Industrial Chemistry Technology

APRC 1995-1996

section 1 of 2

Industrial Chemistry Technology:

Report of the Program Review Panel

February 19, 1996

PRP Panel Members:

(1) Bill Killian, Coordinator, ICT program
and Chair of the PRP Panel
(2) Dave Frank, Physical Sciences Department Head
(3) Prabhakara Shetty, Associate Professor of Chemistry
(4) Greg Conti, Assistant Professor of Plastics
(5) Dave Dellar, Chemical Technician, Dow Chemical Co.
and ICT program graduate

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Section 1

INCT: Program Overview

Section I: Program Overview

The Industrial Chemistry Technology (INCT) program is a two-year course of study leading to an associate's degree. It is the only degree-granting program offered by the Department of Physical Sciences. The program has existed at Ferris State University for some thirty years providing hundreds of chemical technicians for companies in Michigan and the Midwest. Since its inception the INCT program has been geared toward developing the skills that a chemical technologist needs to succeed in Industry. The skills of experiment planning, safety consciousness, defined calculating, teamwork, and overall laboratory technique development have always been and remain central to the program. These are quite simply the skills that have kept the INCT placement levels so high and Fortune 500 companies returning here year after year to hire the graduates. The average graduation rate over the past seven years has been fifteen students per year.

The students in the program are a varied group. One characteristic that they have in common is that they enjoy working in laboratory. During their two years on campus, they need to complete the same basic science courses as a four-year chemistry major would complete at any other university. However, the variety of math and science courses at Ferris makes it possible for a student to arrive underprepared in mathematics and still complete the program in two years and a summer. The program also attracts some transfer students from other four-year institutions, often because a student prefers to earn a two-year degree rather than a four-year degree. Other than their uniformly high interest in science and mathematics, the students in this program are as diverse as the campus population at large.

Most of the instruction in the INCT program is provided by faculty members in the Department of Physical Sciences. The greatest percentage of the credit hours are in chemistry, physics, and industrial chemistry courses. One faculty member of the department, William Killian, serves as the program coordinator. Since most time intensive industrial chemistry courses are taught during the winter term, he usually teaches a large general chemistry course in the fall to balance his load. However, there are times when other professors within the department have shared responsibility for some of the professional courses. This has been a benefit for the department as a whole, as more faculty members gain a better appreciation of the overall program, as well as exposing the students to more than one point of view during their professional experience.

The American Chemical Society (ACS) provides certification for programs in chemistry across the nation. At the bachelor's level, they certify mainstream chemistry degrees (typically leading to graduate study) as well as degrees with an emphasis in specialty areas, such as biochemistry. However, only over the past few years the ACS has also been certifying two-year programs. Currently, we are in the final stages of this certification process. This will involve an on-site visit. The curriculum, instrument holdings, and philosophy of our program have already been reviewed by ACS.

Since the INCT coordinator has taught all of the professional courses in the program, the major responsibility for revision rests with him. He regularly consults with graduates to see if course material is appropriate. In addition, an INCT review board (consisting of eight members from industry, several of them graduates of the Ferris program)also provides feedback. The INCT review board has been actively involved in curricular review, semester conversion, instrument acquisition and other issues of importance to INCT. Review board members stressed their overall satisfaction with the program. The results of the review panel evaluation are enclosed later in this report.

Sections 2 - 9

Plan and Survey Instruments

Sections 2 - 9

Plan and Survey Instruments

The Program Review Panel carried out several different activities to evaluate the quality of the Industrial Chemistry Technology program. The questionnaires that were used to gather information are presented in this section, while the conclusions discovered from these questionnaires are presented in Section 12.

On the following pages, you will find the instruments related to these review activities:

2. *Advisory Board Perceptions.* A survey was distributed to the eight members of the INCT advisory board. Eight members of the board responded.

3. *Perceptions of INCT Graduates.* Each graduate of the INCT program was sent a questionnaire. This questionnaire was sent with the annual letter that is written to all INCT alumni. This letter was sent out to the three hundred INCT alumni on record in our files. Responses were provided by 31 of the former students.

4. *Perceptions of the Physical Sciences Department.* Since the INCT program in housed in the Physical Sciences department, we thought that it would be advisable to determine their perceptions of the strengths and weaknesses of the program. The survey form sent to all department members is described in this section, along with a brief explanation. Sixteen faculty members were given the chance to reply, and forms were received from eight professors.

5/6. *Employer Follow-Up/Labor Market Analysis.* This analysis is based on telephone interviews with representatives of several of the major employers of the INCT students. No questionnaire was distributed, so there is nothing in this section about this activity. The results of the interviews are presented in the next section.

7. *Student Evaluation of Instruction.* An evaluation form is included here. The form was distributed to registered students in any INCT class. Thirty total students in various stages of completion of the INCT degree responded to this forty-three question survey.

8. *Evaluation of Facilities and Equipment.* This analysis is based on data recently compiled for a self-study report submitted to the American Chemical Society.

9. *Curriculum Evaluation.* All the data for this analysis is derived from INCT program objectives and required class information.

Section 2

Advisory Board Perceptions

Section 2

Advisory Board Perceptions of Industrial Chemical Technology

The INCT advisory committee was issued a questionnaire over the course of the last two years. The questionnaire was divided into two parts. The first of these two sections consisted of items to be rated on a scale of 1 to 5 with the larger numbers representing a more positive response, while also allowing for a non-committal response and comments to be added in further explanation. These items were divided into five separate categories. The second section of the questionnaire asked three open-end questions concerning program strength, needs for improvement, and solicited comments for both the program and the advisory committee. The responses to this survey instrument are summarized below.

RESPONSE BY PERCENTAGE-Total Number of Respondents = 8	Poor				Excellent	Don't
(Percentage totals for each response may not total 100% due to rounding)	1	2	3	4	5	Know
INSTRUCTIONAL PROGRAM CONTENT AND QUALITY ARE:						
Based on performance objectives required for employment			38%	12%	50%	
Designed to provide practical job application experience				37%	63%	
Responsive to upgrading and retraining needs of employed persons				63%	25%	12%
Reviewed and revised to keep current				37%	63%	
INSTRUCTIONAL EQUIPMENT IS:						
Well maintained				63%	37%	
Current and representative of that used on the job			25%	38%	37%	
INSTRUCTIONAL FACILITIES:						
Provide adequate lighting, ventilation, heating, power, etc				50%	38%	12%
Allocate sufficient space to support quality instruction				50%	38%	12%
Meet essential health and safety standards				50%	25%	25%
PLACEMENT:						
Services are available to students completing the program				25%	75%	
Job opportunities exist for students completing the program					100%	
FOLLOW-UP STUDIES:						
Demonstrate students are prepared for entry level employment				50%	50%	
Collect information on job success/failure of former students				50%	38%	12%
Provide information used to review/revise the program				37%	38%	25%

Below are the three open-ended questions asked and a summary of the responses received.

1) What are the strengths of the college's occupational program in your field(s)?

RESPONSES:

....the program produces very academically sound students
....among the best in the state
....technically very intensive
....gives students a strong practical background
....students are well prepared to begin work when graduated
....strong program coordinator, he follows up on graduates
....INCT is a field with high demands for grads
....students have a good theoretical background as well as hands on experience in Chemical Technology

2) What are the major needs for improvement in the college's occupational program in your field(s)?

RESPONSES:

....none at this time
....need to add more Quality Management course work to keep up with business trends
....more laboratory experiences (co-op in industry for a semester)....
....chemical analysis are being automated so rapidly that a stronger emphasis in computer skills would be
helpful

3) Additional Comments?

RESPONSES:

....INCT coordinator has done a good job utilizing the expertise of the advisory committee
....coordinator gathers information, but does not overuse the resource
....advisory committee should meet more often
....need more communication between those in the workplace and those teaching the future workforce
....INCT program at Ferris is the best in the state (the primary tool used to evaluate the program is the performance of the students)
....keep up the good work

Section 3

Perceptions of INCT Graduates

Graduates

Graduates of the Industrial Chemistry Program were given a survey consisting of three parts. The first part touched the area of overall knowledge, the second in regard to attitude; and the final part in regard to ability. The total survey consisted of 21 questions and 31 people provided responses to one or all of the areas.

A copy of the survey is provided. The responses are tallied in the appropriate boxes. The potential choices were excellent through poor with a not applicable box also available.

Ferris State University
Physical Sciences Department

November 1, 1995

Dear ICT Alum:

This fall brings the beginning of some major physical changes in the Science Building here at Ferris State. This semester will be the last to house the ICT program in its presently configured space on the North wing of the 3rd floor. We will spend next semester, temporarily, on the other end of the third floor working out of the Quant lab, while the North wing is renovated. Next summer, the Science Building will be closed down completely, and next school year we will be in our redone space. After all is said and done we will have an improved physical plan, a more spacious instrument room, and an inside link to the Starr Building. I guess the only hurdle is getting all the instruments packed away and then re-setting up next year without breaking or losing anything in the process.

As you may be aware, the hiring patterns of several key employers that come annually to campus have been highly unpredictable over the last few years. Therefore, more than ever before I am asking your help in identifying employment openings you may know about for fresh ICT graduates in the upcoming year. This network has been invaluable in helping place some of our students over the last several years. Our graduating class for 1996 projects at seventeen, which would be our largest in the last six years.

Last year's students all successfully moved out into industry or continued pursuing their education. In industry, Chuck Ploof went to Amway, Tim Van Wormer and Ann Simor went to CYTEC Industries, Connie Cooper went to EFX Labs in Lansing, Eric Nittolo went to the Graceland Fruit Company in Frankfort, Carolyn Larson went to Laprino Foods in Remus, and Suzanne Lehr went to Dow. On the academic side, Antonio Bryant transferred to Central Michigan University to work on a B.S. in chemistry, Frank Fuss is doing the same at MSU; while Leanne Reinick completed and William Young will complete their respective bachelor's degrees in plastics engineering here at Ferris. Please join me in extending a hearty congratulations to this fine group of people. I really enjoyed working with each and every one of them.

As I wrote last year, we formally applied to the ACS for ICT program certification. After meeting with the committee responsible for granting certification at the ACS meeting in Chicago in August, we were approved to advance to the next step. This step should conclude with an on-site visit later this year by an ACS representative. The resulting report based upon that visit should formally put us in line for documented ACS certification.

Those of you who graduated five or more years ago may well remember when I enclosed a survey for you to fill out as part of a University review of ICT. We are again in that five year cycle requiring a University review of our program. Therefore, I am again enclosing a survey much as I did before. Please fill it out and return it when you have time. I have also enclosed a page of comments people sent with their surveys of five years ago. May I strongly encourage you to again respond in writing, either to embellish a survey question or comment in general on any aspect of the ICT program such as safety, notebook keeping, etc.

I hope those of you who graduated under Norm got his letter last year along with mine. I know that he, as well as I, await and appreciate answers to our letters and updates of all types on your individual careers. These personal contacts have kept the ICT program in special company when compared to other Ferris programs across campus. Again, a special thanks to all of you who sent donations or gave of your time with a visit to our students. Best of luck and stay in touch.

Sincerely,

Bill

Bill Killian
Program Coordinator

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STUDENT FOLLOW-UP SURVEY

KNOWLEDGE

How do you feel your MAJOR coursework at FSU was in preparing you in the following areas?

	Not applicable	Poor	Fair	Good	Excellent
1. Subject matter and processes of your specialty (major)	—	—	3	13	17
2. Issues and trends pertinent to your specialty	—	—	4	20	9
3. Concepts of human growth/development pertinent to your specialty	2	—	6	15	10
4. Theories pertinent to your specialty	—	—	2	17	14
5. Alternative strategies for applying skills of your specialty	—	—	5	18	10
6. Management and organizational skills of your specialty	1	—	4	17	11

ATTITUDE

How do you feel your MAJOR coursework at FSU was in preparing you in the following areas?

	Not applicable	Poor	Fair	Good	Excellent
1. Believing that learning is a life-long process	—	1	-	14	18
2. Respecting the uniqueness and worth of each individual	—	1	—	19	13
3. Accepting responsibility of preparing for the future	—	—	—	12	21
4. Confidence in your personal competence	—	—	2	12	19

ABILITY

How do you feel your MAJOR coursework at FSU was in preparing you in the following areas?

	Not applicable	Poor	Fair	Good	Excellent
1. Apply knowledge in defining problems and solving them	–	–	1	11	19
2. Establish a productive environment on and off the job	–	–	–	18	14
3. Respond to people from different social and cultural backgrounds on formal and informal occasions	2	–	6	18	6
4. Formulate plans and make appropriate applications	–	–	3	14	15
5. Select and use appropriate materials/aids	–	–	2	12	18
6. Evaluate success of performance in career	2	1	4	17	8
7. Communicate ideas clearly and simply in correct English	–	–	5	15	12
8. Find information; interpret and apply findings	–	–	1	10	21
9. Identify values and respond ethically	1	–	2	21	8
10. Integrate career and personal goals	1	1	7	16	7
11. Meet responsibilities of citizenship	4	2	5	15	6

Survey Results

In regard to the graduate follow-up survey, the responders graded between good and excellent in all areas questioned. Specifically, in the knowledge section, subject matter in chemistry and chemical theories were regarded as being areas graduates were prepared in a most excellent fashion.

The attitude section ranked out as the highest overall rated area of student preparation during the time these graduates were part of the FSU Industrial Chemistry program. Graduate responses emphasized the excellent way in which they were prepared to accept responsibility and act with confidence while working in laboratory.

The ability section also ranked out high. The graduate responses emphasized that while in ICT they developed problem solving skills, became confident in finding information, and learned to formulate plans. All of these tools are important to their continued success in the laboratory.

Finally, a number of former students expressed their opinions with written comments in areas they felt were of significant importance. These comments were pulled from their individual surveys or letters they wrote accompanying the survey. These are collected on the following pages.

The INCT program was excellent and I indicated that with answers above. I have attended three schools, (FSU, CMU and SVSU) and from those the INCT program alone gave me the knowledge and skills required to make it. The sound fundamentals in areas such as; writing reports, lab techniques, personal interaction and problem solving, which were all stressed have allowed me to do well in my job and even caused me to prosper at times.

The technical training and hands-on experience I got from the INCT program has helped me on the job more than most of the things I learned from the more advanced chemistry classes such as organic and p-chem.

The INCT program was the key to realizing my potential and goals for the future. The program gave me the skills that I need to excel at my company. I have found that the technicians that graduate from the INCT program at Ferris are more prepared for technical applications in the laboratory than most B.S. chemists upon entering the industry. My only hope is that one day I will be able to apply at least half of the things that I learned from Bill Killian and the INCT program. I strongly feel that this one of the top, if not the top, 2-year scientific academic program in the state.

I learned every day I was there. My cornerstone was my INCT training. It was a very fruitful and enriching time. There was mutual respect.

I am a graduate of the 1983 class. I went on to finish my B.S. in chemistry with no problems while working as a tech. I use the same problem solving and people skills that I learned in INCT. I'm planning to start working on my MBA in the fall.

I graduated from the INCT program in 1989. Not only did the training I receive prepare me for my job at Dow, it helped advance my progress at Saginaw Valley State University in obtaining my B.S. in Chemistry in just 2 years. The diversity of courses offered in the program with special emphasis on safety and keeping excellent laboratory notes helped make me a success in Dow's Plastics division. My career successes thus far can all be traced back to my graduation from the Ferris INCT program.

In the current job market, A.S. degree will get minimal $ or advancement. B.S. doesn't go very far.

INCT was a great program and I feel that the hands-on practical experience put me in a solid position. The subject matter and course work was great and useful.

The INCT program prepared me for the rigorous pace of the B.A. program. My chemistry was extensive and it gave me a good foundation to build on.

This survey has prompted me to write this letter to express my strong belief in the value of the INCT program. It is my opinion that this program undoubtedly offers one of the best 2-year degrees available and even surpasses some of the available 4-year degrees. I suppose specific examples serve the purpose best. During my summer position following graduation, I worked alongside many B.S. chemists and was very surprised to discover that I had a greater knowledge of some very common instrumental analytical techniques as compared to these people. In particular, one B.S. chemist did not know the general method of spectrophotometry, a technique covered extensively in INCT. Upon entering the chemical engineering curriculum at Northwestern, I again observed the value of my INCT coursework. Two of my INCT classes transferred in as C-level science electives at this nearly Ivy league school. It is an excellent program which can be ascertained, if by nothing else, from the salaries that companies will pay for someone with this 2-year degree; higher than many 4-year programs leaving Ferris at the same time.

I have worked here for 3 1/2 years since completing my M.S. degree in Chemical Engineering from M.S.U.

The program would not be the same if William Killian was not at its helm. His aggressive style of preparation has developed parts of me that I did not think I had. My current field may not overly emphasize the course of study, but my train of thought was properly prepared to take on any endeavor that came my way.

Dow has targeted Ferris State University as a primary school from which to hire chemical technologists. Based on the track record of past graduates (within Dow), the company sees the INCT program as a premier source for chemical technologists. From what I've seen of many FSU INCT grads, I would completely agree with those from other companies. Under the guidance of Bill Killian, the INCT program prepares students to think logically and creatively, work safely, and keep good data book records.

I've been studying here at Purdue a little over a year now, and now as I look back on working full time and going to school full time I really don't know how I did it. In retrospect I believe that it was your influence that propelled not only myself but so many others to succeed.

Congratulations on the renovation and expansion of the INCT area. The money spent is well-deserved by the program. Congratulations also on the first-step ACS approval of the program.

Entering the INCT program was the best decision I have made in my life. In my opinion I have had more laboratory training than what a B.S. graduate would of had. I don't know of another program where the instructor works non-stop on providing his graduates with good paying jobs. This truly is an excellent program that I strongly recommend students to look at.

Section 4

Perceptions of the

Physical Sciences Department

Analysis of Department Faculty Survey

The faculty questionnaire was sent to sixteen faculty members and eight were received.

Following is the analysis of the responses:

1. The following areas were overwhelmingly responded as above expectation:

    a. Current data on job performance requirements and trends are systematically used in evaluating this program.

    b. Students and potential students of this program are identified through recruitment activities, treated equally in enrollment selection, and not discouraged by unrealistic prerequisites.

    c. Instructor or other qualified personnel advise students on program and course selection.

    d. Instructor or other qualified personnel providing career planning and guidance services have current and relevant occupational knowledge and use a variety of resources to meet individual student career objectives.

    e. This program includes information which is valuable to students once they have entered the work force.

    f. The university has an effective system for locating jobs and coordinating placement for students in this program.

    g. All persons responsible for directing and coordinating this program demonstrated a high level of administrative ability.

    h. Faculty members in this program have five or more years of relevant employment and/or teaching experience.

Physical Sciences Faculty Survey

1 2 3 1. Written measurable objectives have been developed for all occupational courses in this program, and are used to plan and organize instruction.

1 2 3 2. Current data on labor market needs and emerging trends in job openings are systematically used in developing and evaluating this program.

1 2 3 3. Current data on job performance requirements and trends are systematically used in evaluating course content of this program.

1 2 3 4. Current follow-up data on graduates are consistently and systematically used in evaluating this program

1 2 3 5. Instruction in all required courses recognizes and responds to individual student interests, learning styles, skills, and abilities through a variety of instructional methods.

1 2 3 6. Applicable supportive courses are closely coordinated with this program and are kept relevant to program goals and current to the needs of the student.

1 2 3 7. Opportunities are provided for related work experience, cooperative education, or internship for students in the program. Student participation is well coordinated with classroom instruction and employer supervision.

1 2 3 8. Students and potential students of this program are identified through recruitment activities, treated equally in enrollment selection, and not discouraged by unrealistic prerequisites.

1 2 3 9. Instructors or other qualified personnel advise students on program and course selection.

1 2 3 10. Instructors or other qualified personnel providing career planning and guidance services have current and relevant occupational knowledge and use a variety of resources to meet individual student career objectives.

1 2 3 11. This program includes information which is valuable to students once they have entered the work force.

1 2 3 12. The University has an effective system for locating jobs and coordinating placement for students in this program.

1 2 3 13. Success and failure of program graduates are assessed through periodic follow-up studies. Information learned is used to modify this program.

1 2 3 14. An active and organized effort is made to inform the public of the program training objectives, to encourage community support.

1 2 3 15. Responsibility, authority, and accountability for this program are clearly identified and assigned.

1 2 3 16. All persons responsible for directing and coordinating this program demonstrate a high level of administrative ability.

1 2 3 17. Student to faculty ratio in this program permits optimum program effectiveness.

1 2 3 18. Faculty members in this program have five or more years in relevant employment and/or teaching experience.

1 2 3 19. The University encourages and supports the continuing professional development of faculty through such opportunities as conference attendance, curriculum development, and work experience.

1 2 3 20. When appropriate, paraprofessionals (aids or laboratory assistants) are used to provide classroom help to students and to ensure maximum effectiveness of instructors in this program.

1 2 3 21. Office and clerical assistance is available to instructors and used to ensure their maximum effectiveness.

1 2 3 22. Equipment used in this program is current, representative of what is used in jobs for which the students are being trained, and in sufficient supply to meet students' needs.

1 2 3 23. Equipment for this program is operational, safe, and well maintained.

1 2 3 24. Computer hardware and software used in this program are in sufficient supply to meet the needs of instructors and students.

1 2 3 25. Instructional facilities meet the program objectives and student needs, are functional, and provide maximum flexibility and safe working conditions.

1 2 3 26. Scheduling of facilities and equipment is planned and used in a manner consistent with quality instruction.

1 2 3 27. Instructional materials and supplies are readily available and in sufficient supply to support quality instruction.

1 2 3 28. Learning resources for this program are available and accessible to students, current and relevant to the occupation.

1 2 3 29. Library resources are adequate to meet the program needs.

1 2 3 30. Adequate funds are allocated in the University's operating budget to support achievement of approved program objectives. Allocations are planned to consider instructor input.

1 2 3 31. The advisory committee for this program is active and representative of the occupation.

1 2 3 32. Funds are allocated to provide for new equipment as well as equipment replacement and repair. Fund allocation is consistent with the objectives of this program and based on instructor input.

Please add your comments to clarify any of the above issues or regarding the program in general.

INCT-Program Faculty Questionnaire Response

Question #	1 Above Expectation	2 Acceptable	3 Below Expectation	4 N.A.
1	5	3		
2	4	3		1
3	5	2		1
3	6	2		
5	4	4		
6	4	4	1	
7	4	1	1	1
8	8			
9	6	2		
10	7	1		
11	8			
12	6	1		1
13	4	3		
14	2	4		2
15	4	3		1
16	6	2		
17	4	4		
18	7	1		
19	3			
20	2	5	1	
21	2	4	2	
22	2	6		
23	5	3		
24		7	1	
25	4	4		
26	3	4		
27	3	5		
28	2	5	1	
29	1	5	2	
30	1	5	1	1
31	4	3		1
32	2	4	1	1

Faculty General Comments:

a. Program is a leader in the state of Michigan in producing well-trained chemical technicians, unfortunately not enough high school students are aware of this fact.

b. This is probably the most comprehensive two year program I have ever seen in any field. In this program students get hands-on experience in FT-IR., NMR, GC and HPLC, along with intensive training in laboratory safety, handling toxic wastes and disposal, book keeping and data handling.

c. The Industrial Chemistry program gives a viable alternative to many FSU students who like science but decide against pharmacy or various medically related majors. It allows students who enjoy lab work and problem solving the opportunity to use their talents in an important area where professional industrial needs exist.

Sections 5 & 6

Employer Follow-up
&
Labor Market Analysis

Employer Follow-up
&
Labor Market Analysis

This part of the report summarizes data obtained from a half dozen major companies that have hired chemical technologists over the past several years. These companies include The Dow Chemical Company, Dow Corning, Amway, Pharmacia & Upjohn, Eli Lilly, Dow Elanco and Cytec. Each of these companies were asked to project their hiring outlook for the near future. Specific comments from company representatives are included.

There is a little known, but critically important national trend that the reader should be aware of as the data is reviewed. A report written by Secretary of Labor, Robert B. Reich and released by the Bureau of Labor Statistics (Fall '94), projects that between the years 1990 and 2005, there will be a 37% increase in demand for "technicians." These technicians are roughly defined as "...those who often wear dresses or ties (like white-collar types), but they also often work with their hands and use tools (like the blue-collar types)." The report goes on to say that these new jobs require education beyond high school, but don't always demand a four-year degree. They offer challenges and opportunities for women and men willing to keep pace with new technology.

In 1994, The American Chemical Society granted full division status to The Division of Chemical Technicians. According to officers in the ACS, today's chemical technicians are responsible for tasks previously reserved for BS chemists.

During the recession of the early 90's, The Dow Chemical Company and others slowed the hiring of graduates to adjust to a radically changing business climate. This trend appears to be slowly reversing with an increase in hiring planned for 1996. Dow continues to be an active supporter of the INCT program with summer internship programs, on-site tours, on-campus speakers, and financial grants to qualified students. Ferris' INCT program is targeted as an important regional source for highly-qualified chemical technologists.

Technologists coming to Dow's Midland site will work in areas such as Research and Development, Health and Environment, Manufacturing, or Analytical.

After recovering from bankruptcy proceedings involving breast implants, Dow Corning appears to be poised to hire a number of technologists in the near future. Specifically, they expect to hire "6-8 over the next two years." In spite of the negative publicity Dow Corning is having, it is having "no problem attracting new people." Corning representatives see the companies future as very bright for 2-year INCT graduates. Ferris INCT grads are "well prepared" during their college courses. Graduates can expect to begin working in the manufacturing area, then go on to the Analytical Lab, QA and more advanced positions.

Amway predicts hiring 2 technologists per year over the next 2 years, and are fairly certain that they will hire during 1996. The technologists have been well prepared for the jobs they're in.

Opportunities for growth of new hires is considered "stable." New hires work primarily in the area of quality assurance.

Another Fortune 500 company that has had a long history of hiring program graduates is Pharmacia & Upjohn (formerly the Upjohn Company). Actual hiring is expected to be 10-12 technologists over the next couple of years. "High performance individuals can expect upward mobility." Technologists typically perform analytical chemistry techniques in the Quality Control and Fine Chemicals area. The representative spoke very highly of the program and the consistent quality of graduates they have hired.

Eli Lilly is another major company having a history of hiring program graduates. Though specific hiring numbers were unavailable at the time this report was being written, a number of unsolicited, positive comments were voiced regarding Bill Killian and his methods of preparing students for the workplace. Comments included "students hit the ground running", "graduates were head and shoulders above the rest" were common.

Dow Elanco, a joint venture company between The Dow Chemical Company and Eli Lilly is in the midst of company downsizing and has no plans for hiring during 1996. The hiring outlook for 1997 is unclear, but will likely look much like 1996. Many groups have downsized over the past 12 months. One positive note, INCT grads "possess the basic fundamentals of applied chemistry that have allowed them to come up to speed quickly..." "Good opportunities exist for techs and a well-defined career path exists." Techs typically work in R&D. Those with farming background may have opportunities in field research.

A company relatively new to hiring program graduates is Cytec Industries, Inc., of Kalamazoo, MI. Over the past couple of years, four graduates have been hired. Students preparation for these industrial positions was "more than adequate." A slow, but steady demand for technologists exist. The company predicts needing a couple of graduates each year for the near future. Graduates typically work in a QC lab as part of a manufacturing facility.

Information pertaining to this study, but not gathered directly from the phone surveys, reveals a broader, regional interest in program graduates. For the first time, Procter and Gamble (Cincinnati, OH) will be interviewing INCT grads this year. Essex Specialty Products (Auburn Hills, MI) BASF (Wyandote, MI), Abbot Labs and Consumers Power have also shown modest, but continued interest in hiring INCT graduates.

Section 7

Student Evaluation of Instruction

STUDENT PERCEPTIONS OF INCT

Students from 1995 and 1996 were polled with the same 43 question form concerning the Industrial Chemistry program. Thirty total students participated to some extent in the survey. A copy of the survey and the raw results are included.

Student responses reflect an overall feeling of accomplishment and satisfaction with their ICT program. They feel strongly that they are being well prepared and are gaining confidence in their field. They feel the teaching staff is knowledgeable, interested in their progress, and helpful to them as they bridge academics into the workplace.

College FERRIS STATE U.

Title of Your Program INCT

STUDENT PERCEPTIONS OF OCCUPATIONAL EDUCATION PROGRAMS

Check statement that best describes your objective for attending the college:

- Prepare to get a job X
- Improve job skills for present occupation ..... ____
- Prepare for transfer to another college ..... ____
- Personal interest ..... ____
- Other (Describe) ..... ____

INSTRUCTIONS: Rate each item using the following guide:
EXCELLENT means nearly ideal, top 5 to 10%
GOOD is a strong rating, top one-third
ACCEPTABLE is average, the middle-third
BELOW EXPECTATIONS is only fair, bottom one-third
POOR is seriously inadequate, bottom 5 to 10%

A Comment column has been provided if you wish to explain your rating

		Keypunch Instructions	Poor 1	Below Expectations 2	Acceptable 3	Good 4	Excellent 5	Don't Know	COMMENTS
Please rate each item below:									
1. Courses in your occupational program are:									
• Available and conveniently located.	1		–	–	2	9	17	1	
• Based on realistic prerequisites.	2		–	–	1	11	17	–	
• Available at moderate cost.	3		–	1	15	6	8	–	
Written objectives for courses in your occupational program:									
• Are available to students.	4		–	–	–	13	17	–	
• Describe what you will learn in the course.	5		–	1	2	13	14	–	
• Are used by the instructor to keep you aware of your progress.	6		–	1	–	9	19	–	
3. Teaching methods, procedures and course content:									
• Meet your occupational needs, interests and objectives.	7		–	–	2	6	20	–	
• Provide supervised practice for developing job skills.	8		–	1	1	7	18	1	
4. Related courses (such as English, Mathematics, Science) are:									
• Pertinent to occupational instruction.	9		–	1	4	16	9	–	
• Current and meaningful to you.	10		–	1	9	12	8	–	
5. Work experience (or clinical experience) in your occupational program is:									
• Readily available at convenient locations.	11		–	1	4	12	5	7	
• Readily available to both day and evening students.	12		–	2	8	5	6	8	
• Coordinated with classroom instruction.	13		–	1	1	12	9	6	
• Coordinated with employer supervision.	14		–	1	5	8	7	9	
6. Career planning information:									
• Meets your needs and interests	15		–	–	2	11	16	–	
• Helps you plan your program	16		–	–	2	9	17	1	
• Helps you make career decisions and choices.	17		–	1	2	9	16	1	

PROE

STUDENT PERCEPTIONS OF OCCUPATIONAL EDUCATION PROGRAMS

		Keypunch Instructions	Poor 1	Below Expectations 2	Acceptable 3	Good 4	Excellent 5	Don't Know	COMMENTS
6. Career planning information (Continued):									
• Helps you understand your rights and responsibilities as an employee	18	–	1	5	8	12	1		
• Helps you evaluate job opportunities in relation to salary, benefits and conditions of employment.	19	–	–	3	12	14	–		
• Is provided by knowledgeable, interested staff.	20	–	1	2	5	21	1		
• Explains nontraditional occupational opportunities for both sexes.	21	–	3	3	10	12	2		
7. Job success information on former students in your occupational program:									
• Is provided to help you make career decisions.	22	–	–	1	11	16	1		
• Indicates how many job opportunities there are in your occupation.	23	–	–	1	12	15	1		
• Identifies where these job opportunities are located.	24	–	–	–	13	14	2		
• Tells about job advancement opportunities.	25	–	–	3	9	16	2		
8. Placement services are available to:									
• Help you find employment opportunities.	26	–	1	2	6	17	3		
• Prepare you to apply for a job.	27	–	1	3	4	18	3		
9. Occupational instructors:									
• Know the subject matter and occupational requirements.	28	–	–	–	3	26	–		
• Are available to provide help when you need it.	29	–	–	–	2	27	–		
• Provide instruction so it is interesting and understandable.	30	–	1	1	4	22	–		
10. Instructional support services (such as tutoring, lab assistance) are:									
• Available to meet your needs and interests.	31	–	–	8	11	9	1		
• Provided by knowledgeable, interested staff.	32	–	–	5	9	12	2		
11. Instructional lecture and laboratory facilities:									
• Provide adequate lighting, ventilation, heating, power, and other utilities.	33	1	1	1	15	11	–		
• Include enough work stations for the number of students enrolled.	34	1	1	2	10	13	–		
• Are safe, functional, and well maintained.	35	–	1	2	16	10	–		
• Are available on an equal basis for all students.	36	1	–	1	13	14	–		
12. Instructional equipment is:									
• Current and representative of industry.	37	–	3	4	11	8	3		
• In sufficient quantity to avoid long delays in use.	38	–	4	5	10	7	3		
• Safe and in good condition.	39	–	1	4	13	8	3		
13. Instructional materials (e.g., textbooks, reference books, supplies) are:									
• Available and conveniently located for use as needed.	40	1	–	–	8	19	–		
• Current and meaningful to the subject.	41	–	1	1	8	19	–		
• Not biased toward "traditional" sex roles.	42	–	–	1	8	19	1		
• Available at reasonable cost.	43	1	1	11	7	9	–		

Section 8

Evaluation of Facilities and Equipment

FACILITIES AND EQUIPMENT

The information in this section has been drawn from the self-study report submitted to the American Chemical Society for the accreditation procedure.

A. Facilities

APPROXIMATE DEPARTMENTAL FLOOR SPACE

Number of lecture rooms 5
Area ..... 7240 ft^2

Number of teaching laboratories 10
Area ..... 10,720 ft^2

Average number of laboratory stations per lab

25-28 in general chemistry
22-25 in organic chemistry
15-20 in analytical chemistry
10-12 in instrumental chemistry
12-15 in industrial chemistry
15 in biochemistry

Are any laboratories used by different courses at the same time ..... yes

Storage and preparation rooms ..... 1660 ft^2

Special facilities (instrument room, cold room, etc.). 1120 ft^2

Total floor space for chemistry ..... 20740 ft^2

Please note: These figures were accurate before the remodeling project began this January. Right now, we are operating with about half the floor space (half of the Science Building is being remodeled), and following the project there will be an increase in space dedicated to chemistry.

B. Equipment

The following equipment is available (department-wide) for use by students in the ICT program:

Item	*Quantity*
Atomic absorption spectrometer	1
Analyzer, trace metals	1
Calorimeters	3
FT-IR spectrophotometer	1
Gas chromatographs	8
Liquid chromatographs	4
Melting point apparatus	4
pH meters	15
Polarograph	1
Refractometers	4
Rheometers	2
Scintillation counter	1
Spectrometers, IR	3
Spectrometers, uv-vis	2
Spectrophotometer, nmr	2
Spectrophotometers, vis	7
Viscometers	3

Section 9

Curriculum Evaluation

Curriculum Evaluation

Successful graduates of the Industrial Chemistry Technology (ICT) program are equipped with the skills to enter the chemical industry at the entry level of technician. Many of our graduates have been hired by chemical or pharmaceutical companies such as Dow Chemical, Dow Corning, Dow Elanco, Upjohn, and Eli Lilly. Some of our graduates work for smaller companies that need a small staff in research or quality control. An increasing number of our students have combined the two-year ICT degree with another bachelor's degree (including chemistry, plastics, or environmental/health management). The current ICT curriculum has been designed to meet the needs of this diverse audience.

GOALS AND OBJECTIVES

The main goal of the ICT program is to prepare students to work as chemical technicians. The technician must have an excellent background in the science of chemistry as well as the applied science of chemical technology. Furthermore, graduates must possess the general knowledge and skills to serve as a productive member of a working team. Thus, students also obtain a background in communication, behavioral sciences, humanities, and mathematics.

The ICT curriculum is designed to help students achieve the following objectives. The following list shows these objectives, along with the courses that help students attain them:

	Objective	Course
A.	Learn how to interpret and communicate basic chemical terminology.	General and organic chemistry; all INCT courses
B.	Understand how the mole and related concepts are used in calculations involving chemical reactions.	General chemistry; INCT 220
C.	Relate material and energy balances of chemical equations.	INCT 220
D.	Predict the course of simple chemical reactions.	General and organic chemistry
E.	Know how to prepare mixtures of specified compositions when the components of the mixtures are expressed in different quantitative units.	General chemistry; INCT 220; INCT 230
F.	Follow directions in the preparation of materials	INCT 120; INCT 125, INCT 230
G.	Use appropriate units with calculations.	General chemistry; INCT 220; INCT 230
H.	Know how to keep a laboratory notebook, including the notation of unexpected occurrences.	INCT 230
I.	Communicate chemical concepts and information clearly, both orally and in writing.	Communication classes and all INCT classes

J.	Prepare compositions or compounds, given the directions. Identify references which might provide appropriate directions	Organic chemistry; INCT 230
K.	Suggest the use of alternate materials in preparing compositions.	INCT 230
L.	Conduct chemical analysis under supervision.	Quantitative and Instrumental Analysis; INCT 230
M.	Learn to use common scientific instruments such as pH meters, IR and UV-vis spectrophotometers, and liquid and gas chromatography.	Quantitative and Instrumental Analysis.
N.	Know the basic rules of laboratory safety, and conduct laboratory procedures using safe practices.	INCT 125
O.	Become literate in computer software appropriate for the chemical industry, including work processing, spreadsheet, and database management.	ISYS 105 and all INCT classes

PROGRAM COURSES

See Table 1 (at the end of this section) for a list of chemistry, industrial chemistry, physics, math, and computer courses required for the program. Table 2 presents the catalog description for he chemistry and ICT classes. Following this table is a sample syllabus for each chemistry and industrial chemistry class in the program.

In addition to the classes listed in Table 1, students must also take the following classes to obtain their degree:

General Education	Course Titles	Credit Hours
ENGL 150	English 1	3
ENGL 250	English 2	3
ELECTIVES	Communication Competence	3
	Cultural Enrichment	3
	Social Awareness	3

Students must complete a minimum of 63 semester credit hours of instruction to obtain the associate's degree in ICT.

COMMENTS ON THE PROGRAM

1. *The curriculum is designed to provide flexibility for students.* We have purposefully chosen not to include a checksheet with this review, because most students do not follow it anyway. The program is designed to accommodate science-oriented students who discover during their

first year of college that they enjoy working in a lab setting so much that they would like to pursue a career involving labs. If a student has followed a pre-optometry or pre-pharmacy program for a year at Ferris, he or she can still complete the ICT program in one additional year if it is entered by the beginning of the sophomore year.

2. *The content of the INCT courses was designed in consultation with industrial members of the ICT advisory board.* On the quarter system there were seven courses with an "ICT" prefix; on the semester system only four are labeled "INCT". Much of the content of the seven courses was substantially rearranged into new logical packages. After two full years of the semester system, the program coordinator believes that students are still mastering the essential skills and abilities needed for industry.

3. *The final professional class in the course sequence, INCT 230, serves as an on-campus "internship" experience.* Students in this course spend eight hours per week in lab, working on a variety of projects. These projects provide students with the opportunity to work in a situation similar to what they will see on the job.

4. *The ICT program has few courses designed only for students in the program itself.* The four specialized INCT courses account for 10 credit hours out of the 63 hour total required for graduation. Thus, ICT students spend more than 5/6 of their time in courses in CHEM, MATH, PHYS, etc. All of the non-INCT classes are required by at least one program other than ICT. This helps increase the overall efficiency of the program. It would be a mistake to judge the program "cost" of ICT on the basis of program courses alone, because they do not account for a large part of the curriculum.

5. *Students can easily make the transition from ICT to a four-year degree in chemistry.* Many of our graduates, for purposes of advancement, choose to enter a B. S. program after they obtain work. These graduates have a good foundation to advance their studies, because they have already completed three years of chemistry (one year each of general chemistry, organic chemistry, and analytical/instrumental chemistry).

TABLE 1:

Curriculum of Required Courses College: Ferris State University

List below all required courses in chemistry, physics, mathematics, biology, and computer science in their normal progression. The total hour figures requested in column 4 should total class and laboratory hours for the entire period of the course, excluding examination periods (e.g., a two-semester course in organic chemistry with three class and four laboratory hours per week for a total of 30 weeks would be reported as 90 class and 120 laboratory hours). If desired, amplifying remarks may be added by a numbered footnote using a separate, attached page for the purpose.

Course #	*Course Title*	*Prerequisites*	*Class Hours*	*Lab Hours*	*Textbook and Author*	*Every year?*	*Last offered*	*Enrollment*
Fall Semester, Year One								
CHEM 121	General Chemistry 1	1 yr. each of HS algebra and chemistry	60	45	*General Chemistry* (Ebbing)	yes		323
INCT 120	Orientation to Industrial Chemical Technology	Corequisite–CHEM 121	30		*Chemical Technology Handbook* (Pecsok)	yes		24
MATH 120	Trigonometry	MATH 115 (algebra)	45			yes		147
Winter Semester, Year One								
CHEM 122	General Chemistry 2	CHEM 121 and MATH 115	60	45	*General Chemistry* (Ebbing)	yes		42
INCT 125	Safety and the Chemical Laboratory	CHEM 121	30		*Chemistry of Hazardous Materials* (Meyer)	yes		15
ISYS 105	Microcomputer Applications	none	45			yes		478
PHYS 211	Introductory Physics 1	MATH 115	45	45	*College Physics* (Wilson)	yes		206

Course #	Course Title	Prerequisites	Class Hours	Lab Hours	Textbook and Author	Every year?	Last offered	Enrollment
Fall Semester, Year Two								
CHEM 221	Organic Chemistry 1	CHEM 122	60	45	*Organic Chemistry* (Solomon)	yes		132
CHEM 231	Quantitative Analysis	CHEM 122	45	60	*Quantitative Chemical Analysis* (Harris)	yes		30
INCT 220	Industrial Chemical Calculations	CHEM 122; Corequisites: CHEM 221 and INCT 120	30		• *PC Simplified Practical Steps to Quality* (Amsden) • *Basic Calculations for Chemical and Biological Analysis*	yes		15
PHYS 212	General Physics 2	PHYS 211	45	45	*College Physics* (Wilson)	yes		67
Winter Semester, Year Two								
CHEM 222	Organic Chemistry 2	CHEM 221	60	45	*Organic Chemistry* (Solomon)	yes		33
CHEM 317	Instrumental Analysis	CHEM 231; Corequisite: CHEM 222	30	60	*Undergraduate Instrumental Analysis* (Robinson)	yes		14
INCT 230	Chemical Manufacturing and Analysis	CHEM 221 and CHEM 231	15	120	*Chemical Technicians' Ready Reference Handbook* (Slugar & Ballinger)	yes		13

Table 2

Catalog Description of Required Courses for the ICT Program

CHEM 121 - General Chemistry 1 5 Credit Hours (Lec 4, Lab 3)

Fundamental principles, laws and theories of general chemistry, including stoichiometry, gas laws, thermochemistry, atomic structure, chemical bonding, periodicity, liquids and solids, solution chemistry, and theories of acids and bases. Concurrent laboratory/workshop sessions include exercises illustrating the principles discussed in lecture. Students who anticipate enrolling in chemistry courses at the 200-level or higher should take this course.

CHEM 122 - General Chemistry 2 5 Credit Hours (Lec 4, Lab 3)

Continuation of Chem 121, including oxidation-reduction reactions, electrochemistry, chemical equilibrium, chemical kinetics, nuclear chemistry, thermodynamics, and descriptive chemistry of metals and nonmetals. Laboratory involves some experiments illustrating topics discussed in lecture along with several sessions devoted to the qualitative analysis of common cations and anions.

CHEM 221 - Organic Chemistry 1 5 Credit Hours (Lec 4, Lab 3)

Modern bonding theory in organic molecules, theory of reactions, stereochemical principles, chemistry of alkanes, cycloalkanes, alkenes, dienes, alkynes, aromatics, and alcohols, with special emphasis on reaction mechanisms. Concurrent laboratory includes basic laboratory techniques, synthesis, TLC and GC, stereo chemistry and spectroscopy workshops.

CHEM 222 - Organic Chemistry 2 5 Credit Hours (Lec 4, Lab 3)

Study of ethers and epoxides, carbonyl-containing compounds, aldehydes, ketones, carboxylic acids and their derivatives, carbanion chemistry, aliphatic and aromatic nitrogen-containing compounds, with special emphasis on bio organic compounds, amino acids and polypeptides, carbohydrates and lipids. Concurrent laboratory includes multistep syntheses, spectroscopic analysis, and the systematic identification of organic compounds with emphasis on chemical separation and purification techniques.

CHEM 231 - Quantitative Analysis 4 Credit Hours (Lec 3, Lab 4)

Quantitative and modern instrumental methods of analysis, including data handling, statistics, volumetric and gravimetric techniques, potentiometry, spectroscopy, and liquid chromatography. Concurrent laboratory includes the topics referred to above.

CHEM 317 - Instrumental Analysis 3 Credit Hours (Lec 2, Lab 4)

The theory and instrumentation of modern analytical techniques explored, including potentiometry, infrared (IR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, atomic absorption (AA) spectroscopy, and gas chromatography. Concurrent laboratory work includes projects involving these techniques.

INCT 120 - Industrial Chemistry Technology 2 Credit Hours (Lec 2)

Chemical industry: development and practical application of chemistry in an industrial setting. The role of the industrial chemist and/or technologist. Use of scientific literature and the study of patents.

INCT 125 - Safety & the Chemical Laboratory 2 Credit Hours (Lec 2)

Introduction to the chemical lab and the safety related responsibilities of the practicing chemist and/or technologist. Emphasis on the safe handling and storage of hazardous materials, recognizing non-compatible materials, understanding and interpreting safety documents such as MSDS sheets, and being a safety conscious lab worker.

INCT 220 - Industrial Chemical Calculations 2 Credit Hours (Lec 2)

A review of the stoichiometric and weight relations in the chemical industry; emphasis on problem solving. Statistical process control; statistical techniques for evaluating experimental results. Scale-up problems and the use of industrial units.

INCT 230 - Chem Manufacturing and Analysis 4 Credit Hours (Lec 1, Lab 8)

A laboratory intensive course stressing the preparation and analysis of various materials including plastics, pesticides, petroleum products, as well as a variety of pure substances. Characterization by instrumental methods, testing by use of American Society tests and materials methods, and notebook keeping are also emphasized. Lecture topics include polymer synthesis and characterization as well as special topics in analysis.

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Chy121.doc

CHEMISTRY 121
General Chem I
SYLLABUS

I. INSTRUCTOR

L. Jacobs Office: HF - 333 Phone: 592-2596 Office Hours: 1:00 MTWF (Other hours by appointment)

II. TEXT / REQUIRED MATERIALS

General Chemistry, fourth edition, by Ebbing
Lab Workbook for Chemistry 121 & 122 by FSU Chemistry Faculty
Scientific Calculator
Eye protection. Glasses or goggles **MUST** be worn in the lab **AT ALL TIMES.**
Safety glasses and/or goggles are available at the bookstore. Contact lenses should NOT be worn in the lab.

III. COURSE OBJECTIVES

CHEM 121 is a study of the fundamental principles, laws and theories of general chemistry, including nomenclature, stoichiometry, gas laws, thermochemistry, atomic structure, chemical bonding, periodicity, liquids and solids, solution chemistry and theories of acids and bases.

IV. COURSE PREREQUISITES

Successful completion of one year of high school chemistry (or CHEM 103 - Prep Chem) and algebra (or MATH 110 - Fundamentals of Algebra) are prerequisites to CHEM 121. Also, completion of, or concurrent enrollment in MATH 115 - Intermediate Algebra.
Reading, writing, and algebra at the college level are required.

V. COURSE REQUIREMENTS

Lecture: The lecture part of this course meets 4 hours each week (12:00 MTWF) in SCI - 130. **Attendance is required for every lecture!** For each unexcused absence, five (5) points will be DEDUCTED from your next test score. **Participation is required for every lecture.** For each **unresponsive answer,** five (5) points will be DEDUCTED from your next test score. I may occasionally give a bonus quiz. There are NO MAKE-UPS for these bonus quizzes regardless of the reason for missing. Tests are scheduled for the regular lect/lab periods and you are expected to take the tests at the scheduled times. If you have an acceptable reason for missing a test (e.g., illness or authorized school function), you MUST let me know **BEFORE** the test so that a make-up can be arranged.

The **FINAL EXAM** is scheduled for **Mon, Dec. 11 at 12:00 p.m. in SCI - 130.**
This will be an ACS First Term General Chem Exam. It **WILL COUNT** towards your grade in CHEM 121.
Do NOT make any plans that would prevent you from being present for this test!!!

Lab: The lab part of this course meets 3 hours each week. All lab sections meet in SCI - 310.
Sect. 221 M 8-11, Sect. 222 W 3-6, Sect. 223 Th 12-3, Sect. 224 F 8-11.
ATTENDANCE IN LAB IS MANDATORY!!!
If you have an acceptable excuse for missing lab (e.g., illness) you must let me know **BEFORE** the lab period so that make-up time can be arranged. The lab week runs from Mon to Fri.
If you have unexcused absences for TWO or more labs you will AUTOMATICALLY FAIL the course.
PRE-LAB REPORTS are due at lecture on FRIDAY PRIOR to your lab and POST-LAB REPORTS are due at the END of the lab period. Lab reports are graded on accuracy, precision, sig. figs, units, clarity, set-ups, neatness, etc. There may also be quizzes in the lab.

Homework: Homework consists of the questions and problems at the end of each textbook chapter plus any ques/prob handouts. Doing the homework represents one of the **MOST IMPORTANT PARTS** of the learning process in this course and therefore it is **ESSENTIAL** that you do the homework. To gain the most advantage from the ques/probs be sure that you TRY THEM BEFORE CLASS. It is necessary for you to PRACTICE the various types of problems and material in this course so that you can learn them. The best PRACTICE is the homework problems. Doing them over & over is the most important part of LEARNING the material. It will also be advantageous for you to REWRITE and REWORK the problems done in class ASAP after class.

SLA Workshops: In addition to the regularly scheduled lecture and lab periods for this course there are also two 2 hour SLA (Structured Learning Assistance) Workshop periods per week. These workshop periods will be directed by Mrs. M. Powers. **ATTENDANCE AT THESE SLA WORKSHOPS IS MANDATORY.**
Sections 221 & 222 will meet on MW at 7:00 p.m. in SCI - 120.
Sections 223 & 224 will meet on MW at 5:00 p.m. in SCI - 123.

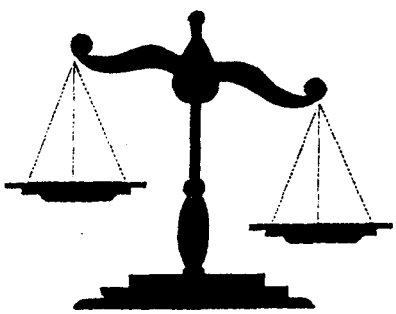
VI. GRADING

6 (1 hr) exams @ 100 pts each	=	600 pts
1 (2 hr) final exam on M Dec 11	=	200
lab	=	150
non - bonus quizzes	=	50 (most likely on Fridays)
	total =	1000 pts

A word of advice on taking test: Read (skim) all of the questions and problems first, quickly, before answering any of them. Then go back and **DO THE EASY ONES FIRST.** Do not waste time on the hard ones until you have all the easy ones finished.

Your final grade will be based on the following tentative scale:

	88% B+	76% C+	63% D+	
94% A	83% B	70% C	58% D	<55% F
90% A-	80% B-	65% C-	55% D-	



CHEMISTRY 121

Fall Semester 1995

Monday	Tuesday	Wednesday	Friday
First Day Aug 28 of Class Course Intro.	Aug 29 ACS HS Chem TEST	Aug 30 Seating Chart Chap 1 Chem & Meas	Sept 1 Chap 1
Sept 4 Labor Day - No Classes	Sept 5 Chap 1	Sept 6 Chap 1	Sept 8 Chap 1
Sept 11 Chap 2 Atoms, Molecules, and Ions Lab # 2 Meas of Phy Prop	Sept 12 Chap 2	Sept 13 Chap 2	Sept 15 Chap 2
Sept 18 **TEST No. 1** **Chap 1 & 2** Lab # 3 Form.of a Hydrate	Sept 19 Chap 3 Chem Rxs: An Intro.	Sept 20 Chap 3	Sept 22 Chap 3
Sept 25 Chap 3 Lab # 4 Inorg. Nomen.	Sept 26 Chap 4 Chem Calc.	Sept 27 Chap 4	Sept 29 Chap 4
Oct 2 Chap 4 Lab # 5 Stoichiometry	Oct 3 **TEST No. 2** **Chap 3 & 4**	Oct 4 Chap 5 Gaseous State	Oct 6 Chap 5
Oct 9 Chap 5 Lab # 7 Mol Wt Vol Liq	Oct 10 Chap 5	Oct 11 Chap 6 Thermochem	Oct 13 Chap 6
Oct 16 Chap 6 Lab # 8 Heat of Neutral.	Oct 17 Chap 6	Mid-Term Oct 18 Warn's **TEST No. 3** **Chap 5 & 6**	Oct 20 Chap 7 Quantum Theory
Oct 23 Chap 7 Lab # 6 Iron Analysis	Oct 24 Chap 7	Oct 25 Chap 8 Electron Config & Periodicity	Oct 27 Chap 8
Last Day Oct 30 for "W" Chap 8 Lab # 9 Alum	Oct 31 Chap 8	Nov 1 Chap 8	Nov 3 **TEST No. 4** **Chap 7 & 8**
Nov 6 Chap 9 Ionic/Coval Bond Lab # 10 Lewis Formulas	Nov 7 Chap 9	Nov 8 Chap 9	Nov 10 Chap 9
Nov 13 Chap 10 Mol Geo/Bond Lab # 12 Acid/Base Tit'n	Nov 14 Chap 10	Nov 15 Chap 10	Nov 17 **TEST No. 5** **Chap 9 & 10**
Nov 20 Chap 11 Liqs & Solids Lab - No lab	Nov 21 Chap 11	Nov 22 Chap 11	Nov 24 T - Day **No Classes**
Nov 27 Chap 12 Solutions Lab # 13 Mol Vol of N_2	Nov 28 Chap 12	Nov 29 Chap 12	Dec 1 **TEST No. 6** **Chap 11 & 12**
Dec 4 Chap 13 Acids/Bases	Dec 5 Chap 13	Dec 6 Review	Last Day Dec 8 of Class Review

FINAL EXAM on MONDAY, DEC 11 at 12:00 (noon) in SCI - 130

Chem 12
Jacobs

CHEM 122 Syllabus
Winter Sem 1996
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CHEMISTRY 122
General Chemistry 2
SYLLABUS

I. INSTRUCTOR

L. Jacobs Office: H-F - 333
Office Hours: 1:00 MTWF
(other hours by appointment)
Phone: 592-2596

II. TEXT/REQUIRED MATERIALS

General Chemistry, fourth edition, by Ebbing
Lab Workbook for Chemistry 121 & 122,
by FSU Chemistry Faculty
Qualitative Analysis and the Properties of Ions In Aqueous Solutions, second edition,
by Slowinski/Masterton
Scientific Calculator
Eye Protection. Glasses or goggles **MUST** be worn in the lab **AT ALL TIMES.**
Safety glasses and/or goggles are available at the bookstore. Contact lenses should NOT be worn in the lab.

III. COURSE OBJECTIVES

CHEM 122 is a continuation of CHEM 121. The primary objectives are the study of: Redox Rxs, Chem Kinetics, Chem Equilibrium, Thermodynamics, Electrochemistry, Nuclear Chem, Introduction to Organic Chemistry, and certain chemical families. The lab will include Qualitative Analysis of Unknowns.

IV. COURSE PRE-REQUISITES

Successful completion of CHEM 121 and MATH 115 (or higher) are pre-requisites to CHEM 122.
If you do not have the proper pre-requisites, you must drop the course.
If you received an "F" in CHEM 121, you are NOT eligible for CHEM 122.
If you received a "D-" in CHEM 121, you are NOT prepared for CHEM 122.
If you received a "D", "D+", or "C-" in CHEM 121, then you must plan to spend EXTRA time on CHEM 122.
Reading, writing, and algebra at the college level are required.

V. COURSE REQUIREMENTS

Lecture: The lecture part of this course meets 4 hrs each week (12-1:00 MTWF) in HEC 202.
Attendance is required for every lecture!
For each unexcused absence, five (5) points will be DEDUCTED from your next test score.
Participation is required for every lecture.
For each unresponsive answer, five (5) points will be DEDUCTED from your next test score.
I may occasionally give a bonus quiz.
There are NO MAKE-UPS for these quizzes regardless of the reason for missing. Tests are scheduled for the regular lect/lab periods and you are expected to take the tests at the scheduled times. If you have an acceptable reason for missing a test (e.g., illness), you MUST let me know BEFORE the test so that a make-up can be arranged.

The FINAL EXAM is scheduled for Mon, Apr. 29 at 12:00 p.m. in HEC-202. This will be an ACS comprehensive General Chemistry Exam. It WILL COUNT towards your grade in CHEM 122.
Do NOT make any plans that would prevent you from being present for this test.
There will be some text material that you will be responsible for studying essentially on your own. Be sure that you do NOT neglect this responsibility.

Lab: The lab part of this course meets 3 hrs each week: Sect 221 on M 3-6 Sect 222 on W 3-6
Sect 224 on Th 12-3 Sect 223 on F 8-11
All lab sections meet in SCI-310.
ATTENDANCE IN LAB IS MANDATORY. If you have an acceptable excuse for missing lab (e.g., illness), you must let me know **BEFORE** the lab period so that make-up time can be arranged. **If you have unexcused absences for TWO or more labs, you will automatically FAIL the course.**
Pre-lab reports are due at the **FRI LECT PRIOR** to the lab week and post-lab reports are due at the **END** of the lab period. Lab reports are graded on accuracy, precision, sig. figs., units, clarity, set-ups, neatness, etc. There may also be quizzes in lab.

The first six (6) lab experiments will be from the Lab Workbook for CHEM 121 & 122. The last six (6) lab experiments will be from the book, Qualitative Analysis and The Properties of Ions in Aqueous Solution, 2nd edition, by Slowinski, Masterton. The lab work for this part of the semester will be considerably different from previous lab work. It consists of the qualitative analysis of various cations and anions. You will be working on your own most of the time. In order to do your lab work efficiently and accurately you will need to spend time preparing for lab by studying the lab book and doing the pre-lab exercises for each analysis group. Checking the integrity of the reagents for qualitative analysis is also your responsibility.

SLA Workshops: In addition to the regularly scheduled lecture and lab periods for this course, there are also two 2-hour SLA (Structured Learning Assistance) Workshop periods per week for Sects 222 & 223. These workshop periods will be directed by Mrs. M. Powers. **ATTENDANCE AT THESE SLA WORKSHOPS IS MANDATORY.**
Sect 222 will meet on MW at 1-3:00 in PHR 305
Sect 223 will meet on MW at 3-5:00 in SCI 112

Homework: Homework consists of the questions and problems at the end of each textbook chapter and at the end of each labbook chapter plus any ques/prob handouts. Although I will not be collecting the homework, it represents one of the MOST IMPORTANT PARTS of the learning process in this course and therefore it is **ESSENTIAL** that you do the homework. To gain the most advantage from the homework questions and problems, be sure that you **TRY THEM BEFORE CLASS.** It will also be necessary for you to **PRACTICE** the various types of problems encountered in this course so that you can recognize them immediately on a test. **PRACTICE** on the homework problems (doing them over & over & over) is your best opportunity for **LEARNING** the material. It will also be advantageous for you to **REWRITE** your class notes and **REWORK** the problems done in class **ASAP** after class.

A word of advice on taking tests: Read (skim) all of the questions and problems first, quickly, before answering any of them. Then go back and **DO THE EASY ONES FIRST.** Do not waste time on the hard ones until you have all the easy ones finished.

VI. GRADING

5 (1 hr) exams @ 100 pts each	500 pts
1 (2 hr) final (ACS) exam	200
12 lab grades @ 15 pts each	180
2 lab quizzes @ 10 pts each	20
non-bonus quizzes	100
	1000 pts

Your final grade will be based on the following tentative scale:

	88% B+	76% C+	63% D+	
94% A	83% B	70% C	58% D	<55% F
90% A-	80% B-	65% C-	55% D-	

CHEMISTRY 122

Winter Sem 1996

Monday	Tuesday	Wednesday	Friday
First Day **Jan 8** of Class Course Intro. Lab # 18 Bal Redox Eqs	**Jan 9** Chem 121 Review	**Jan 10** Seating Chart Chap 13 Ox-Red Concepts	**Jan 12** Chap 13
Jan 15 M. L. King Day **No Classes**	**Jan 16** Chap 13	**Jan 17** Chap 21 Metallurgy & Main Group Metals	**Jan 19** Chap 14 Rates of Reaction (Kinetics)
Jan 22 Chap 14 Lab # 20 Iodine Clock	**Jan 23** Chap 14	**Jan 24** Chap 14	**Jan 26** **TEST No. 1** Chap 13, 14, 21
Jan 29 Chap 15 Chem Equil; Gaseous Reactions Lab # 19 Cu Sequence	**Jan 30** Chem 15	**Jan 31** Chap 15	**Feb 2** Chap 16 Acid-Base Equilibria
Feb 5 Chap 16 Lab # 17 Graph GlassBead	**Feb 6** Chap 16	**Feb 7** Chap 16	**Feb 9** Chap 16
Feb 12 Chap 16 Lab # 21 K_a	**Feb 13** Chap 16	**Feb 14** Chap 16	**Feb 16** **TEST No. 2** Chap 15 & 16
Feb 19 Chap 17 Solubility & Complex Ion Equilibria Lab # 23 K_f	**Feb 20** Chap 17	**Feb 21** Chap 17	**Feb 23** Chap 17 Chap 18 Thermodynamics & Equilibrium
Feb 26 Chap 18 Lab # 17 Graphing BB's	**Feb 27** Chap 18	Mid-Term **Feb 28** Warn's Chap 18	**Mar 1** **TEST No. 3** Chap 17 & 18
SPRING BREAK	**MARCH 2 THRU MARCH 10**		**SPRING BREAK**
Mar 11 Qual Scheme Lab: Group I Analysis	**Mar 12** Chap 21	**Mar 13** Chap 19 Electrochemistry	**Mar 15** Chap 19
Last Day Mar 18 for "W" Qual Scheme Lab: Group II Analysis	**Mar 19** Chap 19	**Mar 20** Chap 19	**Mar 22** Chap 19
Mar 25 Qual Scheme Lab: Grp II Unk/ Grp III	**Mar 26** Chap 19	**Mar 27** Chap 22 Nonmetals	**Mar 29** **Test No. 4** Chap 19, 21, & 22
Apr 1 Chap 20 Nuclear Chemistry	**Apr 2** Chap 20	**Apr 3** Chap 20	**Apr 5** **GOOD FRIDAY** **No Classes**
Apr 8 Chap 20 Lab: Grp III Unk	**Apr 9** Chap 20	**Apr 10** Chap 20	**Apr 12** Chap 22
Apr 15 Qual Scheme Chap 22 Lab: General Cation Unk	**Apr 16** Chap 23 Transition Elements	**Apr 17** Chap 24 Organic Chemistry	**Apr 19** **Test No. 5** Chap 20, 22, 23
Apr 22 Qual Scheme Chap 24 Lab: Anion Analysis	**Apr 23** Chap 24	**Apr 24** Chap 24	Last Day **Apr 26** of Class Review

FINAL EXAM on MONDAY, APR 29 at 12:00 (noon) in HEC - 202

SIGNIFICANT FIGURES

1. There are two kinds of numbers:
   a. Exact numbers - **numbers that are known to be absolutely accurate.**
      (1) **counted values (number of people in a room)**, or
      (2) exact conversions (1 ft = 12 inches)
      Exact numbers do not influence the determination of significant figures in a calculated result.
   b. Inexact numbers - numbers that are obtained from actual measurements (data), or from estimation. In all measurements some estimation (uncertainty) is involved which leads to inexact values. **The number of significant figures in the data for a problem determines the number of significant figures in the calculated result.**

2. Significant Figures - digits that are believed to be correct by the person making the measurement. They indicate the degree of uncertainty in a measurement. The last digit in a reported measurement is assumed to be an estimation (uncertain figure) but it is considered to be significant. The more significant figures there are in a measurement, the more precise the measurement is, and the more accurate (closer to the true value) it is <u>assumed</u> to be.

3. The rules for counting significant figures in a number are:
   a. Nonzero integers are significant, e.g. 216.3 has four sig. figs.
   b. Zeros. There are three classes of zeros:
      Captive zeros. These fall between nonzero digits and are <u>always</u> significant, e.g. 206 has three sig. figs.
      Leading zeros. These are zeros that precede all nonzero digits. They are <u>never</u> significant, e.g. .0025 has two sig. figs.
      Trailing zeros. These are zeros at the right end of the number. They are significant <u>only if the number contains a decimal point</u>, e.g. the number 1200 has only two sig. figs., but 1200. has four sig. figs.
   c. Scientific notation (powers of ten or exponential notation). All zeros in the base number are significant, e.g. 7.230×10^4 has four sig. figs.

4. The rules for using significant figures in calculations are:

   a. For <u>multiplication and division</u>, the number of sig. figs. in the result is the same as that in the measurement with the smallest number of significant figures, e.g. 1.23 cm x 12.34 cm = 15.2 cm^2

   b. For <u>addition and subtraction</u>, the answer can have only as many decimal places as the measurement with the fewest decimal places, e.g. 1.234 g + 56.7 g = 57.9 g. Also, if a number is known only to the tens place, e.g. 180 mL, then the result of addition or subtraction with that number can be known to no better than the tens place. [e.g. 180 mL + 111.5 mL = 290 mL]

5. The rules for rounding a number are:

   a. A measurement is ***<u>never</u>*** rounded; only the results of calculations are rounded.

   b. When the digit to be dropped is less than 5, it is just dropped, e.g. 7.34 rounded to two sig. figs. is 7.3.

   c. When the digit to be dropped is 5 or more, the preceding digit is increased by 1, e.g, 7.35 rounded to two sig. figs. is 7.4.

ORGANIC CHEMISTRY 221, Fall 1995

(5 credits, 4+3)

Dr. P. Di Raddo 592-2584 (office) H. Ferris 332

Office hours: M,W,R,F 9:00-10:00

Texts: (Reqd) "*Organic Chemistry*" McMurry Third Edition (Lecture)
"*Microscale and Macroscale Organic Chemistry*" Williamson Second Edition (Lab)

Course Content: Modern bonding theory in organic molecules; group functions; chemistry and stereochemistry of alkanes; cycloalkanes, alkenes and alkyl halides with special emphasis on reaction mechanisms in aliphatic systems. Study of aromatic compounds, dienes, alkynes, alcohols, ethers and organometallic compounds with emphasis on substitution-elimination and electrophilic aromatic substitution reactions. Concurrent laboratory includes basic laboratory techniques such as TLC and GC, synthesis, stereochemistry workshops, UV, IR, NMR and MS theory and analyses, and an intoduction to qualitative analysis. Prerequisite CHEM 121 and 122.

POINT DISTRIBUTION AND GRADING

EXAMS (100 points each X 3)	300
LABS (Reports, Workshops, Preparation) (no late makeup labs available)	150
FINAL EXAM (comprehensive; no makeup possible)	200

A, A−: 92-100% B±: 82-91% C±: 68-81% D±: 53-67% F: Below 53%

EXAM SCHEDULE

EXAM	DATES
One	Sept.
Two	Oct.
Three	Nov.
Final	Dec. Finals week

If you miss an exam because of an excused absence you must contact me within one class day in order to schedule a makeup exam. Makeups are for excused absences only (deaths and sickness with doctor's note)

READING ASSIGNMENTS AND SUGGESTED PROBLEMS

Chapter 1 Structure and Bonding
Problems: 20, 21, 23, 24, 26-28, 35, 38, 42

Chapter 2 Bonding and Molecular Properties
Problems: 23, 24, 26, 33, 35, 36, 38, 40, 45

Chapter 3 Alkanes and Cycloalkanes
Problems: 19, 21, 22, 24, 28, 31, 32, 34, 35, 40, 45, 48

Chapter 4 Stereochemistry of Alkanes-Cycloalkanes
Problems: 21, 24, 27-31, 41, 48

Chapter 5 An Overview of Organic Reactions
Problems: 16, 18, 20-23, 34

Chapter 6 Alkenes: Structure and Reactivity
Problems: 19, 21-23, 25-27, 33, 35, 36a-d, 37, 39, 41

Chapter 7 Alkenes: Reactions and Synthesis
Problems: 21-25, 27, 30, 33, 34, 35c

Chapter 8 Electronic structure of Alkynes
Problems: 17, 22-24, 26, 28, 29, 35

Chapter 9 Stereochemistry
Problems: 26-29, 32, 33, 35, 39, 40, 43-46, 49

Chapter 10 Alkyl Halides
Problems: 17-22, 27-30

Chapter 11 Nucleophilic Substitution-Elimination Reactions of Alkyl Halides
Problems: 20, 21, 23-26, 29-32, 36

Chapter 12-13 Spectroscopy
Problems: To be assigned

Chapter 14 Conjugated Dienes
Problems: 17-19, 22, 23, 25, 28, 30, 39

Chapter 15 Benzene and Aromaticity
Problems: 19, 20, 23, 27, 31

The lecture part of this course meets 4 hours per week and labs last up to 3 hours per week. A diligent student is expected to study a minimum of 2-3 hours per hour of lecture. Attendance and participation is expected for every lecture and may be factored into your final grade. The suggested problems provided in this syllabus have been selected to reinforce an understanding of the topics covered in class. Remember that the organic textbooks cited in this syllabus are not to be read as novels. Rather as you read and study you ought to in addition attempt as many problems as possible with pencil and paper close at hand. The use of notecards is particularly effective in condensing for you the key points of the material covered and can facilitate your studies. Don't hesitate to write in your book- it is not the Bible- or to rewrite your class notes if you find this useful in understanding the material.

Chem 22
D. Radd

ORGANIC CHEMISTRY 222

Winter 1996
(5 credits, 4+3)

Dr. P. Di Raddo 592-2584 (office) H. Ferris 332

Office hours: M,W,F 9:00-10:15

Texts: "*Organic Chemistry* " McMurry Third Edition (Lecture)
(Reqd) *"Microscale and Macroscale Organic Chemistry"*
Williamson Second Edition (Lab)

Course Content: Study of aromatic compounds, carbonyl-containing compounds, aldehydes, ketones, carboxylic acids and their derivatives. Also carbanion chemistry, aliphatic and aromatic nitrogen containing compounds will be considered with special emphasis on bioorganic compounds such as polypeptides, carbohydrates and lipids. Concurrent labs include multistep syntheses, spectroscopy workshops in NMR and MS and the systematic identification of organic molecules.

POINT DISTRIBUTION AND GRADING

EXAMS	(100 points each X 3)	300
LABS	(Reports, Workshops, Preparation) (no late makeup labs available)	150
FINAL EXAM	(comprehensive; no makeup possible)	200

A, A⁻: 92-100% B±: 82-91% C±: 68-81% D±: 53-67% F: Below 53%

EXAM SCHEDULE

EXAM	DATES
One	February
Two	March
Three	April
Final	Finals week

If you miss an exam because of an excused absence you must contact me within one class day in order to schedule a makeup exam. Makeups are for excused absences only (deaths and sickness with doctor's note)

READING ASSIGNMENTS AND SUGGESTED PROBLEMS

Chapter 16 Electrophilic Aromatic Substitution Reactions of Benzene
Problems: 31, 33, 34, 37, 39, 40, 45, 49, 50

Chapter 17 Alcohols and Thiols
Problems: 26, 27, 29, 30, 31, 34, 37, 41, 43, 48, 52

Chapter 18 Ethers, Epoxides and Sulfides
Problems: 22, 23, 25, 28, 34, 29

Chapter 19 Aldehydes and Ketones: Nuc Addition Reactions
Problems: 30, 31, 33, 38, 39

Chapter 20 Carboxylic Acids
Problems: 14, 15, 20, 21, 22, 28, 36, 39

Chapter 21 Carboxylic Acid Derivatives
Problems: 36, 37, 38, 39, 53, 59

Chapter 22 Carbonyl Alpha Substitution Reactions
Problems: 26, 27, 34, 35

Chapter 23 Carbonyl Condensation Reactions
Problems: 27, 29, 39

Chapter 25 Aliphatic Amines
Problems: 24, 25, 28, 29

Chapter 26 Aryl Amines and Phenols
Problems: 18, 24, 26

Chapter 24 Carbohydrates
Problems: 27, 28, 31, 32, 33, 34, 36

The lecture part of this course meets 4 hours per week and labs last up to 3 hours per week. A diligent student is expected to study a minimum of 2-3 hours per hour of lecture. Attendance and participation is expected for every lecture and may be factored into your final grade. The suggested problems provided in this syllabus have been selected to reinforce an understanding of the topics covered in class. Remember that the organic textbooks cited in this syllabus are not to be read as novels. Rather as you read and study you ought to in addition attempt as many problems as possible with pencil and paper close at hand. The use of notecards is particularly effective in condensing for you the key points of the material covered and can facilitate your studies. Don't hesitate to write in your book- it is not the Bible- or to rewrite your class notes if you find this useful in understanding the material.

Industrial Chemistry Technology

APPLC 1995-1996

section 2 of 2

COURSE OUTLINE

CHEM 231
Quantitative Analysis
Fall 1995

Instructor: Dr. Prabhakara Shetty
HF 340, 592 2589

Office Hours: MW 10:50-11:50AM
TR 3:30-4:30 PM

Text Book: Quantitative Chemical Analysis by Daniel C.Harris
Fourth Edition; W.H. Freeman and Company

Testing Policy: Four hourly tests of 100 pts. each

Final exam will be cumulative and worth 100 pts.

Six announced quizzes worth 20 pts. each, and you can drop one quiz of lowest grade.

Ten homework assignments worth 10 pts. each.

Grading Policy: 75% of the grade comes from the lecture part and 25% of the grade comes from the lab. part.

Conversion of numerical grades to letter grades: Numerical grades will be converted to letter grades at the end of the quarter using the following guidelines:

below 59.5%	F
59.5 - 69.4%	D- tO D+
69.5 - 79.4%	C- to C+
79.5 - 89.4%	B- to B+
89.5 and above	A- to A

Topics:

1. Introduction to chemical analysis
2. Statistical approaches to error in analysis and data handling
3. Chemical equilibrium: concept and calculations
4. Acids, bases and buffers
5. Volumetric analysis: titrations and equivalence points
6. Gravimetric analysis: the limits of solubility
7. Introduction to instrumentation
8. Electrochemistry
9. Molecular spectroscopy
10. Chromatography

Goal:

The main goal of this course is to enable students to understand the concepts of classical and modern quantitative analysis involving both wet and instrumental methods.

Chem 317
Shetty

CHEM 317
Instrumental Analysis
3 Credits

Instructor:	Dr Prabhakara Shetty	Winter 1996
Office:	HF 340	SCI 123
Telephone:	592 2589	MW 10:00 to 10:50 AM
Office Hours:	MW 11:00 to 11:50 AM	
	TR 10:00 to 10:50 AM	

Recommended References: Principles of Instrumental Analysis by Skoog
Undergraduate Instrumental Analysis by Robinson
Quantitative Chemical Analysis by Harris

Lecture outline:

1. Review of concepts of analytical chemistry: graphing, data manipulation and reporting, including methods of calibration, S/N ratio.
2. Radiant energy: refractive index, turbidimetry, mephelometry, luminscence, UV/VIS.
3. Potentiometry: ion selective electrodes.
4. Gas chromatography: theoretical plates, temperature programmed elution.
5. Nuclear magnetic resonance and Infrared spectroscopy.
6. Atomic spectroscopy: emission and absorption
7. Thermal analysis.

Laboratory outline:

1. Potentiometric methods involving pH and ion-selective electrodes
2. Refractometry
3. Infrared Spectroscopy
4. Nuclear magnetic spectroscopy
5. Atomic absorption
6. UV/VIS spectrophotometry
7. Gas chromatography
8. Thermometric titration
9. Automated techniques.

Requirements

Ten quizzes	200pts (20 pts each)
Final Exam	100 points (cumulative)
Laboratory	150 points

Grading Scale:

92.5 % and above	A
89.5 to 92.4 %	A-
86.5 to 89.4 %	B+
82.5 to 86.4 %	B
79.5 to 82.4 %	B-
76.5 to 79.4 %	C+
72.5 to 76.4 %	C
69.5 to 72.4 %	C-
66.5 to 69.4 %	D+
62.5 to 66.4 %	D
59.5 to 62.4 %	D-

Course Objectives:

1. This is a lab intensive course, therefore a lot of emphasis will be placed on developing laboratory skills.

2. To learn the theory, mechanism and operational techniques of various analytical instruments used for chemical analysis.

INCT 120
ORIENTATION TO INDUSTRIAL CHEMICAL TECHNOLOGY
2 Semester Credits

Mr. Killian
M-W-- 11-11:50 AM
Office: SCI 324; phone 592-2590

August 28, 1995
Fall Semester
SCI 314

Textbook: "Chemical Technology Handbook,"
Robert L. Pecsok, Kenneth Chapman, and Wade Ponder

Week of	Topic	Assignment
Aug 28	Role of Chemical Technologist	preface
Sept 4	Chemical Literature	16
Sept 11	Use of the Library	16
Sept 18	Computer Searching	16
Sept 25	Physical/Chemical Properties	Handout
Oct 2	Data/Graphing	12 Exam I
Oct 9	Introduction to Industrial Chemistry	Handout
Oct 16	Diagrams and Drawings	13
Oct 23	Inorganic Process Chemistry	Handout
Oct 30	Organic Chemical Processes	Handout
Nov 6	Pollution Prevention in Industry	Exam II Handout
Nov 13	Notebook & Patents	10 + Handout
Nov 20	Specifications	15
Nov 27	Good Lab Practice	2 paper due
Dec 54	Personal Protective Equipment	3
Dec 11	Final Exam Week	

"Knowledge is of two kinds: we know a subject ourselves, or we know where we can find information upon it."

Dr. Samuel Johnson (1709-1784)

Requirements	
Journal Work	120
Exams	300
Paper on a Chemical Compound	100
Attendence	30

Grading Scale/Total Points	
A >414	C+>347
A->405	C >329
B+>396	C->315
B >383	D >270
B->360	E <270

OBJECTIVES:

1. To introduce you to the curriculum, your future career, its requirements and the instructor.

2. To begin to attack problems like a scientist.

3. Understand and be able to use the chemical literature.

4. Have a working knowledge of patents.

5. To begin to develop the positive attitude essential to becoming a master of chemical material you have been & will be exposed to throughout your academic and professional career.

6. To gain a better understanding of some basic organic and inorganic chemistry.

7. To gain an appreciation for the way industrial chemistry bridges the gap between basic research, engineering, marketing, and common sense.

8. To be informed in a variety of areas of current concern in industrial chemistry through reading recent literature.

9. To improve your skills in scientific communication.

A Few Comments:

In this course the instructor will attempt to "paint" a picture of what your future in chemistry will be like, in addition to regular course material.
in this course too.

You are expected to exhibit a good professional attitude in class, you are now preparing for a career. Absences with good cause are permitted, but notify the instructor. Attendance is required.

Chemical Technology Handbook, is one of several sources we will use.

When the instructor tells you to do something in a specific way please do it that way. If you do not do it his way you are WRONG. Normally it does not make much difference how you solve something, just so long as the answer is correct.

Assignments are an individual matter unless specified otherwise.

There are probably exceptions to every rule.

If you disagree, do so in an agreeable manner.

The instructor knows that he makes mistakes.

Be able to demonstrate that you spending several hours per week reading the chemical literature (including current literature). Literature is generally considered the periodicals, but we could include dictionaries, compendia, encyclopedias and books.

We plan at least one field trip for the class this semester.

A journal will be kept including assignments, homework, and projects. The purpose of the journal is to help organize work done outside of class. You will still need a regular notebook for class notes.

A paper on a chemical compound is required and will be explained in detail.

Inct 125
Killian

INCT 125

CHEMICAL LAB SAFETY

2 Credits

Mr. Killian
W, F 9:00 am

January 10, 1996
Winter Semester, 1996
Science 102

Textbook: "Chemistry of Hazardous Materials, " Eugene Meyer

WEEK OF	TOPIC	ASSIGNMENT	ACTIVITY
1/10	General Safety & Lab Labels	M1	
1/17	MSDS Sheets	M1	
1/24	Physical Properties as Related to Hazards	M2	Unit Test 1
1/31	Compressed Gases & Liquids	M2	
2/7	Hazardous Matter	M3	
2/14	Chemical Reactivity & Combustion	M4	
2/21	Chemistry of Some Common Elements	M6	
2/28	Corrosives	M7	
3/6	**Spring Break**		
3/13	Water Sensitive Materials	M8	Unit Test 2
3/20	Toxilogical Levels	M9	
3/27	Redox Hazards	M10	
4/3	Organic Hazards	M11 & 12	Safety File Due
4/10	Explosives	M13	
4/17	Radiation	M14	Unit Test 3
4/24	A Total Safety Program		
5/1	**Final Exam**		

Requirements

Final Exam	100
Unit Tests	225
Homework/Attendance	125
Safety File	50

Grading

> 92%	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-

Other Considerations

1. Homework assignments will be assigned weekly and will be due 1 week after the assignment has been given. Please do not be late. Keep all homework assembled in a notebook for study.

2. The safety file is a compilation of at least 10 articles, preferable newspaper, on matters of safety. Underline appropriate references in the articles.

3. The course continues INCT 120 and will often reference our text "Modern Chemical Technology" by Pecsok. (Available in our library)

4. Be able to demonstrate you are spending time reading the chemical literature.

5. Attendance is required.

Course Objectives:

1. To continue the development of the attitude and background a successful technologist displays.

2. To become keenly aware of the chemical laboratory from a safety standpoint, through not only recognition, but also appropriate calculations.

3. To be able to make sound judgments from a safety standpoint on what types of materials are on-compatible.

4. To be able to safely work with hazardous materials, limit one's overall exposure to them, and correctly dispose of such materials.

5. To realize and begin to think about the large safety and health problems facing laboratories and the world.

> "I do not know what I may appear to the world;
> but to myself I seem to have been only like a boy
> playing on the seashore, and diverting myself in
> now and then finding a smoother pebble or a prettier
> shell than ordinary, whilst the great ocean of truth
> lay all undiscovered before me."
>
> Sir Isaac Newton (1642-1727)

INCT 220
INDUSTRIAL CHEMICAL CALCULATIONS
2 Semester Credits

Mr. Killian
Lab -T--- 10:00 - 10:50
----F 11:00 - 11:50
SCI 314

August 28, 1995
Fall Semester
Office: SCI 324
Phone X 2590

Textbook: "College Chemistry Outline & Biological Analysis," Goldwhite
"SPC Simplified Practical Steps to Quality," Amsden

WEEK OF	TOPIC & ASSIGNMENT	Assignment/Activity
8/28	Introduction, Measurements & Nomenclature	G
9/4	Concentration	G
9/11	Practical & Advanced Problems	Max Quiz I
9/18	Stoichiometry	G
9/25	Practical & Advanced Problems	G
10/2	Gases	Max Quiz II
10/9	Redox	Handout
10/16	Statistics for Analytical Chemists	G Quiz 1
10/23	Practial & Advanced Problems	G
10/30	Introduction to Statistical Process Control	A Quiz 2
11/6	Graphs	A
11/13	Control Charts	A
11/20	Practical and Advanced Problems	A Max Quiz III
11/27	Basic Chemical Engineering Problems	Handout
12/4	Basic Chemical Engineering Problems	Handout
12/11	Finals Week	Quiz 3

Requirements		Grading	
MAX QUIZZES	3 x 75	> 92%	A
QUIZZES	3 x 50	90 - 92	A-
		87 - 89	B+
		83 - 86	B
	375 pts	80 - 82	B-
		77 - 79	C+
		73 - 76	C
		70 - 72	C-
		< 70	D

OTHER CONSIDERATIONS:

1. Homework will be assigned and posted, practice practice practice or perish! You will receive many handouts.

2. However quizzes will come often and quiz grades of less than C- (70%) will require correct homework to be turned in until a quiz of over 70% is recorded.

3. The diet of problems in this class will hopefully contain a number of challenges. Be ready! Expect to expand your thinking.

4. The last two weeks will cover problems that constitute practical chemical, technologial, and engineering stituations.

5. Many analytical, instrumental and general chemistry books can be consulted to try to help develop strategies to solve problems; use these sources.

Class Objectives:

1. To master basic chemical calculations used by virtually all industrial chemists including stoichiometry, concentration, and gas law problems.

2. To sharpen our basic problem solving skills and apply those skills in unique situations.

3. To expand our understanding of units beyond the traditional system.

4. To solve basic chemical engineering and technological type problems.

5. To learn strategy and attack problems with fundamental sound judgement.

6. To use the basic statistics traditionally relied upon in laboratory work.

7. Understand statistical process control and its place in industry.

> "It is a truth very certain that when it is not in our power to determine what is true we ought to follow what is most probable."
>
> Rene Descartes (1596-1650)
> from Discourse on Method

INCT 230
CHEMICAL MANUFACTURE & APPLIED ANALYSIS
4 credits

Mr. Killian
Lecture: Weds 8-8:50 AM
Lab M 3-6
W 3-6
F 10-12

January 9, 1995
Winter Semester

Textbook: "Chemical Technicians' Ready Reference Handbook," Gershon Shugar & Jack T. Ballinger

WEEK OF	TOPIC & LAB ASSIGNMENT	READING ASSIGNMENT
1/9	Introduction to Methodology: Physical Methods	3,24
1/16	Gravimetric Analysis: Gravimetric Iron	15
1/23	Titrimetrics: ASTM Methods	25
1/30	Volumetric Acid/Base : Non-Aqueous Titration	26
2/6	Rodox Analysis: COD	14
2/13	Complexometric Titrations: Water Hardness	16
2/20	Quantitative IR: Aspirin Assay 2 ways	31
2/27	Midterm Notebook Introduction: Individual Problem	10
3/6	SPRING BREAK	
3/13	Esterification Synthesis: Project I	21
3/20	Esterification	34,37
3/27	Pesticide-Active Ingredient Isolation: Project II	12
4/4	Pesticide	13,20
4/11	Dye Preparation: Project III	11,30
4/18	Polymers-Preparation & Characterization: Project IV	17,19
4/25	Polymers	Handout
5/1	FINAL EXAM	

Requirements	
LAB QUESTIONS/REPORTS	150
MIDTERM	125
ATTENDENCE/TECHNIQUE	50
FINAL	125
LAB NOTEBOOK 2ND HALF	150
HOMEWORK	50

Grading	
> 92%	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-
< 70	D

GENERAL CONSIDERATIONS

1. You will often have to consult "Vogel" and other texts in addition to ours to refresh your memory on techniques like distillation recrystalization etc.
2. The 8 HOURS/WEEK IN THE LAB IS MANDATORY. All projects are ongoing! That is when one is finished another starts, or often two are going at once. There is always something to do!! Budget your time, and manage your projects.
3. Homework assignments are assigned regularly, answers will be posted by selected individuals.
4. Learn to ccoperate as part of a small and a large group.

Manufacture Portion:

1. The text and handouts must be read, consulted, and followed in regard to the 4 projects as well as lab book form. The notebook is essential. KEEP UP!
2. The lab notebook grade will be evenly divided between form and content. The content centers on observations, results, preparation and product.
3. The lab notebook should be a hard bound traditional lab book with numbered pages, not the same one used the first half of the term.
4. It is expected that you read independently on the topic of each project from esterification to polymer production etc.

Analytical Portion:

1. No lab reports are required. However, a set of related questions are required upon completion of each analytical exercise. A portion of the grade will be determined by how accurate and precise your analyses are.
2. Reading in addition to your text is recommended and any of the analytical chemistry or quantitative analysis books in our room are available.
3. A lab notebook is required and attention must be paid to entries.

Overall Objectives

1. To reap the rewards of an independent thinker and worker, as well as learning to cooperate with and be part of a team.
2. To gain a broader understanding of basic analytical and synthetic chemistry while working with real world samples.
3. To become safely familiar with a variety of new reagents and new analytical techniques than integrating this knowledge with your basic wet chemical and instrumental skills to solve laboratory problems.
4. To be able to interpret as well as follow directions and produce reliable data, using methods standard to a wide variety of industries as well as less defined synthetic procedures.
5. To maintain a high quality laboratory notebook in content and form.
6. To complete projects in a timely fashion with presentable results.
7. To always, above all, work safely in the lab.

"What is the meaning of it all, Mr. Holmes?" "Ah, I have no data. I cannot tell," he said.

Arthur Conon Doyle
The Adventure of the Copper Beeches, 1892.

Section 10

Enrollment Trends

ENROLLMENT TRENDS

The following table shows the official enrollment count in the ICT program over the past three fall semesters.

	Fall 1993	Fall 1994	Fall 1995
Total program on-campus enrollment	18	13	16
Freshman	1	1	4
Sophomore	6	4	5
Junior	7	3	3
Senior	4	4	2
Unknown class standing	0	1	2

However, the "official" enrollment record always underreports the number of students in the program. For example, 13 students graduated during 1994-95, and 15 students graduated during 1993-94. Presumably, in Fall 1994, most of the 1994 graduates were working on sophomore-level courses in the program, and the 1995 graduates were taking freshman-level classes the same semester. Thus, the overall "actual" enrollment would be on the order of 28 students, rather than the "official" figure of 13.

Why is there discrepancy? One reason is that many ICT students are enrolled in another degree program at the same time; they often obtain both a B.S. degree and an associate's degree from Ferris. If a B.S. plastics student takes ICT classes, s/he may not officially "register" as an ICT student until shortly before graduation.

Another reason for the underreported enrollment is that many students originally sign up for pre-pharmacy, pre-optometry, and other pre-professional programs as freshmen, and make the decision to switch to ICT some time during the freshman year. Obviously, these students do not get counted as ICT students in their first fall semester, yet they are completing all of the required work on the ICT checksheet.

A better measure of the enrollment trends in ICT may be the enrollment in the second-year professional course, INCT 230 (formerly known as ICT 220). This trend is shown in the next table. *Please keep in mind that this shows the numbers of second-year students only; first year students do not take this class* (thus, these figures would be about half the total enrollment of the program in a given year).

	Spring 91-92	Spring 92-93	Winter 93-94	Winter 94-95	Winter 95-96
Enrollment in INCT 230 or ICT 220	11	15	13	11	17

This pattern shows that enrollment in the ICT program has remained fairly steady over the past five years. Each year there has been between 11 and 17 students completing courses in the second-half of the program. The total program enrollment would also be fairly constant, with about 20-30 students taking classes at the first- or second-year level each of the past five years.

The program has been able to comfortably handle this number of students, given the faculty and financial resources available.

Section 11

Program Productivity/Cost

Program Productivity and Cost

Data on the cost of the Industrial Chemistry Technology program were obtained from the Office of Institutional Studies. The most recent year for which data are available is 1993-94 (the first year of the semester system).

The ICT program relies heavily on coursework from the following three areas: industrial chemistry (INCT), lower-level (undergraduate) chemistry (CHEM-L), and lower-level (undergraduate) physics (PHYS-L). The 1993-94 report includes 166 types of courses; courses are segregated by prefix and by level (graduate, upper-level undergraduate, and lower-level undergraduate). The data concerning the main ICT courses are shown in the following table:

Course description	*Course prefix*	*Course level*	*Teaching cost per credit hour*	*Rank*
Industrial Chemistry Technology	INCT	L	$158.02	63
Physics	PHYS	L	$92.37	117
Chemistry	CHEM	L	$75.93	132

The complete table is attached to this section.

According to the course rankings, 38% of all the prefix/level combinations at Ferris have a higher cost than ICT courses, 70% of all such combinations have a higher cost than physics, and 79% of such combinations have a higher cost than (lower-level) chemistry. Physics and chemistry, two of the foundation areas for ICT, can be characterized, without qualification, as low-cost courses. ICT courses have a higher cost, but courses in many other program areas have a considerably higher cost. It should also be remembered that ICT courses constitute 10 credit hours of the 63 hours required for graduation, so they don't contribute greatly to the overall cost of the program.

This latter point is borne out by other data provided by the Office of Institutional Studies: a ranked listing of program teaching costs. Institutional Studies generated this list by looking at all the courses required by a particular program, determining the total teaching cost (instructors' salaries plus fringe benefits) per student for taking all these courses, and then dividing this figure by the number of credit hours in the program. This is the best figure on campus for the cost or productivity of an overall program, because it includes *all* the courses in a program.

Out of 121 programs on the list, this is how ICT fared:

Program Name and Degree	*Credit hours*	*Total teaching cost*	*Total teaching cost per credit hour*	*Rank*
Industrial Chemistry Technology AAS	63	$6269.18	$99.51	98

As shown above, the ICT program ranks 98th out of 121 programs. That is, more than 80% of all the programs at Ferris have a greater cost per student credit hour than the ICT program.

To look at these numbers from another point of view, we marked with an asterisk all those two-year programs that have a significant laboratory component (excluding pre-professional programs, such as pre-optometry, pre-pharmacy, etc., whose graduates typically go on to more education, rather than seeking immediate employment). The results may be surprising. *Only one two-year laboratory intensive program excluding pre-professional programs* (the radiography program) *is less expensive than the ICT program.*

Again, the complete table showing ranked program costs has been attached to this section.

Clearly, using the criterion of program cost per teaching hour, the ICT program is an excellent program for this institution.

During the semester transition, the curriculum of the ICT program was planned to maximize its reliance on courses that could be taken by students in other programs. The INCT courses in the program were carefully designed to take advantage of the knowledge base laid by the other courses.

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Social Sciences	SSCI	U	$827.39
Manufacturing Engineering Technology	MFGE	L	$492.65
Allied Health Science	CAHS	L	$462.10
Education	EDUC	G	$425.46
Insurance	INSR	U	$420.33
Dental Technology	DTEC	L	$387.49
Photography	PHOT	L	$361.51
Pharmacy Administration	PHAD	G	$359.61
Technical and Professional Communication	TCOM	U	$318.95
Civil Engineering Technology	CETM	L	$308.98
Computer Science	CPSC	U	$307.34
Printing Technology	PTEC	L	$307.26
Social Work	SCWK	U	$302.75
Heavy Equipment Service Engineering Technology	HSET	U	$285.08
Automotive Machine Technology	AEMT	L	$283.61
Education	EDUC	L	$268.42
Technical Drafting and Tool Design	TDTD	L	$260.25
Welding Engineering Technology	WELD	L	$250.54
Optometric Technology	OPTC	L	$249.51
Electrical and Electronics Engineering Technology	EEET	U	$242.32
Technical Illustration	TECL	L	$232.48
Mathematics	MATH	U	$231.20
Electrical and Electronics Engineering Technology	EEET	L	$227.35
Mechanical Engineering Technology	MECH	L	$223.01
Computer Information Systems Management	CISM	G	$220.36
Welding Engineering Technology	WELD	U	$217.45

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Heavy Equipment Technology	HEQT	L	$215.81
Plastics Engineering Technology	PLTS	U	$215.46
Printing Management	PMGT	U	$213.47
Education	EDUC	U	$213.41
Pharmacy Practice	PHPR	G	$212.12
Recreation Management and Leisure Studies	RMLS	U	$209.80
Automotive Body	ABOD	L	$209.65
Architectural Technology	ARCH	E	$208.71
Automotive/Heavy Equipment Management	AHEM	U	$205.24
Medical Record Information Systems	MRIS	U	$202.91
Heating,Ventilation, Air Conditioning & Refrig Tec	HVAC	U	$199.04
Computer Aided Design	CADD	L	$192.21
Clinical Laboratory Science	CLLS	U	$189.38
Opticianry	OPHT	L	$188.71
Manufacturing Tooling Technology	MFGT	L	$188.67
Insurance	INSR	L	$187.67
Journalism	JRNL	L	$182.44
Horticulture	HORT	L	$182.26
Automotive Service Technology	AUTO	L	$177.17
Social Work	SCWK	L	$176.48
Nursing	NURS	L	$176.33
Physical Science	PHSC	L	$174.72
Advertising	ADVG	U	$174.65
Accountancy	ACCT	G	$170.10
Industrial and Environmental Health Management	IEHM	U	$169.39
Retailing	RETG	L	$167.79

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Heating,Ventilation, Air Conditioning & Refrig Tec	HVAC	L	$166.05
Construction Management	CONM	L	$166.02
Construction Management	CONM	E	$165.91
Architectural Technology	ARCH	L	$165.05
Computer Information Systems	ISYS	E	$164.37
Computer Information Systems	ISYS	U	$164.37
Surveying Engineering	SURE	U	$164.11
Product Design Engineering Technology	PDET	U	$163.13
Optometry	OPTM	G	$161.71
Building Construction	BCTM	L	$159.59
Industrial Chemistry Technology	INCT	L	$158.02
Television Production	TVPR	L	$153.80
Economics	ECON	U	$153.35
Pharmaceutics	PHAR	U	$152.93
Plastics Engineering Technology	PLTS	L	$152.25
Public Relations	PREL	U	$150.33
Manufacturing Engineering Technology	MFGE	U	$147.47
English	ENGL	U	$144.31
Advertising	ADVG	E	$144.24
Optometry	OPTM	U	$141.32
Computer Information Systems	ISYS	L	$140.82
Court and Freelance Reporting	CSYS	L	$136.47
Facilities Management	FMAN	U	$136.38
Television Production	TVPR	U	$136.03
Office Systems Management	OSYS	L	$135.51
Clinical Laboratory Science	CLLS	L	$135.14

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Communication	COMM	U	$133.15
80 Construction Management	CONM	U	$132.60
Chemistry	CHEM	U	$130.30
Humanities	HUMN	U	$127.75
International Business	INTB	U	$127.13
Product Design Engineering Technology	PDET	E	$127.13
Literature	LITR	L	$123.51
Computer Science	CPSC	L	$122.69
Dental Hygiene	DHYG	L	$122.40
Respiratory Care	RESP	L	$122.34
Management	MGMT	U	$121.51
90 Office Systems Management	OSYS	U	$120.62
Nuclear Medicine	NUCM	L	$119.83
Nursing	NURS	U	$119.41
Medical Record Information Systems	MRIS	L	$117.72
Metallurgy	MATL	L	$117.26
Literature	LITR	U	$116.59
Accountancy	ACCT	L	$115.05
Accountancy	ACCT	E	$112.35
Accountancy	ACCT	U	$112.35
Food Service Management	FSMT	L	$111.40
100 Pharmacology	PHCL	U	$111.21
Allied Health Science	CAHS	U	$110.14
Health Care Systems Administration	HCSA	U	$109.27
Child Development	EDCD	L	$108.39
Statistics and Quantitative Methods	STQM	U	$107.68

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Nuclear Medicine	NUCM	U	$107.30
Pharmaceutical Chemistry	PHCH	U	$106.88
English	ENGL	L	$105.13
Statistics and Quantitative Methods	STQM	G	$104.82
Marketing	MKTG	U	$103.28
Engineering Graphics	EGRG	L	$102.32
Finance	FINC	L	$102.19
Visual Communication	VISC	L	$101.92
Retailing	RETG	U	$100.44
Biology	BIOL	L	$94.85
Law	LLAW	L	$93.86
Communication	COMM	E	$93.33
Physics	PHYS	L	$92.37
Art	ARTS	L	$91.66
Computer Aided Design	CADD	U	$91.29
Criminal Justice	CRIM	L	$89.87
Biology	BIOL	U	$89.26
Finance	FINC	U	$87.98
Real Estate	REAL	L	$86.31
Technical and Professional Communication	TCOM	E	$86.11
Economics	ECON	L	$83.38
Pharmacology	PHCL	G	$82.19
History	HIST	U	$81.97
Communication	COMM	L	$79.72
Political Science	PLSC	L	$79.60
Anthropology	ANTH	L	$79.13

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Geography	GEOG	L	$77.16
Chemistry	CHEM	L	$75.93
Surveying Engineering	SURE	L	$75.42
Pharmacy Practice	PHPR	U	$73.88
Marketing	MKTG	L	$73.49
Spanish	SPAN	L	$73.29
Psychology	PSYC	L	$73.03
Psychology	PSYC	U	$72.81
Metallurgy	MATL	U	$72.77
Mathematics	MATH	L	$72.09
Professional Golf Management	PGMG	U	$72.02
Professional Golf Management	PGMG	L	$70.35
Humanities	HUMN	L	$69.95
Insurance	INSR	E	$69.20
Criminal Justice	CRIM	U	$67.88
University	UNIV	L	$66.69
Art History	ARTH	L	$65.57
Business Law	BLAW	U	$64.45
Business Law	BLAW	L	$63.60
Health Education	HLTH	U	$60.27
Professional Tennis Management	PTMG	U	$58.46
Radiography	RADI	L	$54.43
Sociology	SOCY	U	$53.86
Political Science	PLSC	U	$53.28
Physical Education	PHED	L	$50.16
Health Education	HLTH	L	$49.46

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Teaching Cost per Student Credit Hour by Prefix and Level - Ranked High to Low 1993-1994 Data

(Teaching costs Include Fringe)

Course Description	Course Prefix	Course Level	Teaching Cost Per Credit Hour
Advertising	ADVG	L	$46.42
History	HIST	L	$45.78
Business	BUSN	L	$45.46
Physical Education	PHED	U	$42.07
Recreation Management and Leisure Studies	RMLS	L	$42.06
Pharmacy Administration	PHAD	U	$41.91
Professional Tennis Management	PTMG	L	$41.76
Sociology	SOCY	L	$41.19
Health Care Systems Administration	HCSA	L	$39.01
Hospitality Management	HSMT	U	$35.67

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs	
Career and Tech Educ/Career & Tech Instr MS	32	$12,418.93	$388.09	
Career and Tech Educ/Postsec Admin MS	32	$11,821.00	$369.41	
Pharmacy/Add-on Pharm.D (Yrs 6 & 7)	71	$25,878.06	$364.48	
Career and Tech Educ/Human Res Dev MS	31	$11,081.63	$357.47	
Career and Tech Educ/Admin Cert MS	32	$10,625.14	$332.04	
Dental Technology AAS	63	$18,706.58	$296.93	*
Printing Technology AAS	76	$19,537.38	$257.07	*
Pharmacy/Track-in Pharm.D (Yrs 3,4,5 & 6)	149	$35,754.15	$240.77	
Automotive Machine Technology AAS	72	$15,504.51	$215.34	*
Optometric Technician AAS	63	$12,345.77	$195.96	*
Technical Drafting and Tool Design AAS	67	$12,587.64	$187.88	*
Info Systems Mgt/Info Systems Emphasis MS	31	$5,805.74	$187.28	
Welding Technology AAS	67	$12,485.13	$186.35	*
Technical Illustration AAS	64	$11,230.53	$175.48	
Automotive Body AAS	67	$11,731.86	$175.10	*
Heavy Equipment Technology AAS	67	$11,694.75	$174.55	*
Electrical/Electronics Engr BS (Yrs 3 & 4)	78	$13,567.11	$173.94	
Industrial Electronics Technology AAS	66	$11,290.38	$171.07	*
Wage Earning Home Economics Educati BS	103	$17,319.15	$168.15	
Civil Engineering Technology AAS	66	$11,061.00	$167.59	*
Business Education BS	103	$17,258.09	$167.55	
Technical Education BS	103	$17,217.48	$167.16	
Allied Health Education BS	104	$17,274.18	$166.10	

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs	
Info Systems Mgt/Acct Emphasis MS	31	$5,071.87	$163.61	
Social Work BS	128	$20,846.37	$162.86	
Plastics Engineering Tech BS (Yrs 3 & 4)	65	$10,476.25	$161.17	
Mechanical Engineering Technology AAS	68	$10,855.32	$159.64	*
Manufacturing Engineering Tech BS (Yrs 3&4)	78	$12,418.55	$159.21	
Manufacturing Tooling Technology AAS	68	$10,759.56	$158.23	*
30 Welding Engineering Technology BS (Yrs 3&4)	71	$10,994.95	$154.86	
Automotive Service Technology AAS	72	$10,968.70	$152.34	*
Product Design Engineering Tec BS (Yrs 3&4)	69	$10,497.27	$152.13	
Mathematics Education BS	115	$17,490.00	$152.09	
Opticianry AAS	69	$10,445.90	$151.39	*
Optometry OD (Yrs 3,4,5 & 6)	163	$24,545.22	$150.58	
Training in Business and Industry BS	100	$15,034.98	$150.35	
Vision Science BS (Yrs 3 & 4)	82	$12,080.45	$147.32	
HVACR Engineering Technology BS (Yrs 3 & 4)	64	$9,261.32	$144.71	
Architectural Technology AAS	66	$9,520.28	$144.25	*
40 Hvy Equip Serv Eng Tec/Mfg Opt BS (Yrs 3&4)	65	$9,245.77	$142.24	
Pharmacy BS	94	$13,270.05	$141.93	
Automotive and Heavy Equip Mgt BS (Yrs 3&4)	70	$9,909.24	$141.56	
Printing Management BS (Yrs 3 & 4)	64	$9,039.79	$141.25	
HVACR Technology AAS	68	$9,575.21	$140.81	*
Hvy Equip Serv Eng Tec/Maint Opt BS(Yrs 3&4)	66	$9,065.85	$137.36	
Ornamental Horticulture Technology AAS	65	$8,923.58	$137.29	*

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs
Journalism AAA	63	$8,471.91	$134.47
Building Construction Technology AAS	63	$8,460.94	$134.30
Actuarial Science BS	120	$16,086.56	$134.05
Biology Education BS	120	$16,050.27	$133.75
Nursing ADN	75	$9,699.47	$129.33
Technical and Professional Communic BS	125	$16,037.30	$128.30
Chemistry Education BS	126	$16,164.75	$128.29
Court and Freelance Reporting AAS	71	$9,049.41	$127.46
Construction Management BS	136	$17,191.78	$126.41
Applied Mathematics BS	120	$15,038.76	$125.32
Child Development AAS	70	$8,738.73	$124.84
Medical Technology (Integrated) BS	139	$17,334.10	$124.71
Medical Tech (Career Mobility) BS (Yrs 3&4)	72	$8,910.01	$123.75
Television Production BS	129	$15,649.84	$121.32
Plastics Technology AAS	70	$8,487.73	$121.25
Rec Ldshp & Mgt/Corp Fitness-Well Track BS	119	$13,965.33	$117.36
Rec Ldshp & Mgt/Leisure Service Track BS	118	$13,842.24	$117.31
Administrative Assistant AAS	66	$7,703.44	$116.72
Computer Information Systems BS	127	$14,819.79	$116.69
Medical Laboratory Technology AAS	73	$8,476.81	$116.12
Accountancy/Computer Information Sy BS	127	$14,739.97	$116.06
Office Automation Systems BS	120	$13,922.96	$116.02
Facilities Management BS (Yrs 3 & 4)	67	$7,720.46	$115.23

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs
Dental Hygiene AAS	77	$8,837.98	$114.78
Insurance BS	124	$14,060.06	$113.39
Surveying Engineering BS	138	$15,636.76	$113.31
Health Information Management BS	127	$14,350.63	$113.00
Public Relations BS	127	$14,327.75	$112.82
Pre-Teaching (Elementary or Secondary) AA	65	$7,270.31	$111.85
Computer Information Systems/Market BS	142	$15,807.61	$111.32
Insurance/Real Estate BS	124	$13,639.58	$110.00
Respiratory Care AAS	73	$7,999.40	$109.58
Advertising BS	125	$13,585.16	$108.68
Rec Ldshp & Mgt/Outdoor-Adv Edu Track BS	124	$13,456.59	$108.52
Accountancy (Cost/Managerial Track) BS	123	$13,306.98	$108.19
Rec Leadership and Mgt/Aquatic Track BS	123	$13,287.04	$108.02
Nursing BSN (Yrs 3 & 4)	60	$6,457.53	$107.63
Nuclear Medicine Technology AAS	69	$7,408.67	$107.37
Accountancy/Finance BS	137	$14,514.23	$105.94
Retailing AAS	67	$7,081.93	$105.70
Health Information Technology AAS	66	$6,966.40	$105.55
Food Service Management AAS	65	$6,832.69	$105.12
International Business BS	127	$13,318.47	$104.87
Business Administration BS	121	$12,641.79	$104.48
Small Business Management BS	120	$12,426.85	$103.56
Operations Management BS	125	$12,897.42	$103.18

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs
Retailing BS	127	$13,016.93	$102.50
Marketing/Sales BS	127	$12,982.22	$102.22
Quantitative Business BS	125	$12,656.74	$101.25
Health Systems Management BS	131	$13,234.01	$101.02
Nuclear Medicine Technology BS	131	$13,110.61	$100.08
Industrial Chemistry Technology AAS -98	63	$6,269.18	$99.51 *
Business Management BS	123	$12,232.81	$99.45
Human Resource Management BS	123	$12,221.18	$99.36
Finance BS	125	$12,366.89	$98.94
Visual Communication AAS	65	$6,379.84	$98.15
Real Estate AAS	62	$6,075.39	$97.99
Marketing/Professional Golf Managem BS	128	$12,459.07	$97.34
General Business AAS	63	$6,119.63	$97.14
Legal Assistant AAS	64	$6,148.18	$96.07
Marketing BS	127	$11,997.29	$94.47
Pre-Law AA	59	$5,537.58	$93.86
Marketing/Professional Tennis Manag BS	129	$12,013.79	$93.13
CJ/Generalist-Corrections BS (Yrs 3 & 4)	65	$6,015.42	$92.54
Biotechnology BS	134	$12,395.90	$92.51
Pre-Criminal Justice AA	63	$5,751.40	$91.29
Applied Biology BS	123	$11,079.62	$90.08
Pre-Optometry AS	101	$8,971.17	$88.82
Liberal Arts AA	60	$5,309.81	$88.50

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Ranked Listing of Program Teaching Costs per Student Credit Hours
1993-1994 Data
(Teaching Costs Include Fringes)

Program Name and Degree	Credit Hours	Total Teaching Cost	Total Teaching Cost / Cr Hrs
Pre-Mortuary Science AS	66	$5,826.65	$88.28
Pre-Dentistry AS	62	$5,460.48	$88.07
Radiography AAS	82	$6,808.78	$83.03 *
Pre-Pharmacy AS	64	$5,312.54	$83.01
120 CJ/Law Enforcement Specialist BS (Yrs 3 & 4)	64	$5,309.54	$82.96
Hospitality Management BS (Yrs 3 & 4)	69	$5,588.06	$80.99

Thursday, October 20, 1994 Source: Office of Institutional Studies (Draft)

Section 12

Conclusions

Conclusions

In this section, the twelve areas of analysis raised by the APRC manual are addressed.

i. Centrality to FSU mission

The mission statement of both the Department of Physical Sciences and the Industrial Chemistry Technology program were constructed and approved within the context of the overall FSU mission. These documents are both readily available. (See, for example, the unit action plans for the INCT program and the Physical Sciences Department from March, 1994, attached to this section. The last page of these documents has the most recent statement of program and departmental mission and purpose.)

The INCT program from its inception has striven to place people in an environment of preparation for positions in industrial research, analysis, and quality control. In preparing people for the ever-changing world of Chemical Technology, the program has remained close to the basic Ferris tradition of preparing students to quickly become competent members of the industrial workforce. The graduate response section directly addresses this question, and it reinforces (especially in the comments) that the mission of preparation is being maintained.

ii. Uniqueness and visibility.

The program is only one of a few in the state of Michigan. Our only competitors are located at community colleges; there is no other comparable program at a four-year state-supported university. In fact, one of our advisory board members has commented in the past that his employer seeks graduates from the Ferris INCT program first because the students "have obtained an associate's degree with a well-rounded, university-type education."

Likewise, the pool of students throughout the entire Midwest with such a curriculum is limited. At the same time, several states in the Midwest (including the state of Michigan) rank among the top ten in the nation in chemical productivity. Up until about 1985, the program primarily has placed graduates in jobs in Michigan since then the program's uniqueness has been so recognized throughout the Midwest that employers from other states (Indiana, Illinois, and, starting this year, Ohio) have been requesting the resumes of our graduates-to-be.

iii. Service to state and nation.

As mentioned in the last part, the INCT program is providing a service to employers in both the state of Michigan and throughout the Midwest.

iv. Demand by students.

According to data shown earlier in this report, the demand by students has remained constant over the last five years. This has been accomplished partly through the constant pool of students available at Ferris (i.e., undecided science students who choose to obtain a two-year degree after sampling the chemistry courses at Ferris, realizing that they enjoy working in a lab) and partly through a more active recruitment campaign for future freshman by writing letters and calling prospective students.

v. Quality of instruction.

With regard to the instruction of students, the results of the surveys (of students, graduates, and advisory board members in the chemical industry) are all quite clear. The student and faculty perceptions of the program and its instruction are quite high and figure to remain so as long as student preparation meets industrial demands.

vi. Demand for graduates.

The demand for graduates in the chemical industry has been cyclical. Fortunately for our graduates, when the large chemical industry has been in a downturn (for example, the lawsuits against Dow Corning over the past few years have put a damper in its hiring plans), other smaller companies have needed our graduates to perform quality control or environmental testing.

Calls from employers are often received because of someone's contact with one of our graduates who is working at Dow, Upjohn, or some other local Michigan company. This for years was the method by which INCT gained visibility in the industrial sector.

However, over the last several years a more aggressive letter-writing campaign in concert with Chicago Tribune job advertising has been undertaken. The INCT coordinator took note of possible employers who might have an interest in INCT graduates, and wrote letters to such companies to let them know about the training of the students and how they might be able to contribute to the companies. As a result, not only are more Michigan companies seeking our graduates, but companies with a more Midwestern base like Eli Lilly and Proctor & Gamble are coming to campus to recruit.

A total list of graduates over the past nine years and where they started after graduation from ICT is included.

The INT program is expanding its area of service from only a few prime Michigan companies to a more diverse set of Michigan as well as Midwestern based companies. Expansion serves two purposes, not only is the visibility of the program increased, but graduates are not so restricted by the hiring trends of only a few select companies.

Demand in Michigan and the Midwest for INCT graduates is indeed cyclical, but the demand continues to persist even when a few companies are not hiring. The current demand for graduates is predicted to increase, due to the current economic health of the traditional large chemical companies. The labor market analysis in a previous section attests to this point. In fact, this year we are expecting that demand will be sufficiently high that some (if not several) of the Ferris graduates will receive multiple job offers.

vii. Service to non-majors

The INCT program does not provide, directly, a large degree of service to non-majors. However, there are some ways in which non-majors benefit from the existence of the INCT program.

First, the program annually enrolls several students whose primary educational goal is *not* to work in the chemical industry, but rather, to pursue some other scientific career. These students have come from the College of Allied Health (pursuing B.S. degrees related to environmental health), the College of Technology (pursuing B.S. degrees in plastics), the College of Education (pursuing B.S. degrees in secondary science education), the College of Arts and Sciences (pursuing B.S. degrees in biotechnology) as well as the College of Pharmacy. They do enroll in the INCT program, but they do so as a way to obtain extra practical experience in chemistry that will enhance their job prospects and mobility in their primary career choice. For example, a student who completes both a biotechnology degree and an INCT degree may have greater opportunities to work in the research division of a pharmaceutical company, such as Upjohn, due to exposure to a wider variety of instrumentation. While these students are, technically, INCT majors, in essence they are not planning the same career path, as technicians, as our other majors.

Second, some of the INCT courses can be taken by students outside the program. The first course in the INCT sequence, INCT 120 (Orientation to Industrial Chemical Technology) is open to all students who have an interest in the chemical technology field, regardless of major. The second course, INCT 125 (Safety and the Chemical Laboratory) is valuable for students planning to work in any type of a chemical lab, including those students who are thinking about teaching chemistry at the secondary level.

Third, the very existence of the INCT program provides a "critical mass" of students that makes it economically feasible for our department to offer some lab-intensive (expensive)

courses to other programs. For example, both INCT students and biotechnology majors are required to take CHEM 231 (quantitative analysis). Both INCT students and secondary science (chemistry) teaching majors are required to take CHEM 317 (instrumental analysis).

viii. Facilities and equipment.

Facilities. Earlier in this report there was a page outlining the amount of laboratory space available in our department. The portion of space devoted exclusively to industrial chemistry has been two laboratories with an interconnecting office and a small storage room in back. The two labs allow the program to dedicate one lab solely to instrumental work, and another lab to preparative work. In chemistry, it is important to keep instruments isolated in a room segregated from spaces where chemicals will be mixed and reacted, because the fumes from such reactions can eventually degrade the instruments' performance, even if the reactions are carried out in a fume hood. Historically, these two labs have provided sufficient working space for the numbers of students enrolled in the program.

However, there have been two major problems associated with the Industrial Chemistry space. First, the two INCT labs are located in one corner of one wing of the Science Building, while the quantitative chemistry lab is located in the far corner of the opposite wing. During the Winter Semester, when INCT students are conducting long-term projects, they need to rely on the facilities of all three rooms. There are several instances when an INCT student must move from one room to another, and the instructor cannot be physically present in each room to provide supervision as close as desired. Second, there has been a lack of working hoods to enable several students to run long-term projects at once.

Both of these problems will be addressed by the remodeling project currently underway in the College of Arts and Sciences. The quantitative chemistry lab will be relocated to a room adjacent to the Industrial Chemistry labs. Extra hoods will be built into the Industrial Chemistry labs. Although no additional space will be devoted to INCT, it is not believed that such space was necessary.

Equipment. When a PRP report was last written for the INCT program in 1991, equipment was identified as one of the weaknesses of the program. At that point, we were in the middle of an equipment-acquisition process intended to upgrade our holdings so that students could be exposed to most major categories of equipment before they entered the workforce. Employers did not seem concerned about the "brands" of equipment that our students used, but they did expect students to be familiar with the major types used on the job especially if students were going into research or quality control settings.

One important reason that we were able to engage in a major equipment upgrade program over the last several years was the availability of money from the Carl Perkins funds for

two-year programs. The list of equipment presented in this document is far more extensive than the one we presented five years ago. Our equipment holdings could be considered at least adequate for the present job of preparing students for industry.

However, we do have a concern for upgrading our equipment holdings in the future. The guidelines for eligibility for Carl Perkins funding were recently rewritten at Ferris, excluding the INCT program from consideration for the equipment grants. Thus, we can no longer rely on this source of funds that served us so well for so many years.

There are two equipment items which we do need in the near future to maintain the "hands-on" quality of our program: an FT-IR (Fourier transform infrared spectrophotometer) and an FT-NMR (Fourier transform nuclear magnetic resonance spectrophotometer). Both instruments should be used by INCT students in a variety of classes. In organic chemistry classes, the students need to learn how to characterize compounds with these instruments. In analytical and industrial chemistry classes, the instruments can be used for both characterization and quantification. The department does not currently possess and FT-NMR machine. While the department does have an FT-IR, due to the numbers of students, they do not currently get sufficient practice with the characterization of organic chemistry compounds.

The FT-NMR is sufficiently expensive that the department cannot possible afford to purchase one out of its departmental budget (its cost exceeds the annual departmental supply-and-expense budget). The INCT program coordinator is currently working with members of the Industrial Advisory Board to see if a donation might be possible from one of chemical companies in Michigan.

ix. Library information services

While many programs have a difficulty with insufficient holdings in the library, the INCT program does not. This program has a greater requirement for journals than for books, because students working on special projects need to research the recent methods presented in technical journals. As a part of the preparation for the American Chemical Society accreditation process, Rick Bearden (the program's liaison librarian) prepared a list of journals that have had relevance for INCT students (as well as other students in chemistry classes), along with the annual cost of supplying these journals. This list is attached as an appendix to this section.

With the availability of on-line searches through the library, students are able to readily identify articles that would be appropriate for their projects. If the library does not have the specific journal required, it is able to obtain a copy of the article in a reasonable amount of time.

Each fall, beginning students in the INCT program are given an introduction to the library, its holdings, and its searching capabilities by one of the members of the library's professional staff.

It should be noted that Rick Bearden has been tremendously supportive of the INCT program. Because he was trained in chemistry, it is very easy for him to relate to the needs expressed by the INCT coordinator.

x. Cost.

This is an area that can be difficult to quantify. One way of measuring the cost is the expense of providing instruction for students. As mentioned before, INCT students obtain their training not only in the INCT courses, but also through their work in chemistry, physics, mathematics, and computer science courses. Reports produced through institutional studies indicates that among all the programs at Ferris, the instructional cost of the INCT program can be characterized as moderately low. In fact, among the two-year laboratory-intensive programs at Ferris, the overall cost of providing education to the students is extremely low.

Another cost of the program is the day-to-day expense in providing materials and supplies for the labs. The main INCT lab course, INCT 230, is a sophomore-level laboratory in which students carry out long term projects. The day-to-day cost per section of running these labs is comparable to other sophomore-level courses offered in the department (organic chemistry, analytical chemistry). The biggest laboratory expense associated with INCT is equipment (especially instrumentation). In order to provide students with the instruments they need, the coordinator has been successful in obtaining some donations from chemical companies who hire the graduates. For example, a few years ago there was a donation of self-contained HPLC (liquid chromatography) units, which are often used in research in a pharmaceutical company. However, since the typical instrument costs about $10,000-$25,000, the department usually cannot afford to buy instruments for this one program solely out of its budget (about $50,000 annually). As mentioned earlier, with the lack of Carl Perkins funds to purchase new instruments and equipment, there is a concern that in the future INCT students will not be exposed to a well-equipped laboratory before they seek employment.

xi. Faculty: professional and scholarly activities.

Only one faculty member, Bill Killian, is permanently assigned to the program as instructor and coordinator. Because he is the only Physical Sciences Department member who serves as a program coordinator, his work in professional activities is more geared towards industrial work than other faculty members. For several summers he has found off-campus assignments with various companies (including Argonne National Laboratory, the Upjohn Company, and Dow Chemical Company). This has helped keep him on the "cutting edge"

of techniques used in chemistry corporations, providing him with new expertise that he can bring back to the students each year. One year, in particular, he served as a safety officer, and has since been more cognizant of ensuring that the department adheres to good safety practices.

A vita for Bill Killian, the INCT program coordinator, is attached to this section as an appendix, providing further information about his background.

xii. Administration effectiveness.

The administration of this program has been divided between the INCT program coordinator and the Physical Sciences department head. The program coordinator has primarily been responsible for recruiting students, advising students, making contacts with employers, and arranging for student tours of chemical companies. The department head has been responsible for setting aside a sufficient portion of the departmental budget for the day-to-day operation of the program and for ensuring that a suitable schedule of INCT and chemistry courses is built. The cooperation between these two individuals has been excellent, so the local administration effectiveness is very good.

FERRIS STATE UNIVERSITY

STRATEGIC PLANNING TO IMPROVE INSTITUTIONAL EFFECTIVENESS:

UNIT ACTION PLANS FORM

Division: Academic Affairs

College: Arts and Sciences

Department/Unit: Industrial Chemistry Technology Program (Phy. Sci. Dept.)

Primary Contact Person: Bill Killian, Coordinator

Phone: 592-2590

MARCH, 1994

I. Goals (What are you trying to accomplish?)	II. Major Activities and Processes (What will be done to implement the goal?) (Who, with whom and when will the effort take place?)	III. Expected Outcomes (What changes will result for whom?) (What will students be able to do?) (What are the expected results?)
Goal 1: On the average graduate and place 12-16 students per year from the ICT program.	1) Program coordinator will recruit students by visiting all levels of freshman/sophomore chemistry classes.	1) 12-18 applicants per year.
	2) Program coordinator will personally follow-up on perspective students from outside.	2) 12-18 applicants per year.
	3) Consult with advisory board to develop recruitment statistics involving them.	3) 12-18 applicants per year.
	4) Expand the opportunities for graduates by contact with employers and universities.	4) 90% placement rate into jobs or further education.
Goal 2: Students will learn how to communicate as part of a team and to work collaboratively and safely in the laboratory.	1) Students will have increasing opportunities to perform laboratory project work simulating the industrial laboratory as part of their education.	1) Improved laboratory notebook skills.
		2) Greater student confidence in modern team-oriented laboratory setting.
Goal 3: Students will obtain a basic background in the concepts, theories, and applications of chemistry.	1) Students will complete the foundation science classes emphasizing basic theory and problem solving.	1) Ability of students to analyze data and perform calculations.
	2) Annual review of ICT program for courses and course content.	2) Updated background provided to student in courses.

IV. Indicators/Sources (How do you know?) (Where did data come from?) (What are the performance measures?)	V. Reporting Process (To whom will results be reported?)	VI. Resource Requirements, if any.	VII. Link to Strategic Plan
1) Program enrollment statistics.	1) Program coordinator, department head, and advisory board.		1C, 4C, 4D, 9B
2) Program enrollment statistics.	2) Program coordinator, department head, and advisory board.	2) Phone/mail costs	
3) Program enrollment statistics.	3) Program coordinator, department head, and advisory board.	3) Costs for advisory board meeting.	
4) Job placement and academic placement statistics.	4) Program coordinator, department head, and advisory board.	4) Costs for telephone calls.	
1) Evaluation of laboratory notebooks and student oral/written reports.	1) Program coordinator, selected department faculty		1A, 3A, 3C
2) Successful completion of assigned laboratory projects.	2) Program coordinator, department head, and advisory board.		
1) Grades in classes.	1) Program coordinator.		2A, 3B
1) Feedback from employers			
2) Annual Report by program coordinator	2) Program coordinator, department head, and advisory board.		

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VIII. Statement of Unit Mission

Statement of unit mission, as it relates to the unit's role in carrying out the University-wide mission.

Mission:

The Industrial Chemistry Technology (ICT) program serves the state of Michigan and Midwest by educating students over a two-year period to work as chemical technicians. This program provides students with a balanced background in both the theory and application of the sciences, especially chemistry. Graduates of this program are equipped with the skills to successfully obtain entry-level employment in the chemical, pharmaceutical, or other related industries and to pursue further education in chemistry or other degree programs.

Purposes:

1. To serve a wide array of students of varying abilities who have an interest in careers in the chemical and related industries.
2. To provide students with an education that blends a background in the liberal arts and sciences, including the science of chemistry, with training in the applied science of chemical technology.
3. To continue revising and updating the program so that it prepares students to make the transition from the university to industry..

IX. Matrix of Strategic Goals and Strategies

Indicate the unit's role in carrying out the University-wide Strategic Plan by circling the goals and/or strategies the unit will address: (Circle all that apply)

1	2	3	4	5	6	7	8	9
(1A)	(2A)	(3A)	4A	5A	6A	7A	8A	9A
1B	2B	(3B)	4B	5B	6B	7B	8B	(9B)
(1C)	2C	(3C)	(4C)	5C	6C	7C	8C	9C
1D		3D	(4D)	5D	6D	7D	8D	9D
1E			4E	5E	6E	7E	8E	9E
						7F	8F	
							8G	
							8H	

FERRIS STATE UNIVERSITY

STRATEGIC PLANNING TO IMPROVE INSTITUTIONAL EFFECTIVENESS:

UNIT ACTION PLANS FORM

Division: Academic Affairs

College: Arts and Sciences

Department/Unit: Physical Sciences

Primary Contact Person: Jeff Christafferson, Chair, Departmental Planning Committee

Phone: 592-2585

MARCH, 1994

I. Goals (What are you trying to accomplish?)	II. Major Activities and Processes (What will be done to implement the goal?) (Who, with whom and when will the effort take place?)	III. Expected Outcomes (What changes will result for whom?) (What will students be able to do?) (What are the expected results?)
Goal 1: Continue to improve the departmental curriculum to meet the overall university mission.	1) Evaluate the general education component (including scientific understanding, critical thinking skills, problem solving skills, and collaborative skills) of courses and programs.	1) A review of entire curriculum for general education component, leading to revision, development, and possible elimination of courses.
	2) Develop a physics teaching minor.	2) Increased numbers of graduates with degrees in the sciences.
	3) Develop an applied chemistry bachelor's degree.	3) Increased numbers of graduates with degrees in the sciences.
Goal 2: Improve the academic performance of students in physical sciences courses.	1) Analyze the baseline performance of students in physical science courses, in order to develop policies for student placement and advancement.	1) Improved students success rate in courses.
	2) Employ strategies to enhance student retention in courses, including opportunities for supplemental instruction.	2) Improved student success rate in courses.
	3) Develop strategies to enhance the teaching of concepts required in subsequent courses.	3) Improved student performance in subsequent courses.
Goal 3: Determine how to assess students for scientific literacy.	*Short-term activity:* 1) Review and refine the definition of scientific literacy (understanding).	1) A clear definition that can guide the implementation of course outcomes and the design of assessment tools.
	Long-term activity: 2) Develop assessment tools for the types of students served by the department.	2) Satisfactory student demonstration (depending upon the type of student) of scientific literacy.
Goal 4: Provide greater opportunities for faculty development.	1) Support in-house lectures and workshops related to the improvement of instruction.	1, 2) Increased faculty awareness about their area of specialty and teaching strategies.
	2) Support external activities of faculty related to professional development.	

IV. Indicators/Sources (How do you know?) (Where did data come from?) (What are the performance measures?)	V. Reporting Process (To whom will results be reported?)	VI. Resource Requirements, if any.	VII. Link to Strategic Plan
1) Review of the entire departmental curriculum by the Curriculum Committee	1) Department		2A, 3A, 3B
2) Program enrollment statistics.	2) Department	2, 3) More departmental faculty	
3) Program enrollment, completion, and employment statistics.	3) Department		
1, 2, 3) Rates of student withdrawals and failures	1, 2, 3) Department	More departmental staff Sufficient funds for tutorial services to aid physical science students	4A, 4B, 4C
1) Curriculum Committee responsible for ensuring that a statement is passed by the department within a year. 2) Student scores on trial forms of assessment instrument(s).	1) Department	1, 2) Sufficient funds for faculty development (see Goal 4.)	1B
1) Annual report of the Faculty Development and Travel Committee regarding the number and scope of activities supported. 2) Reports by individual faculty members to the department	1, 2) Department	1, 2) Increased budget allocations to department to sufficiently fund faculty development.	1D, 7C

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VIII. Statement of Unit Mission

Statement of unit mission, as it relates to the unit's role in carrying out the University-wide mission.

Mission:

The mission of the Department of Physical Sciences is to offer education in the physical sciences that provides both the general education necessary to develop an understanding of the natural world and the advanced knowledge and concepts needed for specialized careers. Our faculty members are dedicated to continued professional growth in order to carry out this mission.

Purposes:

1. To promote the scientific understanding of students by preparing them for life in an increasingly technological society.
2. To provide introductory courses in the physical sciences for all students and specialized courses for students in science- and technology-intensive programs.
3. To offer degrees (either through this department or in cooperation with other departments) in selected professional/technical program.
4. To provide opportunities and resources for the professional development and scholarship of the faculty.

IX. Matrix of Strategic Goals and Strategies

Indicate the unit's role in carrying out the University-wide Strategic Plan by circling the goals and/or strategies the unit will address: (Circle all that apply)

1	2	3	4	5	6	7	8	9
1A	(2A)	(3A)	(4A)	5A	6A	7A	8A	9A
(1B)	2B	(3B)	(4B)	5B	6B	7B	8B	9B
1C	2C	3C	(4C)	5C	6C	(7C)	8C	9C
(1D)		3D	4D	5D	6D	7D	8D	9D
1E			4E	5E	6E	7E	8E	9E
						7F	8F	
							8G	
							8H	

Removed: List of graduates

(Year, name, company + location)

Analytical Chemistry	$373.00
Chemical Marketing Reporter	$95.00
Chemical and Engineering News	$57.00
Chemical Engineering	$29.50
Chemical Week	$99.00
Chemical and Pharmaceutical Bulletin	$570.12
Clinical Chemistry	$195.00
Current Contents: Physical, Chemical & Earth Sciences	$405.00
Environmental Science and Technology	$395.00
Journal of AOAC International (1)	$160.00
Journal of the American Chemical Society	$925.00
Journal of the Chemical Society: Chemical Communications	$745.00
Journal of Chemical Education	$60.00
Journal of Medicinal Chemistry (2)	$497.00
Journal of Biological Chemistry	$670.00
Journal of Organic Chemistry	$670.00
Journal of Heterocyclic Chemistry	$320.00
Journal of Agricultural and Food Chemistry	$303.00
Phytochemistry	$1,379.31
Process Engineering	$155.00
The Science Teacher	$50.00
Technicians Today	$50.00
	$8,202.93
(1) Formerly Journal of the Association of Official Analytical Chemists	
(2) Formerly Journal of Medicinal and Pharmaceutical Chemistry	

Curriculum Vitae
William Killian
Department of Physical Science
Ferris State University
Associate Professor of Chemistry
Big Rapids, MI 49307
(616)592-2590

Education: NORTH PARK COLLEGE, B.A. Biology, 1973. Magna Cum Laude Graduate.
GPA 3.65/4.00

OHIO STATE UNIVERSITY, M.S. Chemistry, 1976.
GPA 3.10/4.00
Area of Research: Synthesis and Characterization of Substituted Dihydropyridines in Relation to NAD/NADH Models.
Instrument knowledge: Experienced in the use of Infrared Spectroscopy and FTIR, Gas Chromatography, and High Performance Liquid Chromatography.

LOYOLA UNIVERSITY, Hours Toward Doctorate, 1985-86.
GPA 3.25/4.00

Experience:

Summer 1994: Visiting Professor, Dow Chemical Company, Lamellar cyrstal & colloid preparation and characterization.

Summer 1993: Faculty Summer appointment, Argonne National Lab, Chemical Technology Safety Officer.

Summer 1991: Research Associate, The Upjohn Company, HPLC method development

Summer
1990 & 1992: Research Associate, Argonne National Lab, Long Path FTIR Studies of Compounds Related to Incinerator Emissions

Summer
1988 & 1989: Summer Scientist, Argonne National Lab, Method Development For The Detection and HPLC Separation of Several Conventional High Explosives

1987-present Associate Professor, Industrial Chemistry Coordinator, FERRIS STATE UNIVERSITY
Courses Taught:

General Chemistry
Instrumental Analysis
Applied Analytical Chemistry

1985-1986 Instructor, GEORGE WILLIAMS COLLEGE, full-time position
College closed in March '86 due to financial exigency.

1984-1985 Instructor, LOOP JUNIOR COLLEGE, part-time position
Courses Taught:

General Chemistry
Environmental Science

1981-1985 Chemist, INLAND STEEL
2 years as an EPA compliance water/waste water chemist
2 years as a quality control chemist responsible for chemical operations at a rolling mill.

1976-1981: Teacher, ST. FRANCIS DeSALES HIGH SCHOOL

1973-1976: Teaching and Research Associate, OHIO STATE UNIVERSITY

Publications/Reports:

"N-ACYL-1, 4-Dihydropyridines BY Acid Catalyzed Condensations," TETRAHEDRON LETTERS, 16, 1407-1410, 1978.

"Development of a Process for Treating Red Water by Organic/Inorganic Separation and Biodegradation," 14th Annual Army Environmental R&D Symposium, Williamsburg, VA, November 14-16, 1989.

"Detection of Chemical Plumes Utilizing Passive-Remote Fourier Transform Infrared (FTIR) Spectroscopy," 44th Pittsburgh Conference & Exposition on Analytical Chemistry and Applied Spectroscopy, Atlanta, Georgia, March 8-12, 1993.

Affiliations: Michigan College Chemistry Professor's Association
American Chemical Society
Gamma Alpha Graduate Scientific Society

References:

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Dr. Jack Demirgian
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Argonne National Laboratory
Chemical Technology Division
Argonne, IL 60439
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Section 13

Recommendations

Recommendations

The greatest strength of the INCT program is that it clearly accomplishes its mission, that is, the professional preparation of technicians in a two-year program to serve the chemical and related industries. The comments of the graduates make this clear, in that they feel well-equipped to successfully compete at their first job. Therefore, a strong recommendation is to keep the curricula, methods of instruction, and instructors evolving in the future in the same manner as each has been evolving over the last ten years.

Another strength of the program has been its ability to incorporate students with a full year or more of collegiate science classes into the program. The course sequence and prerequisites have been arranged to allow students an opportunity of entry into the program and often the ability to finish the program within that year of entry. Most INCT students have come through using this route. Therefore, this flexibility is a key to the program's success. As such, it is recommended that the course sequence be maintained in future scheduling considerations.

The large lab component in terms of "hands on" hours is also a key portion of the program. The main line chemistry and physics classes provide a great deal of typical laboratory experience, while the four-credit INCT 230 (with 8 hours of lab per week) provides a mimicking of a work environment experience for the students. Although at semester conversion some INCT courses gained a chemistry designation, it is recommended that the 10 hours of INCT classes be viewed as the rightful conclusion to this traditional laboratory experience. These hours should not be viewed as an isolated add-on. Together all these laboratory and lecture hours lay down the fundamental principles, techniques and skills required to foster the informed independent thinking so sorely needed in today's research and quality control labs. The successful scientist of any level (Ph.D. to technologist) integrates all of the lab and lecture exposure they have had to solve new problems.

The ties the program has developed with industry are essential to INCT's future success. The coordinator needs to be allowed the freedom to work on these important relationships. The 0.25 FTE release time per semester has enabled the coordinator to spend the time on this task, as well as others related to the administration of this program. These relationships have been nurtured over time and keep Ferris State University in the forefront when local companies as well as Fortune 500 companies are seeking to expand their workforce. Not only have these relationships proved beneficial from a hiring standpoint for our graduates, but input through the Industrial Advisory Board has been important on issues such as semester conversion, ACS certification, and instrument acquisition. They have also been beneficial in keeping the curricula current in regard to skill requirements of graduates. Therefore, it is strongly recommended that the program maintain its strong industrial ties through various means of support.

Enrollment trends have kept program numbers from 20 to 25 (total two-year enrollment) over the past eight years. Also, the graduation rate has been about fifteen students per year over that time period. The program functions efficiently in this range with the possibility of increasing the

graduate number to about 20 per year without any major effect on facilities or resources, other than an extra lab code being added to an already-existing lecture class. After that, increases in time required for extra instrument maintenance as well as instruments themselves, set-ups, and extra lab sections in chemistry as well as the INCT 230 class would result. This excess, however, would be basically handled with overload. At present the numbers of graduates is manageable. With the placement rate at or about 100% and the facilities in the process of an upgrade, the recommendation is to keep the size of the program stable, with an increase in the numbers of students served during the years (such as the current year) when the chemical industry is able to hire numbers of new employees. However, due to the cyclical nature of the economy, there is certainly a trickle down effect on hiring in the chemical industry. The understanding of stable enrollment would be that the high end of 20 or so be the goal in years of a robust economy while the low end of 15 or so be the realistic goal in years of a sputtering economy.

In order to obtain more students when industry conditions warrant, it has proven helpful to engage in intensive recruiting efforts. The program coordinator has spent a considerable amount of time in developing ties with potential employers, and he needs to continue along those lines. That does not leave much extra time for the recruitment efforts. Last year, however, the program was able to contact more potential students than in the past due to the efforts of a paid student employee. This person was a program graduate who was continuing his education towards a bachelor's degree. He was very effective in writing letters and talking to students over the phone, especially since he could answer questions from his own experience about the ins and outs of the program. The program would be enabled to reach more potential students if the University provided sufficient funding to cover the costs of such a student "assistant" in the future.

Finally, the facilities are about to be upgraded to a more workable level. With the overhaul to be completed in Science by 1997, physical facilities should become a strong suit of the program. One area of concern, however, will be the constant upgrade required in scientific instruments. Over the last eight years instruments have been acquired two ways: 1) industrial donation or 2) grants, especially Carl Perkins grants. As mentioned in an earlier section, this latter source of funding (Carl Perkins) is no longer available to the ICT program. The recommendation for the future is for the program to continue to seek out donations, but for the University to provide access to equipment funding targeted specifically to the ICT program at regular intervals, especially to support purchases of moderately priced equipment (in the $5000 to $15,000 range) or to provide matching funds for possible grant-writing endeavors for more expensive equipment.

Appendix G

Program Review Panel Evaluation Form

Appendix G

PROGRAM REVIEW PANEL EVALUATION FORM

Program INCT

Instructions: Circle the number which most closely describes the program you are evaluating.

1. Student Perception of Instruction — Average Score 4.5

5	4	3	2	1

Currently enrolled students rate instructional effectiveness as extremely high

Currently enrolled students rate the instructional effectiveness as below average

2. Student Satisfaction with Program — Average Score 5

5	4	3	2	1

Currently enrolled students are very satisfied with the program faculty, equipment, facilities, and curriculum

Currently enrolled students are not satisfied with program faculty, equipment, facilities, or curriculum

3. Advisory Committee Perceptions of Program — Average Score 4

5	4	3	2	1

Advisory committee members perceive the program curriculum, facilities, and equipment to be of the highest quality

Advisory committee members perceive the program curriculum, facilities, and equipment needs improvement

4. Demand for Graduates — Average Score 4

5	4	3	2	1

Graduates easily find employment in field

Graduates are sometimes forced forced to find positions of their field

5. Use of Information on Labor Market — Average Score 4.5

5	4	3	2	1

The faculty and administrators use current data on labor market needs and emerging trends in job openings to systematically develop and evaluate the program

The faculty and administrators do not use labor market data in planning or evaluating the program

6. Use of Profession/Industry Standards — Average Score 4.5

5	4	3	2	1

Profession/industry standards (such as licensing, certification, accreditation) are consistently used in planning and evaluating this program and content of its courses

Little or no recognition is given to specific profession/industry standards in planning and evaluating this program

7. Use of Student Follow-up Information — Average Score 5

5	4	3	2	1

Current follow-up data on completers and leavers are consistently and systematically used in evaluating this program

Student follow-up information has not been collected for use in evaluating this program

8. Relevance of Supportive Courses — Average Score 4

5	4	3	2	1

Applicable supportive courses are closely coordinated with this program and are kept relevant to program goals and current to the needs of students

Supportive course content reflects no planned approach to meeting needs of students in this program

9. Qualifications of Administrators and Supervisors Average Score 5

5	4	3	2	1

All persons responsible for directing and coordinating this program demonstrate a high level of administrative ability

Persons responsible for directing and coordinating this program have little administrative training and experience

10. Instructional Staffing Average Score 4.5

5	4	3	2	1

Instructional staffing for this program is sufficient to permit optimum program effectiveness

Staffing is inadequate to meet the needs of this program effectively

11. Facilities Average Score 4.5

5	4	3	2	1

Present facilities are sufficient to support a high quality program

Present facilities are a major problem for program quality

12. Scheduling of Instructional Facilities Average Score 5

5	4	3	2	1

Scheduling of facilities and equipment for this program is planned to maximize use and be consistent with quality instruction

Facilities and equipment for this program are significantly under-or-over-scheduled

13. Equipment Average Score 4

5	4	3	2	1

Present equipment is sufficient to support a high quality program

Present equipment is not adequate and represents a threat to program quality

14. Adaption of Instruction Average Score 5

5	4	3	2	1

Instruction in all courses required for this program recognizes and responds to individ- student interests, learning styles, skills, and abilities through a variety of instructional methods (such as, small group or individualized instruction, laboratory or "hands on" experiences, credit by examination)

Instructional approaches in this program do not consider individual student differences

15. Adequate and Availability of Instructional Materials and Supplies

Average Score 4

5	4	3	2	1

Faculty rate that the instructional materials and supplies as being readily available and in sufficient quantity to support quality instruction

Faculty rate that the instructional materials are limited in amount, generally outdated, and lack relevance to program and student needs