Guide to the MSCS Program Sheet

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Welcome to the Stanford Computer Science Department! This guide is designed to help you understand the requirements for the Master of Science in Computer Science (MSCS) and, more specifically, how to use the MSCS program sheet which details your specific course of study leading to the degree.

The MSCS program sheet

The central requirement for the MSCS degree is completion of at least 45 units that represent an approved academic plan. The concrete representation of that academic plan is your program sheet, which lists the courses you intend to use to satisfy the 45-unit requirement. Separate program sheets are available for each of the preapproved areas of specialization; a sample program sheet showing the requirements for the Systems specialization is attached to this guide. Program sheets for the other specialization areas are available from the racks outside Gates 182, and on the web at the following URL: **cs.stanford.edu/Degrees/mscs/programsheets/**.

You must file your initial program sheet before the end of your first registered quarter as a MSCS student. Filing the program sheet, however, does not lock you into taking exactly the set of courses you originally propose. The best way to think about your program sheet is as a contract between you and the department detailing the requirements for the degree. Completing the courses in your approved plan—as long as you fulfill the general requirements that apply to all degrees—will entitle you to graduate with the MSCS degree in your chosen area of specialization. If you need to change your plan of study, you must simply renegotiate the contract, which means filing a new program sheet that represents your updated course of study. You must get your adviser's signature on the revised plan but need not get new signatures for individual courses that were approved on a previously filed program. For example, if you have already gotten approval from your adviser to count courses from another institution toward your breadth requirements, you need not get those signatures again.

The important thing to remember is that, before you will be cleared for graduation, you must have a program sheet on file that matches the courses that you in fact completed. If you decide to change your course of study, you should get a new program sheet signed as soon as possible to ensure that the changes are in fact approved. If you wait until your final quarter and approach your adviser with a program that differs substantially from your original program, you may find that you need additional quarters to complete an approved course of study. By keeping your program sheet up to date, you can be confident that the program you are pursuing is in fact sufficient for the MSCS degree.

Expected background

Students come to the Stanford MSCS program with a wide variety of backgrounds. Some of you have recently completed undergraduate degrees in computer science, while others are taking your first formal computer science courses in many years. The MSCS program is flexible enough for you to design a program that starts at the appropriate level.

The MSCS program assumes that all entering students have acquired the foundations of computer science at the level of an undergraduate minor. At Stanford, these foundations are represented by the following courses, which are considered as the standard prerequisites for the program:

- CS103A/B or CS103X (Discrete Structures)
- CS106A/B or CS106X (Programming Methodology and Abstractions)
- CS107 (Programming Paradigms)
- CS108 (Object-Oriented Systems Design)
- E40 (Introductory Electronics)

If you have taken these courses—either at Stanford or elsewhere—you have the necessary background to begin studying at the MSCS level. If not, you need to think about whether you should take one or more of these courses before you begin more advanced study. The decision is entirely up to you. If you have been working in the industry for several years, you may already have acquired the necessary background on your own. If you are unsure, you should read over the descriptions of these courses in the *Stanford Bulletin* and see whether the topics are familiar. You can also discuss your background with your adviser and get a recommendation about what courses to take.

Taking prerequisite classes at Stanford has advantages and disadvantages. The danger in skipping a prerequisite lies in finding yourself out of your depth in a more advanced course. If you haven't taken many computer science courses or feel that your education in these areas is out of date, you might want to make sure that you have a solid grounding in the discipline by starting with a prerequisite course. On the other hand, taking prerequisite courses will almost certainly delay your MSCS degree. The program you submit for your degree may include at most 21 units from the prerequisite courses in the CS100-109 range and those listed under the general heading of breadth requirements. If you have to take prerequisites and breadth courses beyond the 21-unit limit, you will end up having to take more than 45 total units to complete your degree.

The bottom line is that deciding which prerequisite courses you need to take is entirely up to you. You do not need your adviser's approval to skip a prerequisite if you feel you have the necessary background, although you are certainly encouraged to talk with your advisor about your decision.

Breadth requirement

The Master of Science degree in Computer Science indicates two things to prospective employers. First, it guarantees that you have a broad grounding in computer science as a discipline. Second, it certifies that you have studied a particular area in detail and thus have additional depth in a particular specialty. Both components are important to the Master's program, and it is not possible to secure a Stanford MSCS degree that does not meet both requirements.

Students are asked to demonstrate breadth by taking courses in three general areas, as illustrated by the excerpt from the program sheet shown in Figure 1. Typically, each area is organized as a small set of required courses and a larger set from which you can choose particular courses that fit best with your overall program. To satisfy the breadth requirement, you must demonstrate that you have taken each of the required courses, along with an appropriate subset of the higher-level breadth courses that meet the requirements for each area. You do not, however, need to take these courses at Stanford. If you have taken an equivalent course elsewhere and have received at least a B, you can use that course to satisfy the corresponding breadth requirement, as long as you secure the approval of your adviser. The individual descriptions in Figure 2 include a brief summary of what we expect from each of the breadth courses, so that you will have a better idea of whether the courses you have taken will satisfy the requirement. Note that using a course from another institution to satisfy your breadth

Figure 1. Breadth requirements

Area A: Mathematical and theoretical foundations

Required:	Equivalent elsewhere	Approval	Grade	Units
Probability(Stat116 or MSE220 or CME106)				
Automata and Complexity (CS154)				
Algorithmic Analysis (CS161)				
Choose one of:				
Numerical analysis (CME108 or CME302)				
Logic (CS156, 157, CS258, or Phil 251)				
Mathematical Methods (CS205A)				

Area B: Computer systems

Required:	Equivalent elsewhere	Approval	Grade	Units
Computer Architecture (EE108B or EE282)				
Choose two of:				
Operating Systems (CS140)				
Compilers (CS143)				
Computer Networks (CS244A or EE284)				

Area C: AI and applications

Choose two, including one at 200 level	Equivalent elsewhere	Approval	Grade	Units
Artificial Intelligence (CS121 or CS221)				
Databases (CS145 or CS245)				
Graphics (CS148 or CS248)				

requirements does not give you any units toward the MSCS degree; it merely relieves you from the responsibility of taking that particular course as part of your Stanford degree. By using courses from other institutions to satisfy your breadth requirements, you give yourself time to take more advanced courses.

It is also important to understand that only *coursework* can be used to satisfy the breadth requirement. It is not sufficient to claim that you have already learned the material in some area on your own. At the same time, it is in no one's best interest to have you repeat material that you already know. If a course that's listed in the breadth category would be too elementary, you can usually satisfy the requirement by taking a more advanced course in the same area. If, for example, you believe that you already know everything that CS143 would teach you about compilers, take CS243 instead and ask your adviser to count it as your breadth requirement. In general, you should feel free to substitute more advanced courses for courses listed as requirements if you are ready to do the work at that level. There are, however, some specific exclusions. In particular, CS240 does not serve as an equivalent for CS140 because the more advanced course in this case does not in fact require you to use much of the essential material from CS140.

Sometime early in your first quarter—preferably in the first week or two—you should schedule a meeting with your academic advisor and go over your breadth requirements. If you have taken courses that you would like to use in fulfillment of these requirements, fill in the appropriate information on your program sheet, collect the required supporting documents (see figure 3) and ask your adviser to approve a course waiver (or waivers). You may need to do some convincing. You should be prepared to answer simple questions about the material covered in the course you are seeking to replace. The final decision is up to your adviser. If you can convince your adviser that you have learned the material in a previous course, you can skip the specific requirement and move on to more advanced material. If you can't convince your adviser, you'll have to take the course at Stanford.

Figure 2. Brief descriptions of courses meeting the breadth requirements

1. **Probability (Stat 116 or Man Sci & Eng 220 or CME 106).** The breadth requirement in statistics can usually be satisfied by any course in probability taught from a mathematical perspective. Courses in statistics designed for social scientists generally do not have the necessary sophistication. A useful rule of thumb is that courses satisfying this requirement must have a calculus prerequisite.

2. **Automata and Complexity (CS154).** This course covers basic automata theory as well as the foundations of complexity theory (NP completeness and associated categories of complexity). To meet this requirement, you must submit a course that covers both areas. If you have taken a course that covers only automata theory, you should consider enrolling in CS154N and then using both courses (your previous automata course together with CS154N) to satisfy this requirement.

3. **Design and Analysis of Algorithms (CS161).** The most important thing to realize about CS161 is that it covers material at a higher level of mathematical sophistication than many courses on algorithms at other institutions. A course in "Data Structures and Algorithms" taught—as it is in many schools—as the second programming course would not satisfy this requirement. In general, if you want to use a course from another institution in place of CS161, that course should list both the introductory programming sequence (the equivalent of Stanford's CS106 series) and the introductory theory course (Stanford's CS103 series) as prerequisites.

4. **Numerical Analysis (CME108 or CME302).** If you choose this course for your breadth elective, any equivalent course must focus on numerical methods for scientific and engineering applications and must include calculus or linear algebra as a prerequisite.

5. **Logic (CS156, CS157, CS258, or Phil 251).** Courses used to meet the breadth requirement in logic can come from a range of disciplines, as long as the level of mathematics used in the course is sufficiently rigorous. At Stanford, for example, Philosophy 251 can be used to meet this requirement because it has the necessary mathematical rigor. If you have taken a similar course elsewhere, you should discuss the syllabus with your adviser to determine whether it satisfies the requirement.

6. **Mathematical Methods (CS205A).** This course covers several topics in continuous mathematics that are used in more advanced courses and research in the robotics and vision areas. Although it is certainly true that other institutions cover some of the fundamental material, it is unlikely that any single course at another institution would cover the full set of topics which are chosen to meet specific programmatic needs. If you want to use courses (typically more than one) from your former institution to substitute for CS205A, you will need to talk with the instructor.

7. **Computer Architecture (EE108B or EE282).** If you have taken a computer architecture class elsewhere, it probably meets the systems breadth requirements for Stanford. The course, however, must focus on microprocessor architecture and may not be a simple course in electronic circuits. The Systems specialization requires EE282; for other specializations, either course is appropriate.

8. **Operating Systems (CS140).** Most undergraduate programs in computer science offer a course in operating systems that follows a relatively standard syllabus. If you have taken a course that includes "Operating Systems" in the title, that course will probably serve as an equivalent to CS140. The course used as an equivalent, however, must cover the basic techniques of operating systems listed in the catalog description for CS140. Some higher-level courses in the theory of operating systems—including CS240 at Stanford—do not cover this material and cannot be used as substitutes.

9. **Compilers (CS143).** As with the course in operating systems, the breadth elective in compilers is usually easy to satisfy if you have taken a course elsewhere with "Compilers" in the title.

10. **Computer Networks (CS244A or EE284).** Once again, the material in a computer networks course is reasonably standardized across university curricula. If the course that you have taken covers topics that match those shown in the catalog descriptions of the corresponding Stanford courses, you will presumably be able to use your previous course toward the systems breadth requirement.

11. **Artificial Intelligence (CS121 or CS221).** This course is a general survey of the field of AI, taught at two different levels. The AI specialization requires CS221 as part of the breadth requirement, which means that any substituted course from another institution must match CS221 in its level of rigor and depth of coverage. For other specializations, most courses that present a survey of AI techniques will serve as equivalents to CS121.

12. **Databases (CS145 or CS245).** Most courses in database techniques—as long as they cover the theory of databases and are not simply "how-to" courses for database applications—will serve as an equivalent to the database courses.

13. **Graphics (CS148 or CS248).** Most courses in computer graphics will serve as equivalents for the Stanford requirements.

Figure 3.

Breadth Course Waiver
Computer Science
MS Program

Students wishing to waive Breadth courses based on work completed at another institution must collect the following documents before meeting with their faculty advisers. <u>These documents are required.</u> Your adviser will not evaluate or approve your waiver requests without them. ***Please complete one form per waiver request***.

Name (please print) _____

Stanford course for which waiver is being requested _____

Adviser name (please print) _____

Required documents:

1) The course description, syllabus and textbook list for the 'Breadth course equivalent' course you took at your previous institution. Print out a copy of each and attach them to this form.

2) The Stanford course description, syllabus and textbook list for the Breadth course you want waived (for comparison purposes). Print out a copy of each and attach them to this form.

3) A transcript (a photocopy will be acceptable) showing the grade received in the 'Breadth course equivalent' course you completed at your previous institution. Note that you must have earned a grade of 'B' or better for a waiver to be granted.

_____
(Adviser please fill out this section)

This course waiver request is: Approved_____   Denied_____

Adviser Signature _____   Date _____

Adviser Notes:

The following summarizes the rules for satisfying the breadth requirements:

- You must complete the requirements in each of the three areas listed on the program sheet. The breadth requirements are never completely waived; you must show that you have taken appropriate courses in each of the three areas.

- If you take one of the Stanford courses listed on the program sheet for a particular requirement, you satisfy the corresponding requirement directly and do not need to get your adviser's approval.

- If you have already taken an equivalent course at another institution and have received at least a B, you may ask your adviser to accept that course as satisfying the breadth requirement in that area. To do so, fill in the details of the substituted course on your program sheet, collect the required supporting documents, and then ask your adviser to sign in the space provided on the breadth course waiver form..

- If you use a course from another institution to satisfy the breadth requirements in a particular area, that course does not count for any units in the Stanford program. The advantage of using a previous course to fill a breadth requirement is simply that it allows you to take more advanced courses in your program. It does not reduce the number of units you will have to complete.

- You may not count more than 21 units from the set of courses that comprise the program prerequisites (courses numbered between CS100 and CS109) and the courses listed under the breadth requirement category. If you need to take more courses in these categories, your program will have to include more than 45 total units.

Seminars

The MSCS program requires you to complete at least one 500-level CS seminar (or EE380 or 385A) so that you have some exposure to the research activity of the department. This section of the program sheet is used to list the seminars you plan to count for the degree. Although you may take more, you may only count a maximum of three units of seminars (or other $1 - 2$ unit courses) toward the MSCS degree.

The depth requirement

In addition to the breadth requirement, the Stanford MSCS program requires that all students take at least 21 units in a specific area of specialization. Most students complete one of the ten approved specializations listed in Figure 4, but you may also petition the MSCS committee to approve a specialization of your own design. In order to be approved, individually designed specializations must represent a coherent area of study and must include courses at both the 200 and 300 level.

The requirements for the preapproved specializations are shown in Figure 4. In most cases, a specialization consists of a set of required courses, a larger set of courses out of which you must select some subset, and a larger set from which you select additional courses to fill out the 21-unit requirement. If you choose a specialization that fits precisely into the requirements of one of the preapproved specializations, you should simply check off the courses on the program sheet and then fill in the same set of courses in the designated areas.

Specializations, however, must allow some flexibility. If you have a particularly strong background, for example, you may already have taken some of the courses required for your area of specialization. You may also find that you are unable to complete the precise set of requirements because of course-scheduling conflicts or because certain courses are not offered in every year. Thus, it sometimes happens that the specialization you propose differs in some respects from the stated requirements.

Figure 4. Approved specializations (2007-08 requirements)

1. **Artificial Intelligence**
   a. At least four of the following: CS223A, 223B, 224M, 224N, 224S, 224U, 226, 227, 228, 229
   b. A total of 21 units from (1a) and the following: CS205A, 222, 225A, 225B, 227B, 256, 262, 270, 273A, 274, 275, 276, 277, 278, 279, 294A, 321, 327A, 328, 329, 374 (CS377 and CS379 may be counted with consent of adviser); Econ 286: EE 263, 376A; Eng 205, 209A; Ling 180; Man Sci & Eng 251, 252, 339, 351, 352, 353; Psych 202, 205; Stat 202, 315A, 315B

2. **Biocomputation**
   a. At least four of the following: CS262, 270, 272, 273A, 274, 278, 279
   b. A total of 21 units from (2a) and the following: CS228, 229, 245, 261, 268, 275, 277, 345, 346, 365, 374; BioC 218; BMI 234; Gene 203, 211; StructBio 228

3. **Computer and Network Security**
   a. Each of the following: CS155, 244A, 255
   b. At least three of the following: CS240, 244B, 244C, 259, 261, 344, 365
   c. At least one additional course selected from (3b) and the following: CS240E, 244E, 245, 295, 344B, 345, 347, 355, 361A; EE384A, 384B, 384C, 384M, 384S

4. **Database Systems**
   a. Required: CS245
   b. At least two of the following: CS345, 346 (not given 2007/08), 347
   c. At least four additional courses from (4b) and the following: CS240, 242, 243, 244A, 244B, 244C, 249A, 249B, 255, 262, 270, 271, 272, 276, 315A, 344, 374

5. **Human-Computer Interaction**
   a. Each of the following: CS147, 247, MS&E 134 (or another course on technology in organizations if approved by adviser)
   b. At least two of the following: CS148 or 248, 376, 377 (may be taken repeatedly), 378, 447; Comm 207, 268, 269; Educ 124; Music 250A; SymSys 145
   c. A total of 21 units from (5a), (5b), and the following: CS221, 223B, 229, 242, 249A, 249B, 276, 379Y, 379Z, 448; Comm 272; Engr 231; Ling 180; Man Sci & Eng 234; Mech Eng 101, 115, 206A, 206B, 313, 314, 377; Psych 205, 221, 252

6. **Numerical Analysis/Scientific Computation**
   a. Each of the following: CME 302, 306, 326
   b. At least two of the following: CS205A, 205B; Man Sci & Eng 121; Math 131, 132, 220; Stat 200
   c. At least two of the following: CS223A, 327A, 328, 339; CME 324, 342; AA 214A, 214B

7. **Real-World Computing**
   a. At least two of the following: CS223A, 223B, 248
   b. At least three of the following: CS205A, 205B, 226, 249A, 249B, 262, 268, 277, 348A, 348B, 374; CME 302, 306, 326
   c. A total of 21 units from (7a), (7b), and the following: CS225A, 225B, 228, 229, 247, 270, 271, 272, 273A, 274, 294A, 327A, 328, 448; CME 324

8. **Software Theory**
   a. Each of the following: CS242, 243, 256, 258 (259 may be taken instead of 258)
   b. At least one of the following: CS244A, 245, 295, 343, 345
   c. At least one of the following: CS255, 259, 261, 268, 355, 356, 361A, 361B, 365
   d. At least one additional course from (8b), (8c), or CS346.

9. **Systems**
   a. Each of the following: CS240, 242
   b. At least three of the following: CS243, 244A, 245, 248, 348B; EE271
   c. At least two courses selected from remainder of the previous group (9b) and the following: CS194, 240C, 240D, 240E, 240X, 244B, 244C, 244E, 249A, 249B, 255, 259, 262, 270, 271, 272, 276, 294S, 295, 315A, 315B, 343, 344, 344B, 344E, 345, 346, 347, 348A, 349, 374, 448; EE384A, 384B, 384C, 384S, 384X, 384Y

10. **Theoretical Computer Science**
    a. Each of the following: CS256, 258, 261 (361A, 361B, or 365 may be used as substitutes for 261)
    b. At least four additional courses selected from the following: CS228, 255, 259, 262, 268, 345, 355, 356, 357, 358, 361A, 361B, 364A, 364B, 365, 374; Man Sci & Eng 310. (CS359 and CS369 may also be counted with approval of Prof. John Mitchell.)

To allow for the necessary flexibility, your adviser has some authority to approve exceptions to the requirements listed in Figure 4. It is always appropriate, for example, for the adviser to approve more advanced work in lieu of specific requirements that you have already taken elsewhere. Similarly, the department encourages students to engage in independent research with a faculty member—usually in the form of a CS399 project—which means that it is usually possible to substitute such project units for other requirements.

Beyond standard substitutions such as CS399, advisers will approve only minor changes in the specialization requirements. If you propose more extensive deviations from the standard specializations, advisers will refer those changes to the MSCS committee for review. The general rule is that advisers have the authority to approve a single course change in the stated requirements as long as they believe that the change makes good academic sense and does not weaken the overall program. If you propose a specialization that differs from the stated requirements in two or more courses, your revised program is referred back to the full committee. The MSCS committee is empowered to approve any course proposal, but is generally not willing to support major changes in the requirements unless there are compelling reasons to do so.

Electives

After you have filled in the courses in the various areas described in the preceding sections, you may still fall short of the 45 units required for a MSCS degree, particularly if you have satisfied most of the breadth courses with previous study at other institutions. If you are short of units, you must specify additional electives to bring your program up to the required 45-unit level.

Elective courses are really up to you to select, even though the entire program must be approved by your adviser. In general, courses in computer science numbered at the 100-level or above (with the exception of CS196, 197, and 198) are suitable as electives. Courses in related departments, such as Electrical Engineering, Mathematics, and Statistics, numbered at the 100-level or above and **technical in nature**, are also likely to be approved. On the other hand, courses that are completely unrelated to computer science would not normally be appropriate as electives. If you are unsure about a particular course, check with the MS program administrator in Gates room 182.

Additional requirements

Several of the additional requirements listed at the bottom of the program sheet have already been covered in earlier sections of this guide. A couple of the requirements, however, deserve some additional explanation.

- *Minimum GPA requirement.* In order to receive your MSCS degree, your GPA in the courses you submit on your program sheet must be at least 3.0, which corresponds to a B in Stanford's grading scale. Note that you need not get a B in every course. All the requirement states is that the overall GPA, which is simply the average of the numeric grade weighted by the number of units in each course, must be at least a 3.0. Note, however, that the GPA is computed only for the courses you submit on your program sheet. If you do poorly in several courses, it may be wise for you to eliminate those courses from your program sheet and substitute other courses in which you have done better. Such substitutions may require you to take more than 45 units, but it is important to know that a single disastrous grade will not necessarily doom your entire program.

- *Letter-grade requirement.* This requirement is mostly self-explanatory but nonetheless deserves emphasis. At least 36 of your 45 units, *including all of the depth units submitted for your specialization,* must be taken for a letter grade. Note that seminar courses, which must be taken on an S/NC basis, are not letter-graded courses. The remaining nine units may be taken on a credit/no credit basis if you so choose.