Avg(MCD use) : 5.00   Avg(MMA use) : 5.00   Avg(MCD func) : 4.00   Avg(MMA func):li 6.00

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Hale	CLIENT	3.00	7.00	3.00	7.00

Evaluator	Course package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Major Busslan	MATH 130	1.00	9.00	0.00	10.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00

Avg(MCD use) : 4.95   Avg(MMA use) : 5.05   Avg(MCD func) : 3.86   Avg(MMA func): 6.14

Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Simonich	PHYSICS	3.00	7.00	3.00	7.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

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9　　　　　12　　　　　1　　　　　20

Avg(MCD use) : 4.48　　　Avg(MMA use) : 5.52　　　Avg(MCD func) : 3.70　　　Avg(MMA func): 6.30

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Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Clasen	MATH 130	4.00	6.00	4.00	6.00
Capt Egleston	MATH 141	4.00	6.00	4.00	6.00
Capt Mork	MATH 141	8.00	2.00	5.00	5.00
Capt Mueller	MATH 245	4.00	6.00	2.00	8.00
Capt Pendergraft	MATH 142	6.00	4.00	7.00	3.00
Capt Tuteral	MATH 142	5.00	5.00	4.00	6.00
Capt Wolverton	MATH 243	4.00	6.00	4.00	6.00
Capt Wolverton	MATH 346	6.00	4.00	4.00	6.00
Capt Young	MATH 243	3.00	7.00	3.00	7.00
Dr Lisowski	MATH 245	2.00	8.00	2.00	8.00
Dr Lisowski	MATH 346	0.00	10.00	0.00	10.00
Lt Herrera	MATH 130	10.00	0.00	10.00	0.00
Lt Herrera	MATH 141	10.00	0.00	10.00	0.00
Maj Gurley	PHYSICS	5.00	5.00	3.00	7.00
Major Boedigheimer	MATH 130	3.00	7.00	4.00	6.00
Major Busslan	MATH 130	1.00	9.00	0.00	10.00
Major Cooley	MATH 243	6.00	4.00	4.00	6.00
Major Hall	MATH 141	6.00	4.00	3.00	7.00
Major Hall	MATH 142	6.00	4.00	3.00	7.00
Major Mcharg	PHYSICS	6.00	4.00	6.00	4.00
Major Revak	MATH 142	5.00	5.00	5.00	5.00
Major Schooff	MATH 243	2.00	8.00	4.00	6.00

Avg(MCD use) : 4.82   Avg(MMA use) : 5.18   Avg(MCD func) : 4.14   Avg(MMA func): 5.86

Atch 13

Evaluator	Course/package	MCD useability	MMA useability	MCD functionality	MMA functionality
Capt Barrows	MATH 141	4.00	6.00	4.00	6.00
Capt Barrows	MATH 142	4.00	6.00	4.00	6.00
Capt Brown	MATH 130	4.00	6.00	1.00	9.00
Capt Cusick	MATH 130	4.00	6.00	5.00	5.00
Capt Hale	CLIENT	3.00	7.00	3.00	7.00
Capt Huber	MATH 141	7.00	3.00	5.00	5.00
Capt Huber	MATH 243	3.00	7.00	5.00	5.00
Capt Maddox	MATH 142	7.00	3.00	4.00	6.00
Capt Mandeville	PHYSICS	6.00	4.00	4.00	6.00
Capt Newton	MATH 130	4.00	6.00	1.00	9.00
Capt Newton	MATH 142	3.00	7.00	1.00	9.00
Capt Santoni	MATH 141	6.00	4.00	5.00	5.00
Capt Simonich	MATH 346	3.00	7.00	3.00	7.00
Capt Simonich	PHYSICS	3.00	7.00	3.00	7.00
Capt Trujillo	MATH 245	4.00	6.00	2.00	8.00
Dr Holdener	MATH 243	2.00	8.00	3.00	7.00
Dr Kline	MATH 243	3.00	7.00	2.00	8.00
Lt Col Sarnacki	MATH 245	3.00	7.00	3.00	7.00
Lt Malan	MATH 130	5.00	5.00	5.00	5.00
Lt Malan	MATH 245	5.00	5.00	5.00	5.00
Major Gaudreault	MATH 245	7.00	3.00	3.00	7.00
Major Gaudreault	MATH 346	6.00	4.00	3.00	7.00
Major Hadfield	MATH 141	5.00	5.00	4.00	6.00
Major Hadfield	MATH 346	5.00	5.00	4.00	6.00
Major Rutledge	MATH 142	6.00	4.00	4.00	6.00
Major Waters	MATH 346	7.00	3.00	4.00	6.00

Avg(MCD use) : 4.58   Avg(MMA use) : 5.42   Avg(MCD func) : 3.46   Avg(MMA func): 6.54

EXTENDED COMMENTS
FROM EVALUATION COMMITTEE MEMBERS

Provided on the pages that follow are extended comments from some of the members of the Mathematical Software Evaluation Committee. They provide many interesting and significant ideas, concerns, and suggestions.

Capt Harry Newton (DFMS):

The user interface of mathcad is more intitive and will be easier for cadets to pick up on their own. Pasting graphs into documents works well for both packages. Mathematica requires a huge amount more disk space and RAM and costs more. However, the symbolic and plotting capabilities of MathCad are not sufficient for Math 130 (or any of the calculus courses). I believe that Maple would compete more favorably with Mathematica than MathCad did.

MathCad seems to have no adaptive routines for plotting. Even though, p. 440 of their manual states, "unless you specify otherwise, connects them [the points] with straight lines," but I can't find anywhere in the manual or the help facility a way to "specify otherwise." Consequently, poles of the function may be replaced by a straight line function; e.g., the pole at x=-2 is missed

$$x := -3, -2 - \frac{1}{3} .. -1$$
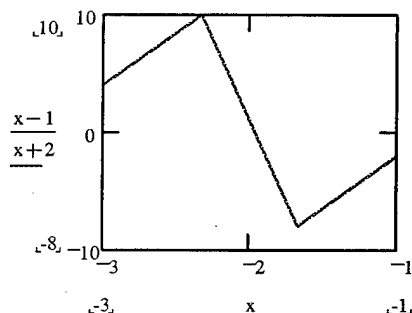
Further, the autoscaling feature for selecting y values seems to try to include the y-value for the pole (if the pole is at a grid point) which results in a flat plot.

$$x := -3, -2.99 .. -1$$
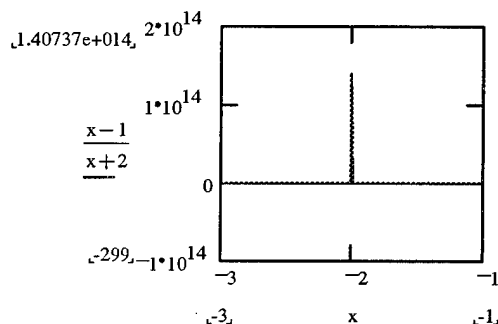
It also appears that the symbollics of mathcad are not up to problem 130.7. I read the manual for this section and played with it for about 30 minutes. I understand that Bruce Maddox was able to work this problem. So, maybe I'm just stupid... <<<Steve, if you quote this, plz paste in the problem>>>

Test Problem 130.10. This is the solution from mathcad for x^20+x^15-26x^10+x^4-x^3+1==0
RootOf(_Z^20+_Z^15-26*_Z^10+_Z^4-_Z^3+1)
Getting it requires pasting from the clipboard and it's a worthless solution. MMA gives a criptically formated answer to the same problem, but at least it's an answer.

Capt Paul Simonich (DFMS):

Based on my limited experience with MathCad 6.0 (testing Math 346 and Physics Test Suites) I would say MathCad 6.0 could work as a software package for our department if we choose for whatever reason, (password problems, ease of use, cost, politics, etc.) to use it. I do believe, however; Mathematica 3.0 is a far superior package though *some* contend it is more difficult to learn than MathCad. Having had to learn how to use MathCad I find that untrue. I recognize my background with Mathematica biases my opinions but I find it a much more logical, friendly package to work with than MathCad.

I have not had to deal with MathSoft, MathCad's maker, but have had extensive dealings with Wolfram and believe they are quite frankly poor business folks handling a superior product. The 2 ½ year delay in getting out 3.0, the nightmare we have had with passwords, and other issues seem to highlight the fact the customer is not the driver at their company. Is this a show stopper? It is hard to say. I think a good indication might be how (and how quickly) they choose to resolve this nightmare password problem we currently encounter.

Another real issue is the amount of man-years already devoted to developing courseware (notebooks) for the various courses taught in the math department.
Unfortunately, you cannot port a notebook from Mathematica to MathCad and hence hundreds of hours of developing some great notebooks would be lost. I think this could be a primary driver to stay with Mathematica if all other considerations prove roughly equal.

Another thing to consider is MathCad 6.0 will run under Windows 3.1 or Win95 while Mathematica 3.0 must have a Win95 platform (also runs under Windows NT, Sparcs, UNIX). Hard drives must also have 120 Megs of free space which could be a problem for some computers (98 - 212 Megs, 99 - 540 Megs, 00 - 1.2 Gigs, 01 - ~ 2.2 Gigs). This presents a problem in that next fall's seniors (class of 98) do not have Win95, though increasing numbers are installing it on their own. This also is a major problem in our classrooms which are approaching 3 or 4 generation old computers that barely run Mathematica 2.2.3. It looks like faculty desktop computers are being upgraded at a rate that it should not be a serious problem come this fall. Also, most if not all, DF lab computers are now running Win95 or will be upgraded soon.

There appears to be a fundamental difference in the philosophy of the two packages. Mathematica does everything symbolically unless you force it otherwise while MathCad does everything numerically unless you force it to utilize the Maple kernel to do it symbolically. I'm not sure if MathCad uses a toned down version of Maple but it appears to be quite inferior in its symbolic capability compared to what we are now using. Mathematica also will do just about anything (much more than our undergraduates will ever utilize) which combined with its symbolic approach probably is the key intimidator of the novice user. This approach, however, probably is necessary for DFMS if we want to continue our use of educational technology to enhance our "reformed" approach to teaching

math. For other departments who care only to have a numeric or graphic approach with an occasional symbolic solution, MathCad might be completely sufficient.

It is my impression that the best thing we could do for cadets (especially non-technical majors) is to choose a software that all core technical courses will use or at least not %&^$% about. I think either MathCad or Mathematica are both suitable for that purpose. DFMS has taken the lead in the past in introducing such software but has met resistance from other department who chose not to use Mathematica because of real or perceived difficulties. I think it would be better for the cadets if we used MathCad if the other departments would follow up and continue to emphasize its use in their courses than for us to stick with Mathematica and not have it used outside our department.

Specific Issues

I do feel the notebook approach to Mathematica provides a superior presentation format, (now that the WYSIWYG palettes are available), to MathCad's "workspace" approach. The ability to compress data into cells, put equations into text cells, convert to HTML, and other reasons make for a much better tool for the instructor to have to present material in the classroom.

The drop down palettes in MathCad "got in my way" as I was trying to do stuff in the workspace. Mathematica's palettes off to the side is better. Also with the ability to produce custom palettes, Mathematica's ability to be tailored to specific courses is far superior.

While I think it is much easier to generate plots in Mathematica, I do think like the fact I can double click on a graphic in MathCad and have dialog boxes available to add labels and do other things to the plots. This is far superior to Mathematica's approach of typing in all the options. I do prefer Mathematica's method of setting domains for its plots, especially when you're doing a 3D plot.

It maks me reeel angre that Wolfram choze not to puttt a speal chexer in thou so manie in the commuunnity haad askedd foo it.

It seems to be harder in MathCad to just highlight one part of an expression to cut, paste, or some other manipulation. The use of the spacebar to "walk your way" through an expression is not as convenient as just clicking anywhere in the expression and editing as Mathematica allows.

Summations, such as were needed to do some Fourier Series expansions, are a magnitude of order more convenient in Mathematica.

For someone comfortable with the constructs of a "do-loop" I think animations might be easier in Mathematica. For the novice doing a simple animation, MathCad's "FRAME" approach might be a bit easier to get through.

On-line help is far superior in Mathematica if you can get the students to use it. My impression is that students will not do this in general and will come and ask a question instead of trying to figure it out using the available help routines. The on-line tutorials and cut and paste of code into the notebook makes for a much better product. Also when errors do occur in coding, I think Mathematica does a bit better in trying to communicate what the error is. Several times I got error messages in MathCad that were vague and when I tried to find help in the online help or book I got nowhere.

Capt Bruce Maddox (DFMS):

Mathcad: Very nice for basic needs, but extended capabilities (graphing, etc.) are lacking in power. Its biggest advantage, its intuitive interface, evaporates when attempting to do a complicated graph or an animation.

Mathematica: More powerful, but has serious problems that make it tough to pick as a favorite. The improvements in its interface appear to be only "skin-deep"--to access its more powerful functions is even more difficult than Mathcad. However, the real problems are deeper yet. This program went through a Beta testing period of only about a month, which means that it is still basically a Beta version but in general, commercial release. I personally had several problems that seemed to stem from "bugs" in the program (that might have been eliminated with a real Beta testing period). Also, the "password" installation system is ridiculous--I waited for four days for a password, with no response. I eventually called Wolfram to get one. (With the current state of affairs, the question of how long the company will be available to support this software comes to mind.)

Overall: Because of the above-mentioned problems, I find it difficult to recommend Mathematica, even though it is definitely a more powerful program.

One final note: The current state of the art in mathematical software is low in terms of power and interface compared to mainstream software. As a result, there is not one program that is going to satisfy everyone. The software chosen will need to be a compromise between power and usability, with consideration given to what the overwhelming majority of users (the cadets) will be doing with it, not what we need to do research, etc.

Major Deb Hall (DFMS):

In terms of Math 130, Math 141 and 142, I really feel as though I could live with either product. Both have quirky little things that I like or dislike about each, but I didn't feel as though it really made a difference in the long run as long the quirks were demonstrated appropriately in class by the instructor. I believe that the format of Mathcad is probably more comfortable for a basic cadet for the following reasons: it is a little easier to insert text, there is easier access to basic palettes and information, The screen is a little brighter and friendlier (my opinion).

However, all of this being said, I feel as though the weaknesses in the multivariate aspects of Mathcad (especially in the graphical areas) are so severe that it outweighs most of the advantages for the beginner. What I really would like to avoid happening is a cadet using one set of software for early math classes and then having to switch. At the present time, there is no reason why a cadet cannot start with Mathematica and use it for all their math courses (to include prob and stats). I don't think Mathcad offers this same opportunity. To me the biggest advantage of all of this software is how it aids visualization. When this aspect is lost or inaccurate (as I feel it presently is in Mathcad), then the remainder becomes pointless. Because of this, I vote for Mathematica again.

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Major Eric Bussian (DFMS):

The following comments should be filtered with
the understanding that, while I am not an MMA
expert, I am very familiar with some of the
basics of using the package to include its
syntax and basic functional structure. I am
a total novice at MathCAD. On the other hand
I have also been using computer algebra systems,
including Maple, since 1991.

My overall evaluation is that MathCAD is
unacceptable for use in Math 130 while MMA
provides full functionality and usability
for this course.

My general philosophy is that a mathematics
software package, in today's environment, must
provide both a computational tool and MORE
importantly a visualization tool. Today's calculators
can provide most of the computational capability
we need. However, even the most advanced calculator
cannot provide the easy visualization capability of
the available mathematics software.

The students in Math 130 are our most unsophisticated
students. The computer software they use must provide
an easy method to visualize the many concepts they
find mysterious. If a student must develop a great deal
of sophistication about a mathematical concept before
using the software then the software is of almost no
use. Once one learns the basic syntax of MMA, the
sophistication of its routines provide an easy method
to visualize difficult concepts. MathCAD, because of
its numerical computation basis simply does not provide
this ability.

Plotting functions is one of the areas in which the
stark differences between these two pieces of software
become most apparent. In MMA one tells the software
which function/functions to plot and the range of
input values and MMA's "adaptive plotting routines"
plots the function, taking into account the first and
second derivatives, so that singularities and other
complexities are correctly portrayed. MathCAD requires

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the user to specify a step size for plotting points and simply fills in the regions between each step with a straight line. The result is that plots of functions with asymptotes in MathCAD routinely come out as horizontal lines with vertical lines at the asymptotes. It takes a great deal of sophistication to get around this. Thus to get a usable plot in MathCAD the student must understand where the singularities in a function occur and must carefully plot around them. This shortcoming also means that a student will almost never get a usable output for functions like Sin(1/x) on [-1,1], which is one of the most interesting functions a calculus or algebra student might study.

Simplifying functions was another area in which MathCAD showed little or no capability. Finding the roots of polynomials requires learning about entry of coefficient vectors and how to read their output -- not something a 130 student will have studied.

The one area in which I think MathCAD outshines MMA is in creating animations -- IF ONE IS WILLING TO ACCEPT THAT THE STEP SIZE OF THE FUNCTION WILL BE RESTRICTED TO MULTIPLES OF POSITIVE INTEGERS. This is a significant shortcoming, but if it can be accepted MathCADs animation routine is easy to use.

So overall, MathCAD is totally unacceptable for Math 130.

Capt Bob Clasen (DFMS):

Here are a few overall comments based on the Math 130 test suite:

- MMA's online help is fantastic. Easy to search; cutting and pasting examples is a breeze. Mathcad's help is lame in comparison.

- Mathcad has a an edge in plotting. Very easy to control output of a plot. Too many options to manually specify in MMA.

- MMA files are a bit more "readable." By that I mean it's easy to see what's going on because inputs and outputs are clearly labeled. Sometimes Mathcad just displays the result, and you can't always remember what that result signifies.

- MMA has some very cryptic error messages. When you screw something up, it's difficult to figure out what went wrong.

- It's kind of annoying to have to keep typing a "*" in Mathcad for expressions like "4*x" instead of just "4x" in MMA. Maybe you just get used to it after a while.

- Overall, I think MMA's a bit better than Mathcad, primarily due to the better online help.

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Dr Brad Kline and Dr Judy Holdener (DFMS):

Below are some general comments regarding the functionality and useability of the two software packages MathCAD and *Mathematica.*

1. Mathematica notebooks appear to the user exactly as documents appear in a word processor. There is a linear arrangement to a Mathematica notebook, and this makes it easy for the user to arrange work in an orderly, sequential fashion. It also makes it easy for someone reading a document, such as an instructor, to follow the user's thought processes. Thus, Mathematica requires little attention from the user as far as keeping work orderly and organized.

The only real aspect in Mathematica which demands the attention of the user is the order in which cells are executed, or whether they are executed at all. One of the most common errors made by a Mathematica user is that of not executing a certain cell needed by a later cell. Or, on rare occasions, a user can become baffled by executing Mathematica cells in some haphazard order. However, Mathematica offers the advantage that, during a given session, the order of execution remains documented with the "In[#]" flags. And, for cases in which Mathematica output has become hopelessly haphazard, one can always restart the kernel and evaluate the notebook from scratch, with cells executing in order of appearance.

By contrast, MathCAD is organized along the lines of a clipboard, similar to a ClipArt gallery. MathCAD demands that the user keep all of the individual cells organized in a logical fashion. The position of a cell in a MathCAD document affects the output of that individual cell, and of all of the cells following it. While this may have certain advantages, it can be extremely confusing. It is also a liability to the current format of the computer assignments in Math 142, 243, and 245. In these assignments, blocks of commands are provided to the cadets. In Mathematica, the linear arrangement of the cells guarantees that the cadet always knows the intended order of execution. However, if the same format were to be used in MathCAD, numerous problems could be created. All a cadet would have to do to become wrapped around the axle is accidentally grab a MathCAD cell and move it up or down in the document, which is much easier to do in

MathCAD than in Mathematica. Also, we had numerous problems within our test documents of earlier definitions interfering with later definitions. For example, we could not get a certain 3-D surface to plot when we used the matrix variables M and N. When we changed to S and T, everything was fine. Apparently, an earlier definition of M and N caused interference.

2. Mathematica provides very clean, simple plotting commands. While there are numerous options which may seem confusing to the beginner, one can easily get by with essentially NONE of these options. Instructors may introduce and cadets may digest the various plotting options as they become relevant or necessary.

MathCAD is very archaic in all of its plotting routines. Just to generate a simple graph in MathCAD requires numerous steps in selecting the number of points for the plot, the step size, the range of the points, and the definition of a plot variable (or matrix). The MathCAD manual suggests a VERY cryptic method for defining the domain values for a plot. In order to plot the function f(x) = 3x over the interval [-1,5] with 50 points, for example, MathCAD suggests defining the list of points $t_i = -1 + \dfrac{6}{50}i$ as i runs from 1 to 50. While we can tell ourselves that this should NOT be confusing to the cadets, the unfortunate truth is, it WILL be. If cadets feel like we expect too much "programming" from them in our math courses now, they are REALLY going to feel that way with MathCAD.

3. MathCAD handles lists of numeric data better. It is definitely a better and faster number-cruncher. We would definitely choose MathCAD for a course in numerical methods, or for research in iteration and fractals. However, in most math courses, we do not have a need to crunch through large sets of data, nor do we have elaborate algorithms requiring 100,000 passes through a certain loop.

4. MathCAD provides nicer animations. To animate a parametric curve with Mathematica, one typically plots a certain number of frames depicting partial plots of the

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curve. The sequence of frames takes a relatively long time to generate, and the end product requires a bit of memory. The animation itself is not that satisfying, either, because of the small number of frames. With MathCAD, one can essentially show the parametric curve being drawn on the screen. MathCAD also gives nice options for the speed of the animation.

5. MathCAD does not support combination of two or more graphics objects. This is a real deficiency, as Math 243 is using combinations of objects (gradient fields within contour diagrams, flow lines on vector fields, tangent planes on surfaces, etc.) more and more in projects and for in-class demos.

6. MathCAD is not the answer to the user-friendliness problem. It is certainly NOT more user-friendly than Mathematica. As part of the group which received no MathCAD training, it took us both about an hour and fifteen minutes, collaborating with one another, just to figure out MathCAD basics, such as executing commands (which we now know happens automatically, but did not realize until about 3 hours into our testing), defining functions, evaluating expressions, etc. In other words, it took us roughly 1-1/2 hours just to complete Test Item 243.1. We do not believe it would have taken us this long the first time we ever used Mathematica.

As mentioned before, the song and dance necessary to plot a graph is ridiculous. We certainly would not get positive cadet response to this feature, and we would probably end up providing lots of plotting templates.

The mouse and keyboard interplay continues to frustrate us. As Judy says, "DON'T HIT THE EQUAL SIGN!...IF YOU HIT THE EQUAL SIGN, WE'RE DEAD!!" It seems like it's impossible to point and click after an x just to enter a superscript. More often than not, when we try to modify a MathCAD cell, we get further and further from the desired expression, as MathCAD begins inserting arbtrary parentheses, commas, and input windows. It's usually best just to start over!

Plus, we have NO IDEA how you define a function with f(x,y), differentiate it with respect to x, and then actually get to SEE THE RESULT!

If we sound like we're frustrated with MathCAD, we are. We cannot imagine that the cadets will feel differently.

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LTC Steve Heinecke (DFMS):

1. Attached is my overall numerical assessment of the usability of MathCAD and Mathematica. I did not evaluate the functionality of either program, nor did I complete the course specific assigned problems.

2. I undertook the assessment as an "honest broker". I had no previous experience using either program, although I've gained minimal proficiency with Mathematica during the course of this semester. I generally consider myself computer literate; I am generally able to figure out and use a wide variety of software without detailed instruction or a manual.

3. I felt frustrated by both packages; both are nearly "user hostile." I was unable to accomplish the assigned objectives without considerable use of the help and index files. In Mathematica I knew I could hit the "ENTER" key and something would happen; I still have not figured out MathCAD syntax. The training for both packages appeared gear toward experienced users of mathematical software packages. I think most of the other trainees got some benefit from the training classes because they could relate operating instructions to something they were familiar with. As a new user, I was lost in both sessions.

4. I do not believe we could expect an incoming cadet to unpack a computer at the beginning of the academic year, assemble/connect its components, and start using either program. We as a faculty must decide whether we wish to teach use of the computer software or if we wish to provide template for the cadets to "fill in the blanks." I believe we currently use the second approach, which vastly underutilizes the capabilities of either program.

5. I do not have a preference for either program; however, I felt that Mathematica was more usable. I think this was based in part by the fact that I could make something happen, even if I only received a string of error messages, using Mathematica. My impression is that Mathematica would involve less time teaching computer software utilization, allowing more time to teach mathematics.

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Comments from Lt Marc Herrera:

Overall, I liked MathCad. The most noticeable problems were that the manual skipped around a lot as far as instructions go. If you're looking on page 400, you might need to know something on page 15 that you find the hard way.

Also, the manual isn't specific as far as describing what you need to do. Their picture shown to periods next to each other, but they never tell you you must hit the semicolon to get those two periods.

It is possible to teach yourself how to do it with only the manual and some time. The help that comes with it is pretty much worthless, but the printed manual helps a lot.

Some functions are also very hard to understand/use, but with any type of instruction I'm guessing it would be much easier.

Well sir, I've spent over half a day just trying how to run Mathematica, and I haven't gotten any further. I think some of the problem is I didn't receive any training, part of it is I've never used it before, and part of it is I didn't have a manual like I did for MathCad. In an effort to help myself, I also asked another Lt. who was an aero major to help, but he'd only used a Dos version before and didn't know what to do either.

I purposely didn't ask for help from one of the division chiefs for a major reason, once a cadet, I know most people will start their project about midnight before it's due, and therefore will be on their own. Using this philosophy with MathCad, I would have been able to get by, but with Mathematica, I wouldn't have been able to do one thing.

If you would like to show me some basic stuff or give me an instruction manual, I can try again to evaluate Mathematica. Just let me know and I hope I was able to help a little bit.

Comments from Maj Paul Waters (DFEM):

Overall capability

I am sure that both packages have the capability to solve all of the problems given. However, with an hour of training and the help functions, there were a lot of problems I could not solve in a timely manner.

For simple problems

Both are adequate. I would lean toward MathCad as it has a more intuitive approach. I also liked the easy manner in which test could be added to MathCad sheets.

For help

MathCad is easier to find stuff and to interpret what it is telling you. However, I couldn't find some things.
Mathematica help was far more extensive but it was very difficult to interpret.

For complex problems

I could not get MathCad to do Fourier Series expansion, but I could get it to accept discontinuous functions.
I could not get Mathematica to do discontinuous functions, but it was very easy to do Fourier Series

Overall

I would probably choose MathCad as it provides better error messaging and is easier to use. But if Fourier Series is important or other stuff like that and MathCad doesn't allow, then I might rethink.

I am not overly impressed with either package from a new user standpoint.

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Comments from Lt Mark Malan (DFAN):

1. The purpose of this memorandum is to summarize my impressions of the software packages evaluated for future use in math and science courses. I did not get through the entire test suite for both software packages, but I would like to offer my inputs based on my limited use and experience as a recent cadet.

2. After spending a number of hours pouring over the problems with both math programs, I have come to the conclusion that they are both equally frustrating to work with the very first time. There are a number of small, inadvertent errors that can be made which would make even the simplest functions, such as graphing, difficult and time consuming to do. Regardless of the software package chosen, I think that it will be necessary to provide some type of formal classroom instruction on the use of the program tool chosen by the Math Department. This is something course directors should consider when producing the course syllabus for the next semester. Obviously, this instruction should be limited to the functions encountered in the course.

3. The use of palates and menus in both programs made them a little easier to use, but for some reason that I could not determine, both software packages started to act-up after a while and refused to yield any results. I do not know if this was because of the machine that I was using (I used the one in your office), or if it was because of operator error. I couldn't even get MathCad to produce a simple graph of y=x. As a cadet (regardless of being a freshman or not), this would become very aggravating considering the other responsibilities and course load demands. I would want something that works almost immediately and requires minimal debugging. Especially considering the opportunities to unintentionally violate individual effort policies.

4.   I realize that is probably doesn't help you very much in determining what software package to choose, but I am divided 50/50 on both programs. I am equally impressed and equally disgusted with both. If I am advocating anything, then it is to have formal training in the classroom on whatever math program is being used. Considering the realm of possibilities with the Mathematica program, it would seem a worthwhile effort to invest time into learning this program.

Comments from Capt Cindy Brown (DFMS):

Mathematica 3.0 has a better help facility and overall is much better at allowing
observations on changing plots. It is a lot easier to change ranges and experiment with
plots. However, everything I did for the Math 130 evaluation used a typed command.
There were no pallettes to help me. To solve this problem, I suggest that each CD create
a course-specific pallette. A Math 130 pallette would need a Plot button with all the
required parameters (AxesLabel, etc..) preprogrammed. I would also include Factor,
Simplify, Solve, etc... With a little experimenting and trial and error, good specific
pallettes could be created for each course.

Mathcad's strengths included commands in the menu bar and a nice "visual" way to
approach graphing. However, the severe limitations on ranges and singularities makes it
too complicated for student's use. The students have to know too much math to plot
certain functions.

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MATHCAD PLUS 6.0
ANOMALIES AND DEFICIENCIES REPORT

This attachment identifies and describes anomalies and deficiencies found with the Mathcad Plus 6.0 software during the Mathematical Software Evaluation performed at the U.S. Air Force Academy during January 1997.

ANOMALIES:

1. 3D graphics use the indices values of the underlying matrix of values plotted for scaling the independent axes instead of the actual values of the independent variables of the function.
2. Contour plot axes scales (start and end values of the plot region) can be changed but the plot does not change in the corresponding manner.
3. Factoring a polynomial like: x3-x2+x-1=0 yields an answer in the form "f(x)=(1,i,-i)" but these are really values for "x" not "f(x)".
4. Several Windows 95 users reported getting "illegal operation" aborts of Mathcad Plus. User actions that led to these aborts wer not reported.

DEFICIENCIES:

1. Mathcad Plus can not superimpose graphics of different types on to the same display. For example, a parametric plot can not be shown with a vector field plot.
2. Mathcad Plus can not symbolically solve for the closed from solutions of any ordinary differential equation.
3. Mathcad Plus can not apply L'Hopital's Rule to the evaluation of limits. This was identified when trying to evaluate: $Lim_{n \to 0} \dfrac{3(1 - \cos(x))}{x}$.

MATHEMATICA 3.0
ANOMALIES AND DEFICIENCIES REPORT

This attachment identifies and describes anomalies and deficiencies found with the Mathematica 3.0 software during the Mathematical Software Evaluation performed at the U.S. Air Force Academy during January 1997.

ANOMALIES:

1. Mathematica 3.0 could not solve some ordinary differential equations that version 2.2.3 could. The problem attempted to be solved with: "**DSolve[{P'[t] == P[t]*(10^(-1) - (10^(-7))*P[t]),P[0] == 5000}, P[t], t]**", does not produce an answer in 3.0 but does in 2.2.3. The problem attempted to be solved with: "**DSolve[(y[x] - (x^2)*y[x])*y'[x] == (y[x] + 1)^2, y[x], x]**", leaves the answer in implicit form, whereas 2.2.3 would return an explicit solution.
2. Putting a "B=" prior to an existing matrix caused the entries in the matrix to be erased.
3. Framed postscript output does not work. (For details, see Major Ken Gurley, DFP).

DEFICIENCIES:

1. Installation unique passwords based on license number and Math ID are completely un-workable for a large installation on novice user computers. There would need to be some mechanism where an up and ready to go installation could be done at the factory prior to shipment.
2. Handy tool bar with editting speed buttons from version 2.2.3 was removed in version 3.0.
3. Packages with standard functions should be automatically loaded. If the user tries a command that requires loading of a package, but does not load the package, there is a shadow definition created that is difficult for a novice user to clear.
4. Definition of piecewise defined functions requires use of the unit step function which is very cumbersome especially for novice users.
5. Pull-down menus (especially those for editting) are not "sticky". That is, it would be nice to be able to pull then down and leave them to complete a sequence of editting functions. (Return of the speed buttons would also resolve this).