Ferris State University
College of Technology

ACADEMIC PROGRAM REVIEW REPORT

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY

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HVACR Program

2000

ACADEMIC PROGRAM REVIEW REPORT
HVACR AAS, HVACR BS

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PROGRAM OVERVIEW

For

AAS in HVACR TECHNOLOGY

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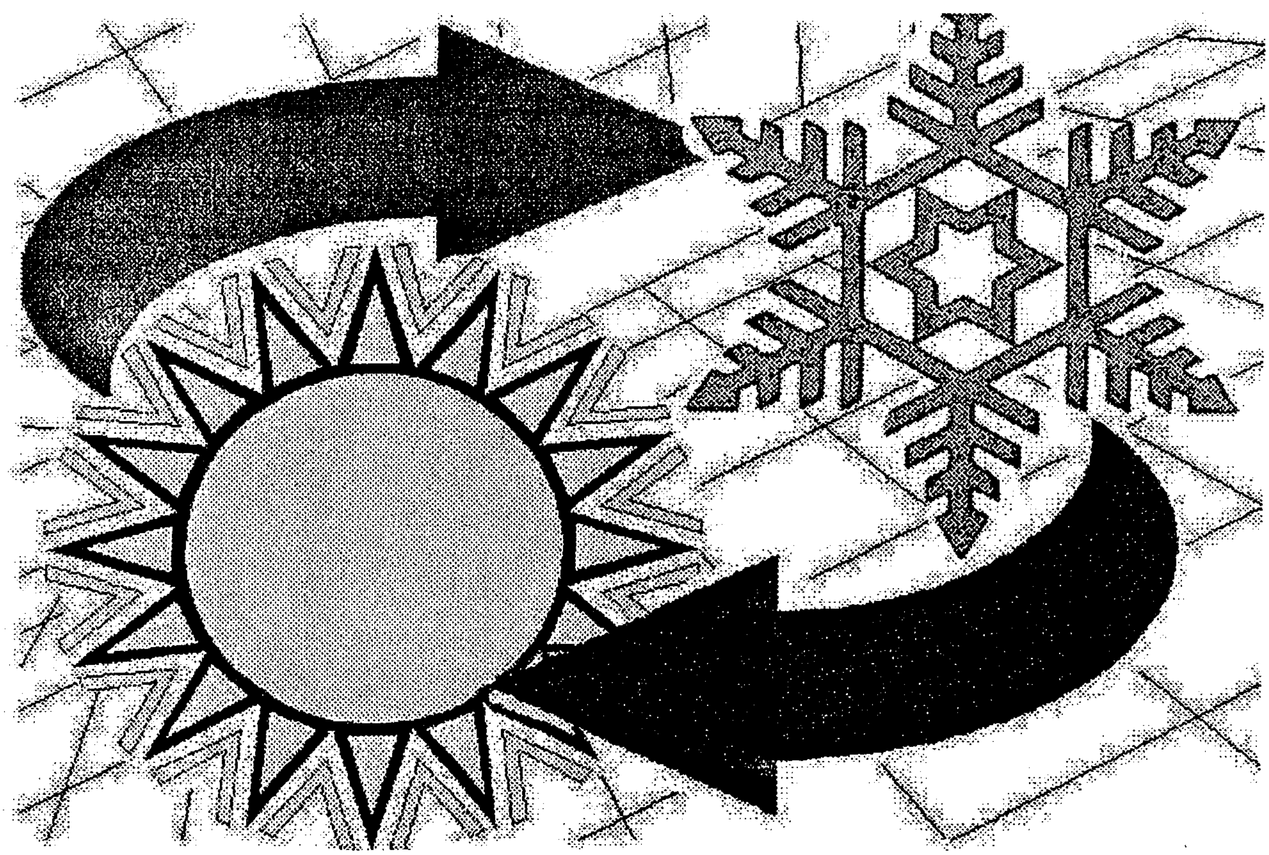

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HISTORY & MISSION

A.A.S. Program:

The Ferris State University, HVACR Technology program has a fifty five year history of high quality technical career-oriented educational offerings that provide the State of Michigan and the nation with prepared HVACR technicians. The mission of the program is to educate students for positions in field service, design, engineering laboratories, and service technology at the upper level of the technological spectrum in the HVACR industry. The associates degree program has modified it's curriculum through the years to stay in tune with the university's mission, including research with replacement (non CFC, ozone depleting) refrigerants & development and administration of nationally mandated refrigerant recovery certifications. This program has a 100% placement of it's graduates filling positions at the community, state and national level. Ferris is the primary source providing degreed HVACR technicians to the State of Michigan. The program also provides technical information and services to the industry on a continual basis, conducting technical seminars that attracts participants from across the nation. Thirty percent of the graduates of this program go on into the Ferris HVACR Engineering Technology Program.

B.S. Program:

The Ferris State University, HVACR Engineering Technology program was conceived by the needs of industry in 1984. The mission of the program is to develop the professional skills and attitudes in students, necessary to measure, monitor, control and maintain HVACR systems at optimum performance. Graduates of this program will serve business and industry in the community, State of Michigan and the nation in the following areas: perform audits and complete energy / economic building and system analysis, to identify, recognize and recommend solutions to problems encountered in HVACR systems found in commercial and industrial buildings, to test adjust and balance mechanical systems and controls for optimum comfort and economy, to optimize building and system operation through the utilization of digital controls and state of the art microcomputer management systems. This program is only one of two programs in the nation providing a laddered baccalaureate program for associate degree graduates in the HVACR field, emphasizing HVACR applied engineering. Currently 40% of the enrollment in the BS program is from out-of-state. The degree is filling the gap between the technician and engineer and has gained international recognition. In the past three years, students from the B.S. program have entered the ASHRAE (American Society of Heating Refrigerating and Air Conditioning Engineers) international HVAC design competition and have placed third, first and second. The Ferris students are successfully competing with Engineering schools from around the world. Ferris students in the CM and FM programs also take courses from the HVACR Engineering Technology Program. The program has several other unique relationships with community, state and nation. The students are required to do a summer internship between the junior and senior year. During the internship, the students must apply the knowledge acquired during the junior year. This gives the students a chance to apply skills learned at Ferris in a real work setting. The internship is also a winning relationship for the companies that hire the interns for the summer. Companies not only get a productive employee for the summer but a potential future employee after graduation. A large number of graduates return to work at the location that they interned. The HVACR Engineering Technology Program currently has internship sites across the nation. Another unique relationship that the BS program has with community and state is the energy audit. During the fall semester of the senior year, students take HVAC 451 which requires them to do a comprehensive energy audit on a real building for a customer. The students collect and analyze data from the building and put together a written report outlining the findings. The students must also give a presentation to the owner regarding the findings of the audit. This is also a win-win situation for student and building owner. The owner gets valuable information on how to better use resources and the students gets valuable written and verbal communication skill practice.

IMPACT & EXPECTATIONS

A.A.S. & B.S. Programs

There is no aspect of public life that does not use the graduates from the HVACR Programs. All facilities demand human comfort and indoor air quality. Inadequate human comfort and indoor air quality translate into greater cost of operation through loss of productivity. HVACR systems must also function at maximum energy efficiency. Poor efficiency also translates into increased cost of operation through wasted resources. Refrigeration systems are used in manufacturing processes, perishable good processing, storage and transport. HVACR programs are critical to maintaining the high quality of life for those citizens in Michigan and the nation. Increased productivity and energy efficiency means that there is more capital available to use on other projects.

IMPACT & EXPECTATIONS (cont.)

A.A.S. & B.S. Programs

The future expectations for both the HVACR Technology graduates and HVACR Engineering Technology graduates look excellent. According to the graduate, employer, advisory board and labor market surveys, there is an increasing demand for the graduates in both programs. HVACR systems are becoming increasingly complicated and require highly trained individuals to work with them. The B.S. program has shown a constant increase in enrollment and currently is exceeding the capacity of the programs resources (facility space and faculty). The competition to hire a B.S. graduate has gotten to the point that companies are offering signing bonuses and conducting interviews early in October of the graduates senior year. This year, all seniors will have accepted jobs by the first of April. Active recruitment is necessary to keep the B.S. program at maximum enrollment, but more importantly, active recruitment will be necessary to increase the enrollment as space allows. Industries continuing and growing demand for B.S. graduates and the high salary and excellent placement will continue to attract students into the program. The A.A.S. program has some competition from other two year HVACR programs and requires recruitment of students for high schools. The HVACR program has used a marketing person in the past to increase enrollment in the A.A.S. program. This succeeded to the point that the A.A.S. program was at maximum capacity. The HVACR program has been without a marketing person for the last two years and the enrollment in the A.A.S. program reflects this situation. The program is currently looking at potential marketing candidates and hope to fill the position by the start of Fall semester of 2000. This should reverse the slight downward enrollment trend in the A.A.S. program

PLANS FOR IMPROVEMENT

The HVACR programs are located in the CTC building, utilizing about 17,000 square feet. The building is also used by the CT program. It has been determined that the HVACR programs need to be moved into a larger space in order to increase the enrollment in both programs. The goal is to triple the enrollment in the B.S. program and double the enrollment in the A.A.S. program. Currently Ferris State University and the State of Michigan are working out the details to conduct a building project that would put the HVACR programs in a new, larger space. The project would also provide for renovations to the CTC building for the CT program. A number of HVACR corporations have stated that they will provide new equipment for the new facility. Johnson Control has already donated over $200,000.00 of state of the art control equipment that is currently being used in a temporary area in the CTC building but can be moved to the new facility.

PLANS FOR IMPROVEMENT – (cont.)

The HVACR programs have also been approached by industry to see if there is a way of placing the HVACR Engineering Technology program on the internet. Again, this degree is so unique, that there are large segments of the country that cannot take advantage of it. One company in particular has an initial employee base of 300, that they would pay to go through the program if it were on the internet. The program is currently looking into the difficulties of placing a highly technical program on the internet. There are also administrative difficulties that must be worked out at the university level. This area still looks like a tremendous opportunity for both the program and university.

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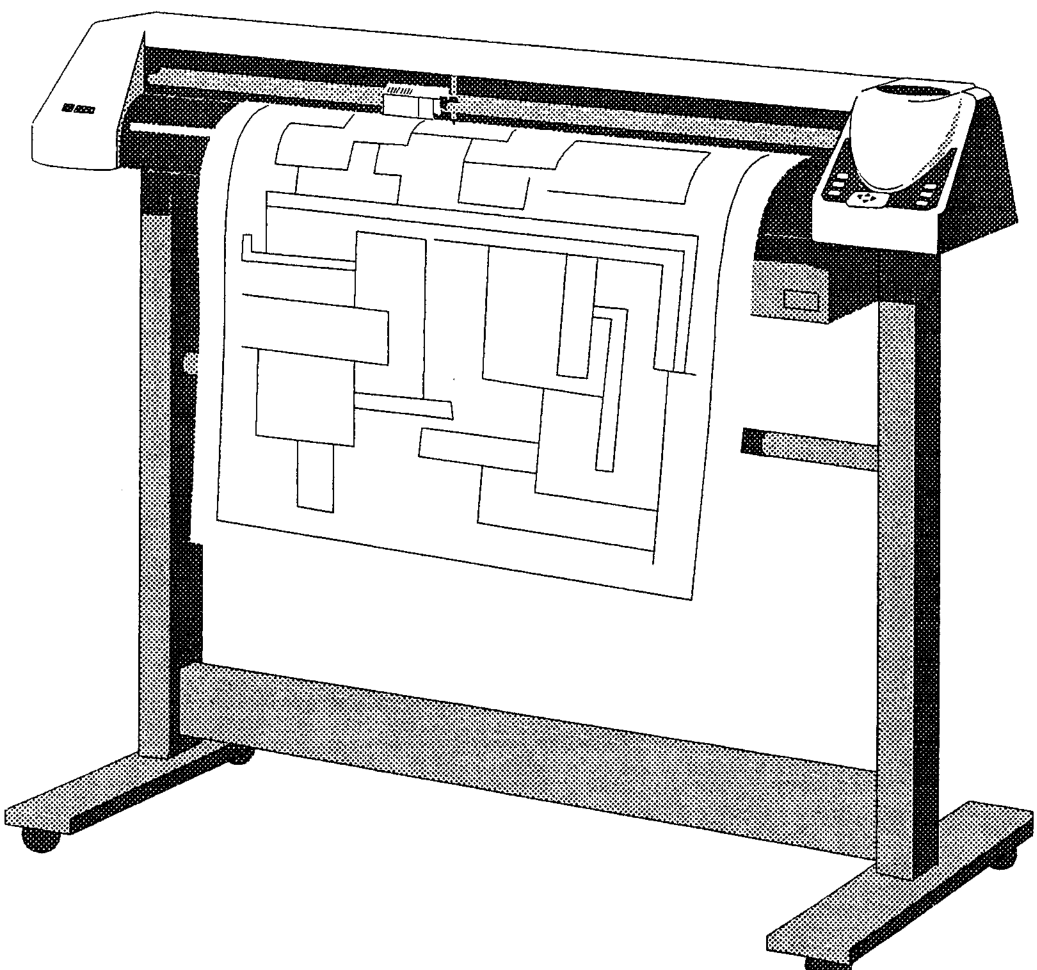
GRADUATE FOLLOW-UP SURVEY

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



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SCOPE & OVERVIEW

HVACR Technology graduate addresses were compiled from student records, alumni services and advisory committee help. A total of 227 past graduate names and address were compiled and sent a copy of the survey and cover letter. A total of 50 responses to the original 227 surveys were received corresponding to a 22% return rate. It should be noted that a large number of 2 year graduates that went on to the 4 year degree only responded to the 4 year survey. This was approximately 50 of the 62 four year respondents. This brings down the total survey count to 177. Also, some 2 year graduates are currently in the 4 year program and did not respond to the 2 year graduate survey but responded to the student survey. This was approximately 20 students, bringing the total down to 157. The actual working 2 year graduates responding to the 2 year survey was about 32%. This rate of return was considered acceptable considering that the survey was sent out between Thanksgiving and Christmas. It was also found out later that a few months earlier an HVAC survey was sent out by the University Center for Extended Learning, which a number of past graduates complained of having to respond to so many surveys.

The survey instrument was constructed to look at a number of different areas. These areas include: success of core curriculum classes with job requirements, success of non-core curriculum classes with job requirements, the need to expand the program and facility, the overall demand for this degree by industry and the immediate productivity of our graduates. The diversity of job positions and starting /current salary information was also sought. The graduates would have the ability to respond to each of the questions in these areas on a five point scale. Response choices include: strongly disagree (DS), disagree (D), neutral (N), agree (A), strongly agree (SA). There was also a response category for not applicable (NA).

The information that can be derived from past graduates is immense. With the quantity of time and money that each graduate put into their degree, the possibility of getting frank answers to the above questions is high. Any short comings of the program would be vocalized by the graduates that are now applying the results of their degree. Serious consideration must and will be given to the results of this survey considering it's value.

FERRIS STATE UNIVERSITY
College of Technology
Construction Department
HVACR Programs

December 1, 1999

Dear Ferris HVACR Graduate:

Ferris State University Could Enhance the HVACR Programs We Need Your Input!

The University's Academic Program review Committee is **reviewing** our HVACR Programs. As a graduate of Ferris State University HVACR program, we need your viewpoint! The result of this review can range from increasing our programs' resources, to placing the program in a probationary status. This process requires your **input**!

The value of your diploma from FSU varies with time and is determined by the reputation of the HVACR Programs. You can help us to enhance the value of your degree by simply completing and returning the enclosed survey by **December 15, 1999**.

In advance, we thank you for your quick response.

Sincerely,

Joe Nott
Associate Professor
HVACR Programs

Please take a few minutes to respond to the enclosed survey.

Enclosed: Graduate Survey

Please complete the following, fold as indicated, tape and mail (no postage needed) by **December 15, 1999.**

A. Education:

Name: ______________________ Check the degree(s) earned at Ferris below.

☐ HVACR AAS Year _____ ☐ HVACR BS Year _____ ☐ Other _________

B. Current Location Information:

Home Address (if it is incorrect): ______________________

Home Phone: ______________ Work Phone: ______________

Company Name: ______________________

Position Title: ______________

Company Address: ______________________

E-mail Address: ______________

C. Program Enhancements:

A. Is there an industry need to increase the number of students? ☐ Yes ☐ No

B. Should the number of faculty per students be increased? ☐ Yes ☐ No

C. Does the program need more specialized equipment in the labs? ☐ Yes ☐ No

D. Do you feel our facilities are adequate at this time? ☐ Yes ☐ No

D. Initial Salary Range:

If you received and AAS in HVAC from Ferris, and then got a job based on that degree, please mark the box corresponding to your initial salary range.

☐ Below $20k ☐ $25k to $30k ☐ $35k to $40k ☐ $45k to $50k

☐ $20k to $25k ☐ $30k to $35k ☐ $40k to $45k ☐ Above $50k

E. Current Salary Range:

☐ Below $20k ☐ $25k to $30k ☐ $35k to $40k ☐ $45k to $50k

☐ $20k to $25k ☐ $30k to $35k ☐ $40k to $45k ☐ Above $50k

F. Career Avenue Which Most Closely Describes Your Daily Activities (circle one):

☐ Estimating / Design ☐ Marketing / Sales ☐ Field or Shop Service

☐ Company Management / Ownership ☐ Lab Technician ☐ Application Engineer / Tech.

☐ Other (.Please describe) ______________________

G. Scientific and Technical Topics for Your Career: (see back of this page)

Please circle your choices in each of the two columns to the right of each topic.

__Relevance:__ Under this column, rate the relevance of the topic to your career using, 5 = Very Important, 4 = Impor tant, 3 = Relevant, 2 = Not Very Important, 1 = Unimportant

__Preparation:__ Under this column, rate the preparation that you received from your HVACR program using, 5 = Very Well Prepared, 4 = Well Prepared, 3 = Fairly Prepared, 2 = Barely Prepared, 1 = Poorly Prepared.

Course Topic	Relevance					Preparation				
Basic Refrigeration	5	4	3	2	1	5	4	3	2	1
Electrical	5	4	3	2	1	5	4	3	2	1
Commercial Refrigeration	5	4	3	2	1	5	4	3	2	1
Commercial Air Conditioning	5	4	3	2	1	5	4	3	2	1
HVAC Design	5	4	3	2	1	5	4	3	2	1
Oil	5	4	3	2	1	5	4	3	2	1
Gas	5	4	3	2	1	5	4	3	2	1
Math	5	4	3	2	1	5	4	3	2	1
English	5	4	3	2	1	5	4	3	2	1
Computer Skills	5	4	3	2	1	5	4	3	2	1
Communication Skills	5	4	3	2	1	5	4	3	2	1

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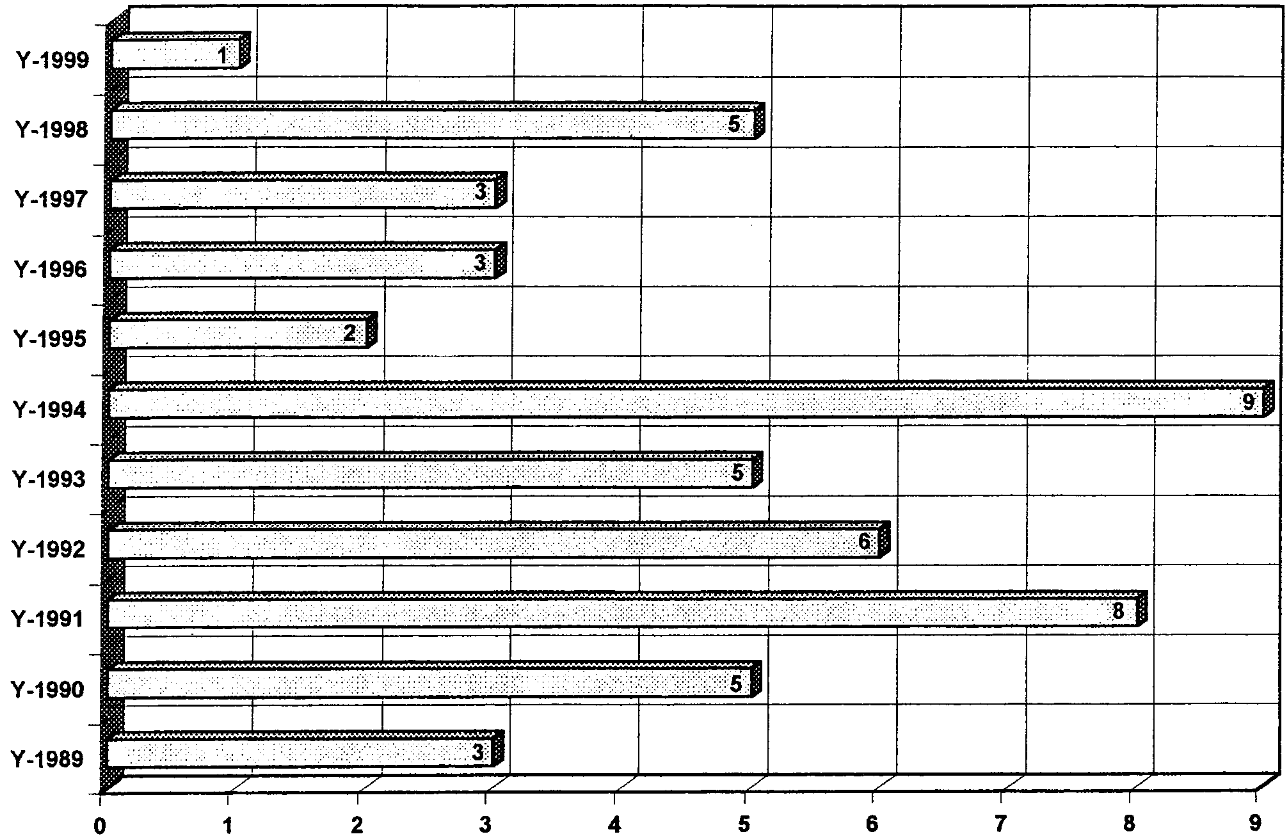
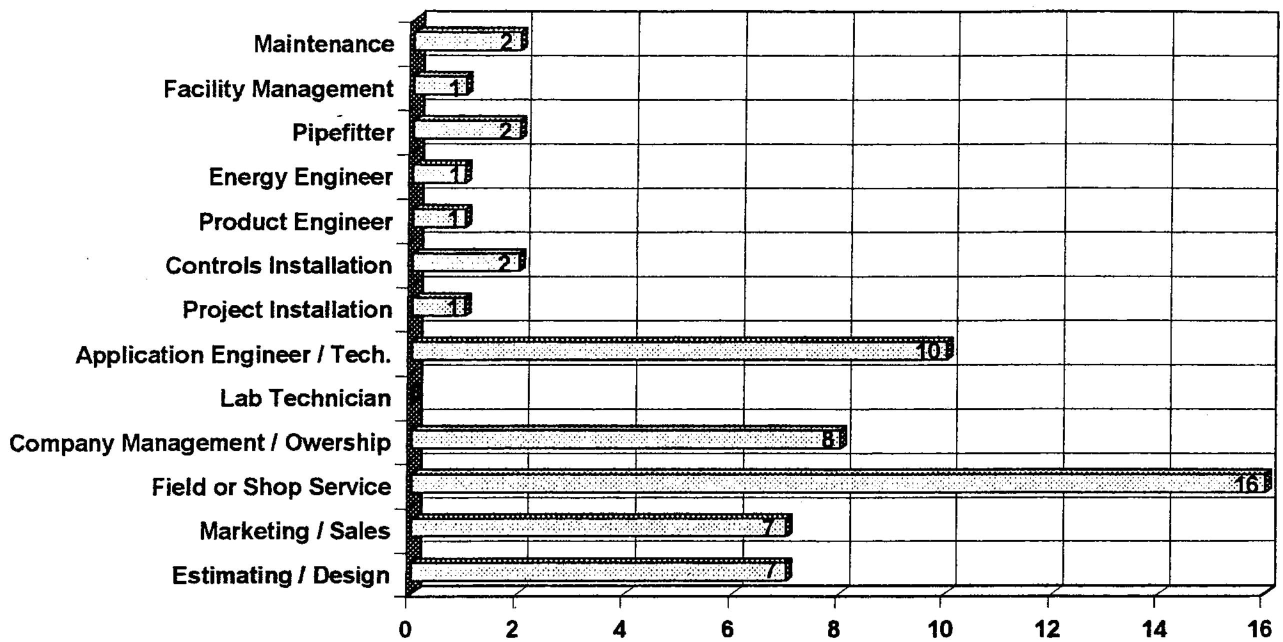
NUMBER OF 2-YEAR GRADUATES RESPONDING BY YEAR GRADUATED



Y-1989	3
Y-1990	5
Y-1991	8
Y-1992	6
Y-1993	5
Y-1994	9
Y-1995	2
Y-1996	3
Y-1997	3
Y-1998	5
Y-1999	1
TOTAL	50

There was a reasonably good distribution of the 50 respondents over the years surveyed. A balanced survey response over this period of time should show if the HVACR Technology Program is heading in the right direction. It should also show if there has been curriculum responses to previous graduate concerns. Recent graduates should help us determine any corrections to the direction our program should be taking.

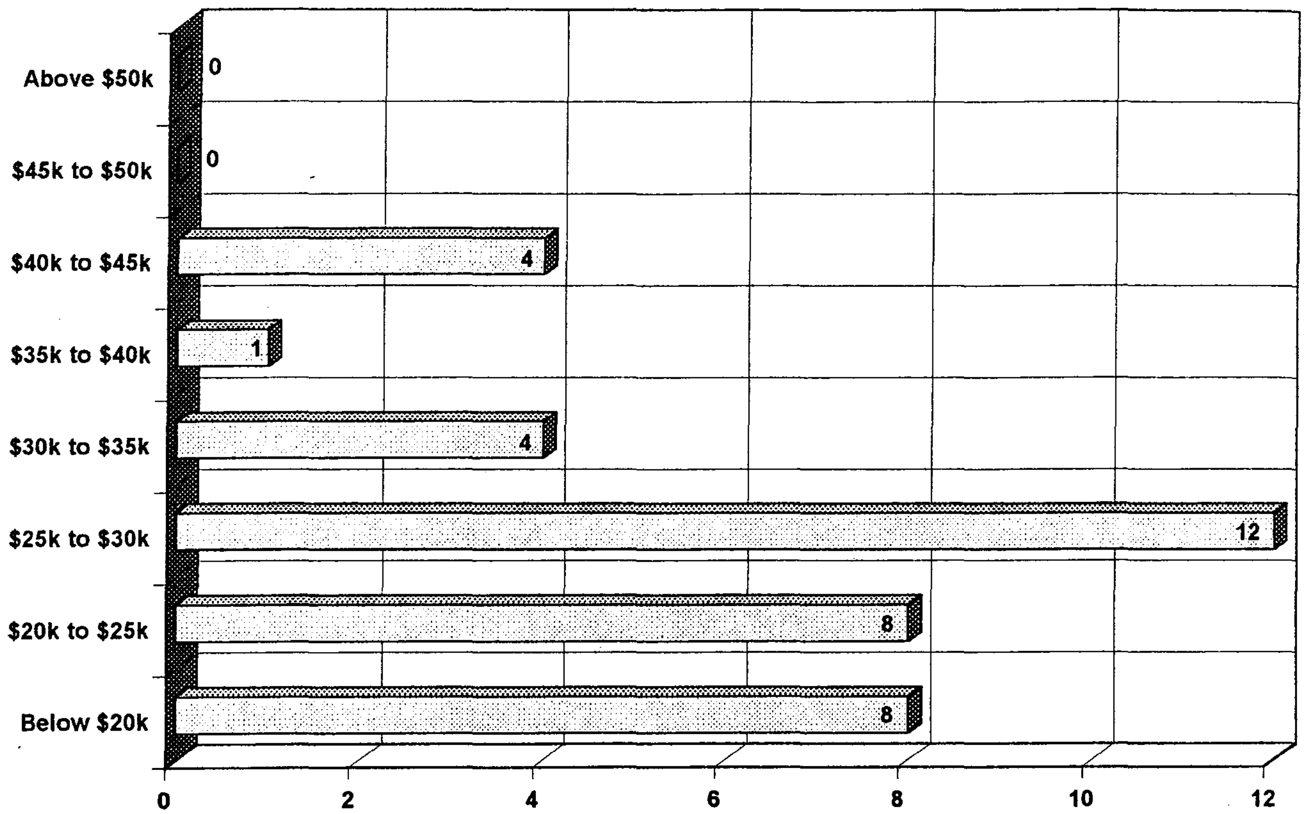
JOB TITLES OF RESPONDENTS



Estimating / Design	7
Marketing / Sales	7
Field or Shop Service	16
Company Management / Ownership	8
Lab Technician	0
Application Engineer / Tech.	10
Project Installation	1
Controls Installation	2
Product Engineer	1
Energy Engineer	1
Pipefitter	2
Facility Management	1
Maintenance	2
TOTAL	58

The graduates of the HVACR Technology Program are finding a wide range of job types. The majority of jobs are in the field / shop service area or application engineer / technician. Satisfaction and success are increased for each individual graduate because of this diversity in job descriptions. All areas appear to be increasing according to graduate comments with ample ability for both lateral and upward advancement within each area and between areas.

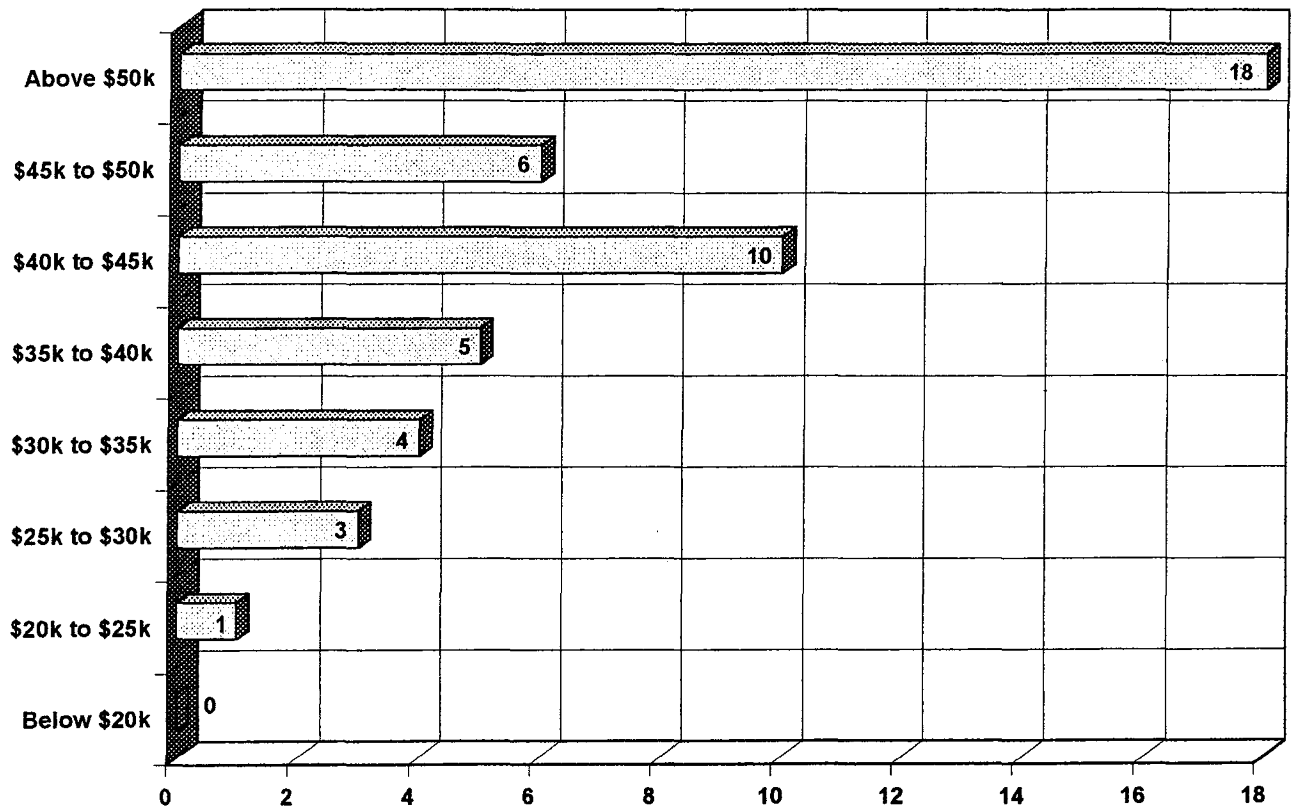
INITIAL STARTING SALARIES FOR 2-YEAR GRADUATES



Below $20k	8
$20k to $25k	8
$25k to $30k	12
$30k to $35k	4
$35k to $40k	1
$40k to $45k	4
$45k to $50k	0
Above $50k	0
No Response	13
TOTAL	50

Starting salaries also have been good for the graduates of the HVACR Technology Program. Because of the 10 year response to the survey the rate of initial salaries vary over the range shown. Graduates from the past 3 years are starting at salaries from the low $30,000 to high $30,000 range. This high initial salary is due to a number of factors including the high demand for the HVACR Technology graduates and the ability of the graduates to be productive for the employer from the very first day. The highly respected name of Ferris State University in the HVACR field is also a factor in high starting salaries.

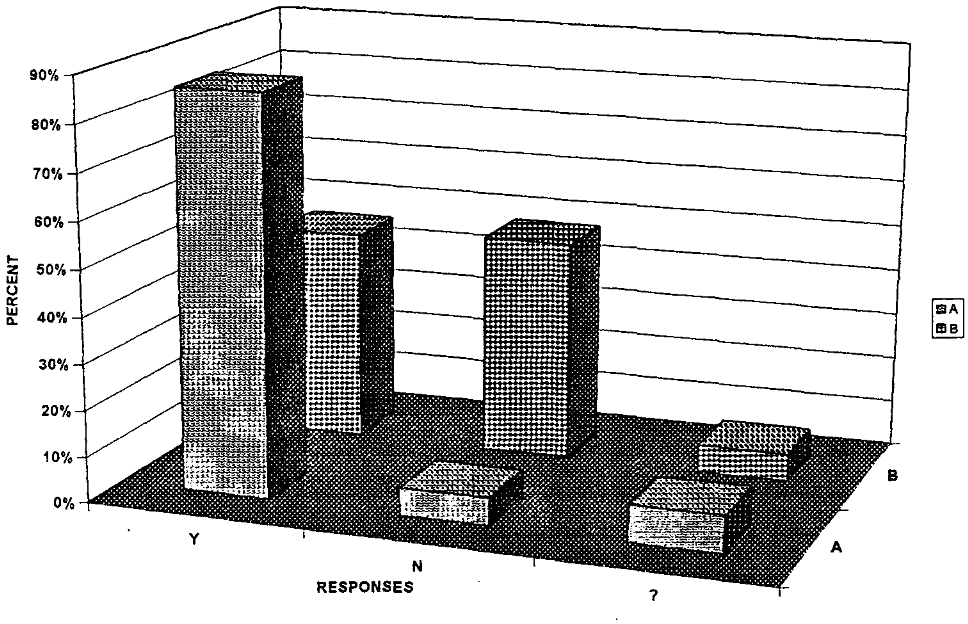
CURRENT SALARIES FOR 2-YEAR GRADUATES



Below $20k	0
$20k to $25k	1
$25k to $30k	3
$30k to $35k	4
$35k to $40k	5
$40k to $45k	10
$45k to $50k	6
Above $50k	18
No Response	3
TOTAL	50

There was a small problem with this question in the survey. The upper range was not high enough to get a good idea of the upper potential earnings for the HVACR Technology program. The highest category surveyed was above $50,000. 36% of the graduates responding to the survey are earning more than $50,000 per year. This degree absolutely allows for the graduate to earn a substantial living. Only 8% of the respondent, in this survey, are currently making less than $30,000 per year.

AAS GRADUATE RESPONSES TO QUESTIONS A & B

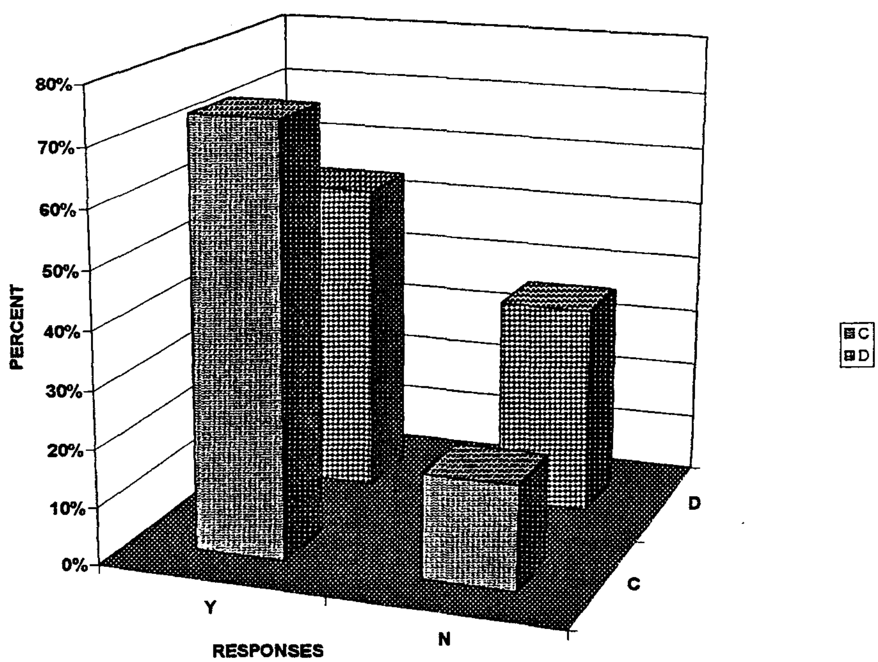


86% of the respondents agree that there is an industry need to increase the number of AAS students.

There was mixed feeling on the student to faculty ratio between graduates. The difference could be the time period that the survey covered. Classes have gotten larger and more crowded.

		Y	N	?	TOTAL
A	Is there an industry need to increase the number of students?	43	3	4	50
B	Should the number of faculty per students be increased?	23	24	3	50

AAS GRADUATE RESPONSES TO QUESTIONS C & D

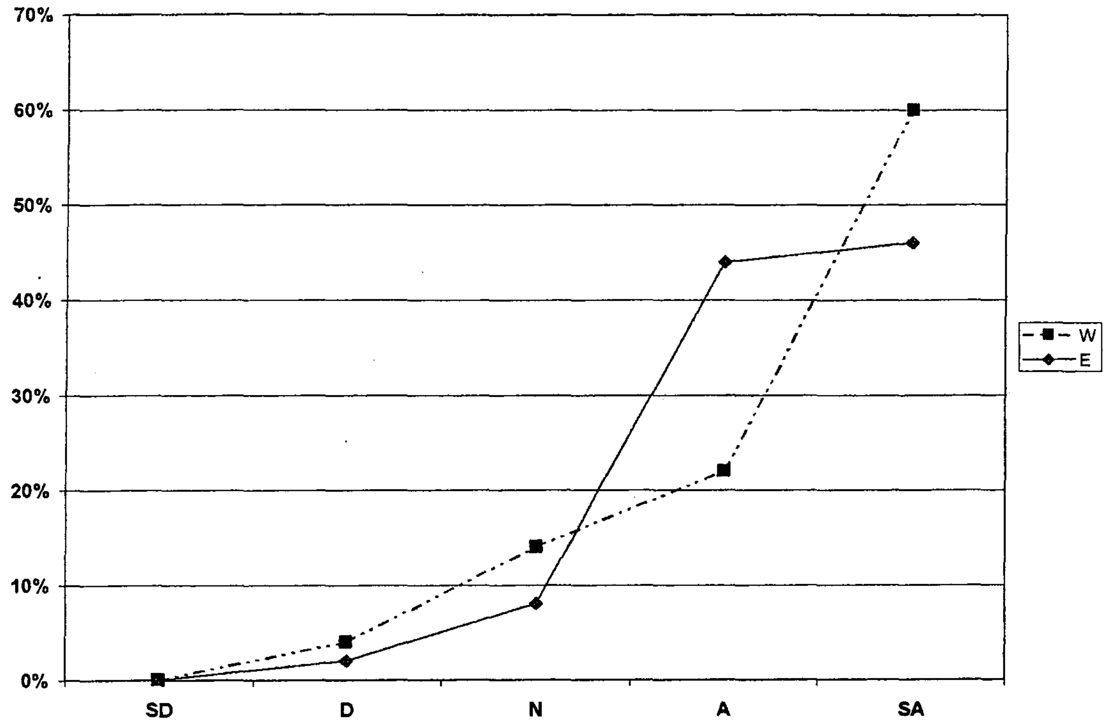


74% of the respondents believe that the HVACR technology program need more specialized equipment in the labs. It is critical that the program keep up with advances in technology to keep our graduates competitive.

36% of the respondents believe that the facility is not adequate. The variation in response, again could be due the time frame of the graduates surveyed.

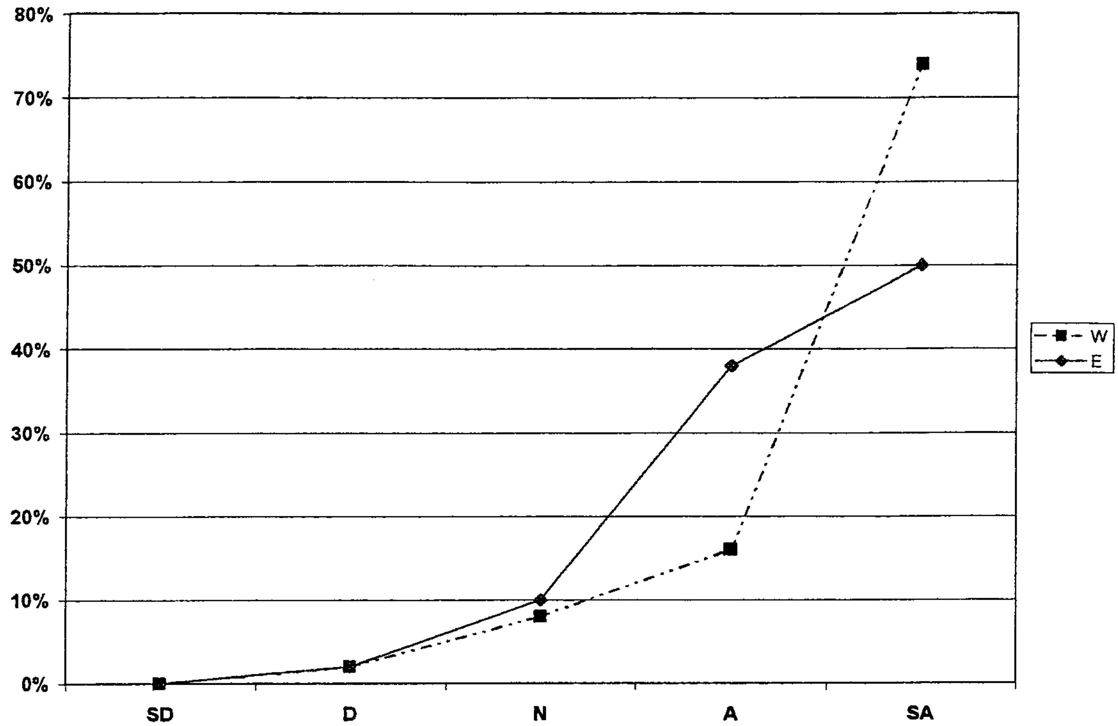
		Y	N	?	TOTAL
C	Does the program need more specialized equipment in the labs?	37	9	4	50
D	Do you feel our facilities are adequate at this time?	27	18	5	50

AAS COMPARISON – BASIC REFRIGERATION COURSES WITH WORK REQUIREMENTS



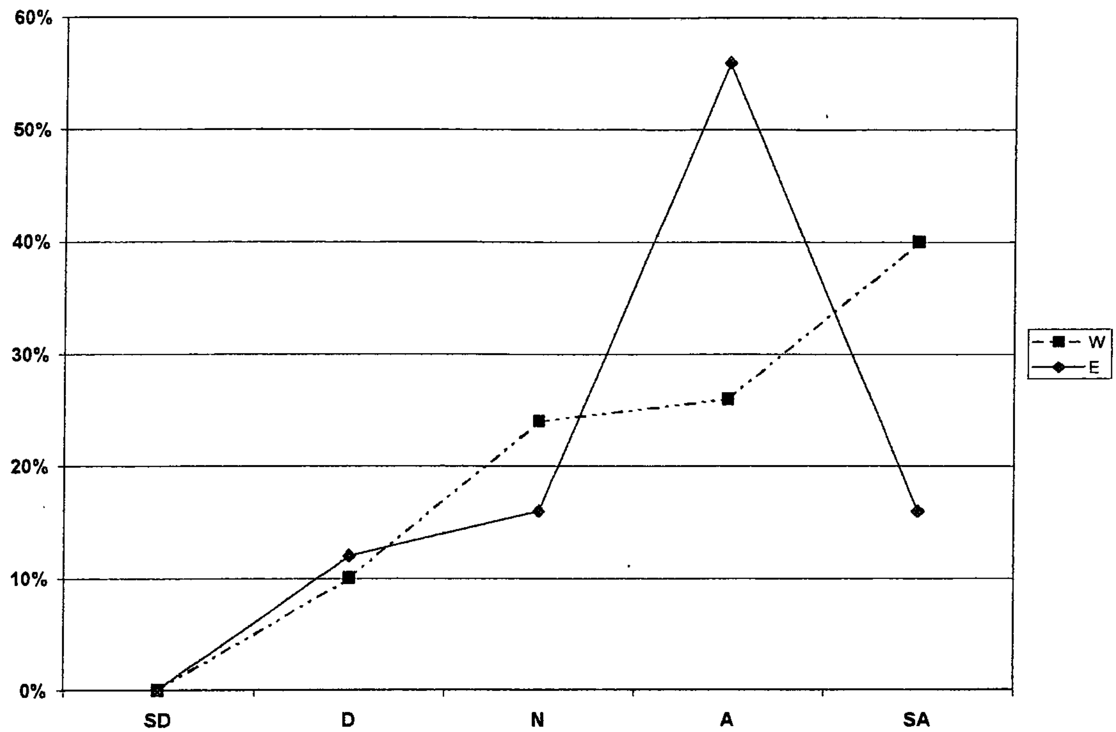
	SD	D	N	A	SA	Ave.
Basic Refrigeration is relevant to your job. (W)	0	2	7	11	30	4.38
You were well prepared in Basic Refrigeration (E)	0	1	4	22	23	4.34

AAS COMPARISON – ELECTRICAL COURSES WITH WORK REQUIREMENTS



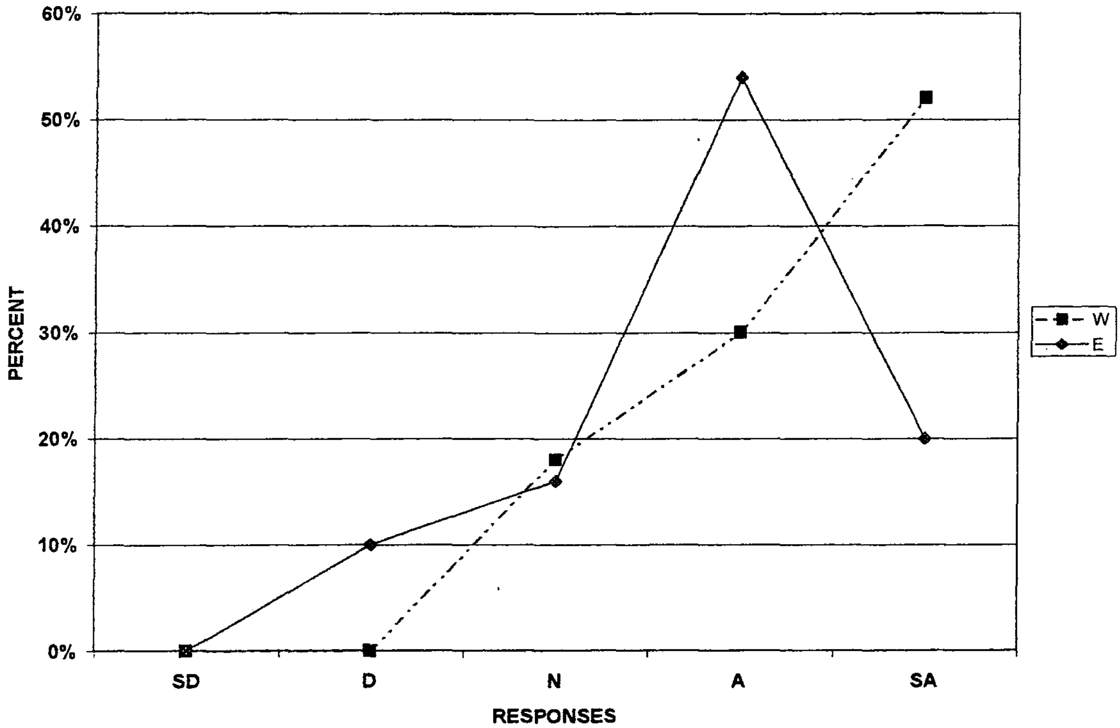
	SD	D	N	A	SA	Ave.
Electrical is relevant to your job. (W)	0	1	4	8	37	4.62
You were well prepared in the area of Electrical (E)	0	1	5	19	25	4.36

AAS COMPARISON – COMMERCIAL REFRIGERATION COURSES WITH WORK REQUIREMENTS



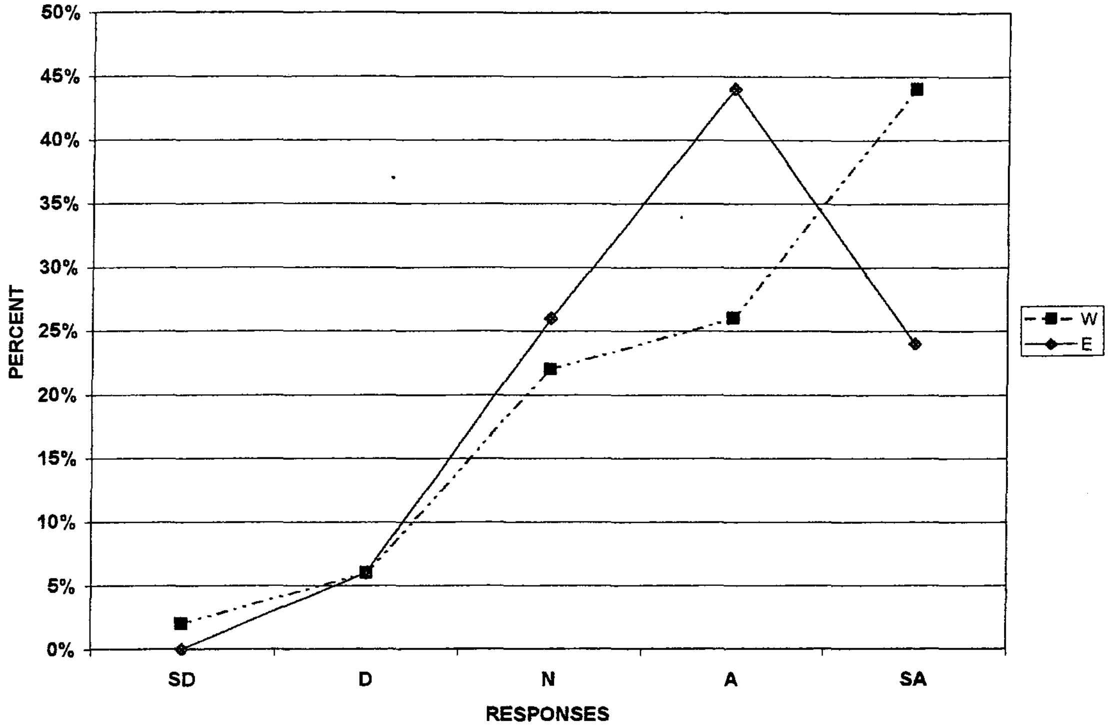
	SD	D	N	A	SA	Ave.
Commercial Refrigeration is relevant to your job. (W)	0	5	12	13	20	3.96
You were well prepared in Commercial Refrigeration (E)	0	6	8	28	8	3.76

AAS COMPARISON – AIR CONDITIONING COURSES WITH WORK REQUIREMENTS



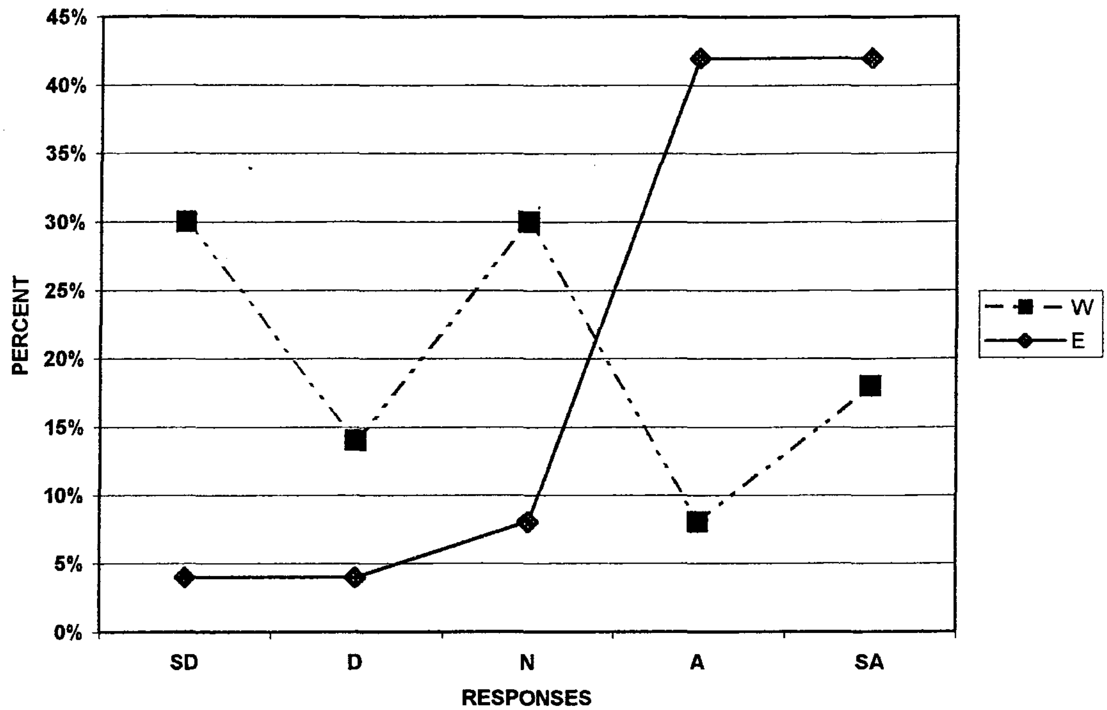
	SD	D	N	A	SA	Ave.
Commercial Air Conditioning is relevant to your job. (W)	0	0	9	15	26	4.34
You were well prepared in Commercial Air Conditioning (E)	0	5	8	27	10	3.84

AAS COMPARISON – HVAC DESIGN COURSES WITH WORK REQUIREMENTS



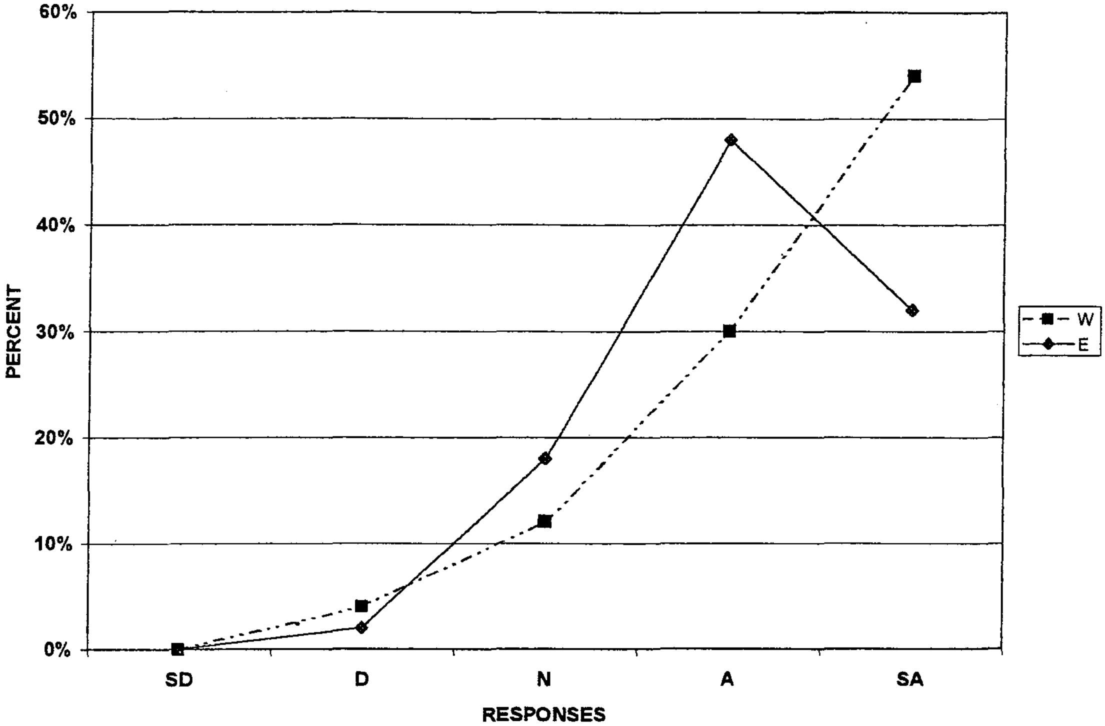
	SD	D	N	A	SA	Ave.
HVAC Design is relevant to your job. (W)	1	3	11	13	22	4.04
You were well prepared in HVAC Design. (E)	0	3	13	22	12	3.86

AAS COMPARISON – OIL HEATING COURSE WITH WORK REQUIREMENTS



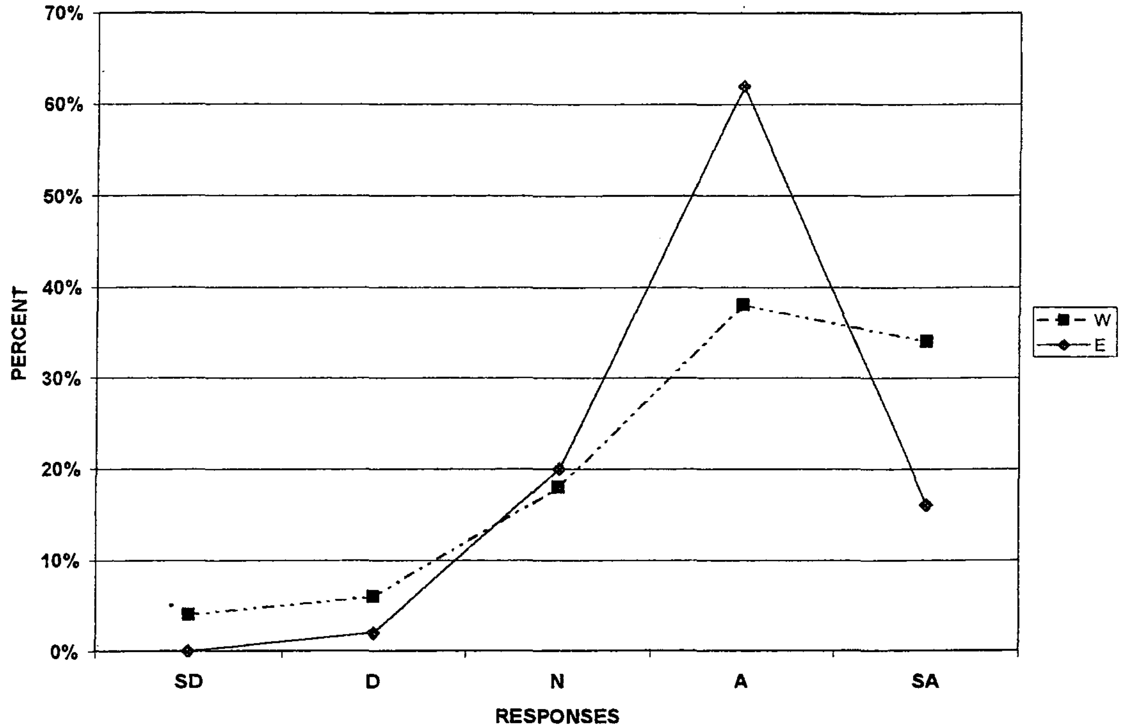
	SD	D	N	A	SA	Ave.
Oil is relevant to your job. (W)	15	7	15	4	9	2.70
You were well prepared in Oil. (E)	2	2	4	21	21	4.14

AAS COMPARISON – GAS HEATING COURSE WITH WORK REQUIREMENTS



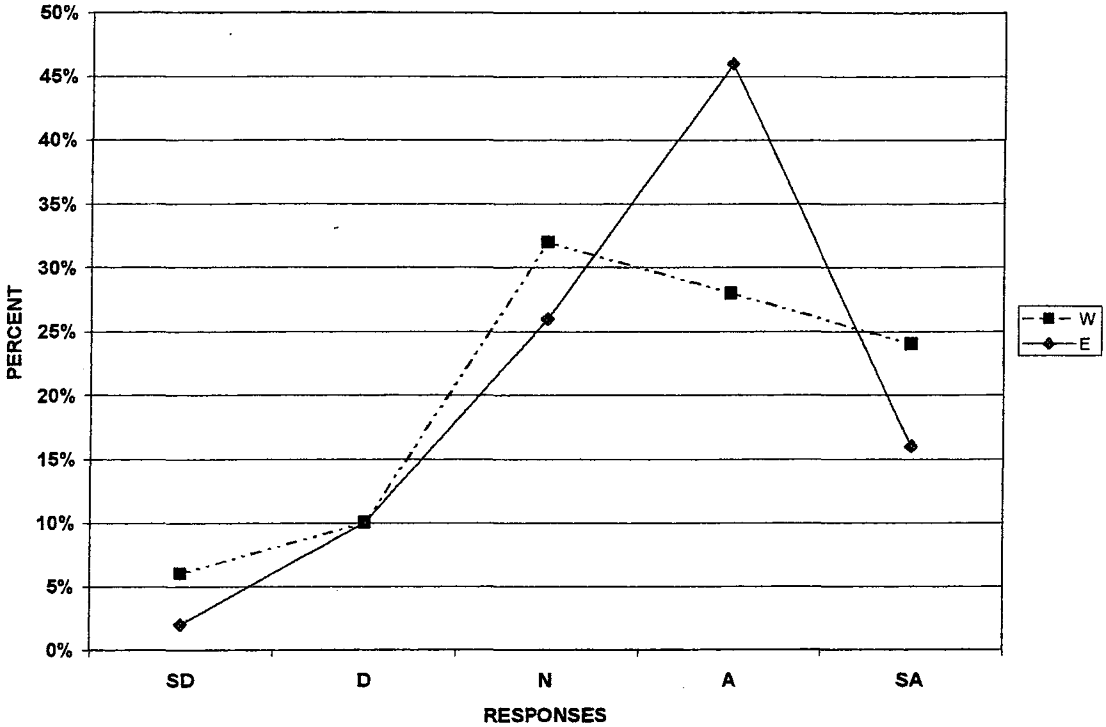
	SD	D	N	A	SA	Ave.
Gas is relevant to your job. (W)	0	2	6	15	27	4.34
You were well prepared in Gas. (E)	0	1	9	24	16	4.10

AAS COMPARISON – MATH COURSES WITH WORK REQUIREMENTS

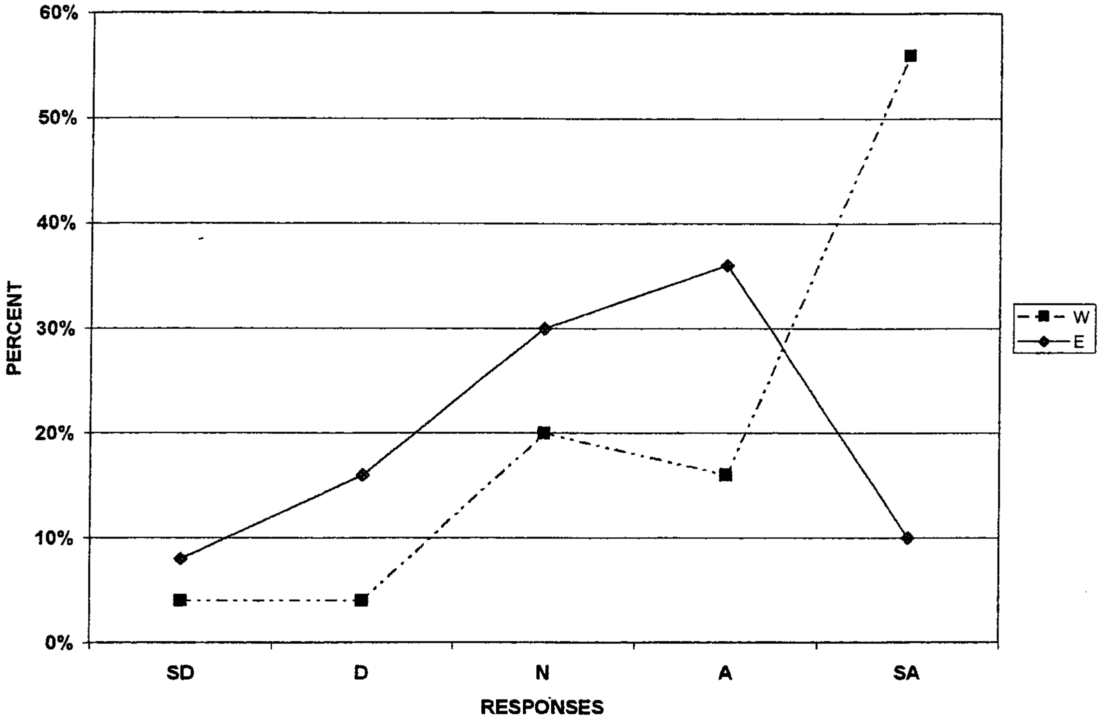


	SD	D	N	A	SA	Ave.
Math is relevant to your job. (W)	2	3	9	19	17	**3.92**
You were well prepared in Math. (E)	0	1	10	31	8	**3.92**

AAS COMPARISON – ENGLISH COURSES WITH WORK REQUIREMENTS

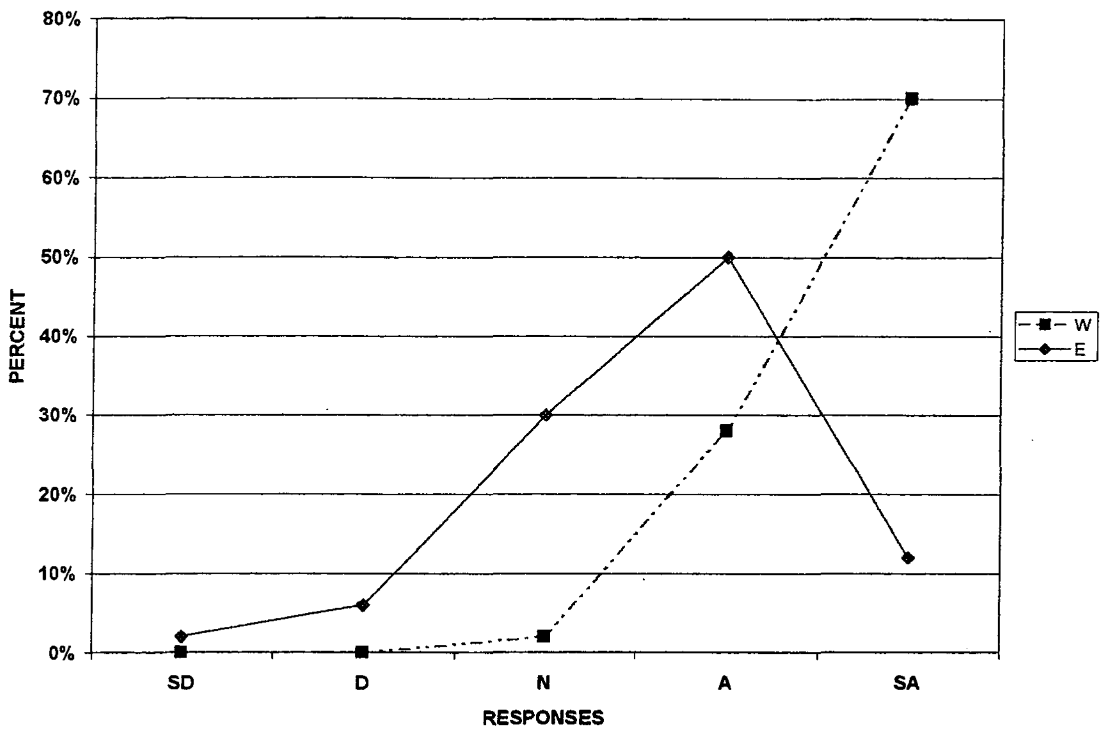


	SD	D	N	A	SA	Ave.
English is relevant to your job. (W)	3	5	16	14	12	**3.54**
You were well prepared in English. (E)	1	5	13	23	8	**3.64**



	SD	D	N	A	SA	Ave.
Computer Skills are relevant to your job. (W)	2	2	10	8	28	**4.16**
You were well prepared in Computer Skills. (E)	4	8	15	18	5	**3.24**

AAS COMPARISON – COMMUNICATION SKILL COURSES WITH WORK REQUIREMENTS



	SD	D	N	A	SA	Ave.
Communication Skills is relevant to your job. (W)	0	0	1	14	35	4.68
You were well prepared in Communication Skills. (E)	1	3	15	25	6	3.64

	NAME	ADDRESS	CITY	STATE	ZIP
1	Mr. Saeed Al-Dosari	344 Finch Court	Big Rapids	MI	49307
2	Mr. Chris Anderson	1988 North Setterbo Road	Suttons Bay	MI	49682
3	Mr. Peter Angel	12443 Lyford Drive	Sterling Heights	MI	48312
4	Mr. William Antcliff, II	7804 Woodbury Road	Laingsburg	MI	48848
5	Mr. Greg Armock	312 Maizie Lane	Sparta	MI	49345
6	Mr. Thomas Ashley	504 Scott	Monroe	MI	48161
7	Mr. Brent Bazuin	239 Sabina Street	McBain	MI	49657
8	Mr. Robert Becker	304 W Franklin Ave	Reed City	MI	49677
9	Mr. Sean Beckett	414 Maple Street	Big Rapids	MI	49307
10	Mr. Paul Beenen	1645 Webster NW	Grand Rapids	MI	49504
11	Mr. Michael Beltz	P.O. Box 6	Freeland	MI	48623
12	Mr. Nicholas Bengel	8864 Barnes Road	Portland	MI	48875
13	Mr. Robert Blackmore	1027 Eaton Street	Key West	FL	33040
14	Mr. George Bliler	5322 Hoag Road	Battle Creek	MI	49017
15	Mr. Jason Boensch	5555 Indiantown Road	Saginaw	MI	48601
16	Mr. James Borsos	237 East Walnut Street	Wauseon	OH	43567
17	Mr. Gregory Bourdon	1221 Pine St.	Essexville	MI	48732
18	Mr. David Bradley	7084 Center Street	Alanson	MI	49706
19	Mr. Robert Braim	10812 Elk Lake Road	Williamsburg	MI	49690
20	Mr. Andrew Brandt	25241 Mintdale Road	Sturgis	MI	49091
21	Mr. Douglas Brown	4811 Atkins Road	North Street	MI	48049
22	Mr. Ronald Brzustowicz	3742 Midway Avenue	Kalamazoo	MI	49001
23	Mr. Broc Buczolich	51807 North Mayflower Rd.	South Bend	IN	46628
24	Mr. Brad Budnik	1513 Virgilene Drive	Rogers City	MI	49779
25	Mr. Mark Bulson	8719 Roosevelt Road	Holton	MI	49425
26	Mr. Matthew Burley	1505 Smith Street	Essexville	MI	48732
27	Mr. Todd Burns	6801 Golfview Lane	Palos Heights	IL	60463
28	Mr. Kevin Byrne	14704 Elk Trail	Wolverine	MI	49799
29	Mr. Michael Camp	517 West St. Joseph Stree	Watervliet	MI	49098
30	Mr. Christopher Canning	12974 Stobart Road	Milford	MI	48380
31	Mr. Brian Carman	856 Webster Street	Traverse City	MI	49686
32	Mr. Darrin Caudill	12533 Stout Ave, NE	Cedar Springs	MI	49319
33	Mr. Richard Charters	4792 Nelson Lane	Oscoda	MI	48750
34	Mr. Donald Clemens, Jr.	P.O. Box 76	Baldwin	MI	49304
35	Mr. Chris Coen	226 Antrim	Charlevoix	MI	49720

36	Mr. John Coffin	8183 Smith Road	Gaines	MI	48436
37	Mr. Joseph Compton	911 Cherry Avenue	Big Rapids	MI	49307
38	Mr. Nicholas Conway	399 Shorewood Court	Valparaiso	IN	46383
39	Mr. Timothy Conzemius	3265 N. Riverwood Drive	Twin Lake	MI	49457
40	Mr. Jason Cooper	6105 Ormada	Kalamazoo	MI	49004
41	Mr. James Corgan	2309 Marquard Avenue	North Muskegon	MI	49445
42	Mr. Mark Crabtree	825 Summer Creek Ct. SE	Kentwood	MI	49508
43	Mr. John Crawford	150 West Summit	Harbor Springs	MI	49740
44	Mr. Dean Deacey	325 Peters Avenue	Troy	OH	45373
45	Mr. Chad Deitering	4121 Merwin Road	Lapeer	MI	48446
46	Mr. Matthew Delay	1418 Ready Avenue	Burton	MI	48529
47	Mr. Jeffrey Demeester	1037 Trent Road	Ravenna	MI	49451
48	Mr. Donovan Denlinger	1311 Village Road	Strasburg	PA	17579
49	Mr. Kevin Dettling	7887 M 52	Manchester	MI	48158
50	Mr. Jeffrey Dey	3160 64th Avenue	Zeeland	MI	49464
51	Mr. Gregory Donakowski	845 Aplin Beach	Bay City	MI	48706
52	Mr. Jeffrey Doran	3776 Mariner	Waterford	MI	48329
53	Miss Shannon Dowd	69531 County Road 215	Lawrence	MI	49064
54	Mr. Micheal Dragoo	4049 West Maple Road	Wixom	MI	48393
55	Mr. Robert Dragoo	2163 East Walton Blvd.	Auburn Hills	MI	48326
56	Mr. Daniel Drys	11620 Weiman Drive	Pinckney	MI	48169
57	Mr. Steven Dungey	4830 Curve Road	Freeland	MI	48623
58	Mr. David Evancho	4551 Hatherly Place	Sterling Heights	MI	48310
59	Mr. Jonathan Fairall	P.O. Box 225	Nokesville	VA	20182
60	Mr. Matthew Feltman	P.O. Box 205	Paris	MI	49338
61	Mr. Mark Fisher	3634 Illinois SW	Wyoming	MI	49509
62	Mr. Timothy Fleet	4191 Westbrook Road	Memphis	TN	38135
63	Mr. Michael Flory	33543 Fernwood Street	Westland	MI	48186
64	Mr. Todd Forner	11559 Brookland Drive	Allendale	MI	49401
65	Mr. Adam Fowler	P.O. Box 533	Schoolcraft	MI	49087
66	Mr. Kevin Frey	5365 Saline Ann Arbor	Saline	MI	48176
67	Mr. Kenneth Frieling	5996 Eagle Point Drive	Fennville	MI	49408
68	Mr. Brian Garza	114 North Granger Street	Saginaw	MI	48603
69	Mr. Theodore Geib, Jr.	2110 Lafayette Avenue NE	Grand Rapids	MI	49507
70	Mr. Bruce Gernaat	2903 West E Avenue	Kalamazoo	MI	49007
71	Mr. Alexander Gifford	2930 Gardentown Road	Grand Rapids	MI	49509

72	Mr. Stephan Gillette	4371 11 Mile Road	Bear Lake	MI	49614
73	Mr. Scott Girardot	7040 Nottingham	West Bloomfield	MI	48322
74	Mr. Bradley Goschke	400 West Main	Rose City	MI	48654
75	Mr. Brent Goschke	400 West Main	Rose City	MI	48654
76	Mr. Scott Green	2035 South Walker Road	Muskegon	MI	49442
77	Mr. Brian Grunst	6414 145th Avenue	Holland	MI	49423
78	Mr. Matthew Hackett	222 South Alamando Road	Shepherd	MI	48883
79	Mr. Eric Hagstrom	16460 Hi Land Trail	Linden	MI	48451
80	Mr. Charles Hanchett	7610 E Riley Road	Corunna	MI	48817
81	Mr. Joseph Hancock	11146 Gilbert Road	Memphis	MI	48041
82	Mr. Mark Harris	21911 Marlow	Oak Park	MI	48237
83	Mr. James Hauser	100 Circle Drive	Alpena	MI	49707
84	Mr. David Hearth	216 Gilbertson	Big Rapids	MI	49307
85	Mr. James Hehl	17852 Oakmont Ridge Circle	Fort Myers	FL	33912
86	Mr. Aaron Helman	223 East Washington	Ionia	MI	48846
87	Mr. Randy Helmke	2912 Huron Avery Road	Huron	OH	44839
88	Mr. Scott Henderson	2070 W 72nd	Newaygo	MI	49337
89	Mr. Michael Heron	303 First Street	Fenton	MI	48430
90	Mr. Aaron Hoffmann	220 A1 Don	Pinckney	MI	48169
91	Mr. Brian Hornbeck	4719 Cape May Avenue	San Diego	CA	92107
92	Mr. Chad House	8797 Burneth Drive	Milan	MI	48160
93	Mr. Jeffrey Huff	PO Box 586	Milford	MI	48381
94	Mr. Robert Hunt	8707 Clyde Park SW	Byron Center	MI	49315
95	Mr. Todd Hurst	7410 North Division	Comstock Park	MI	49321
96	Mr. Andy Jakeway	804 South Broas Street	Belding	MI	48809
97	Mr. Christopher Janda	1221 East Cross Street	Ypsilanti	MI	48198
98	Mr. Mark Janose	513 Venna Place	Coopersville	MI	49404
99	Mr. Michael Janowiak	6160 145th Avenue	Holland	MI	49423
100	Mr. Kevin Jay	704 South Lynn Street	Bryan	OH	43506
101	Mr. Theodore Jensen, III	5076 Biddeford Drive NW	Comstock Park	MI	49321
102	Mr. Steven Jewell	214 East State Street	Cheboygan	MI	49721
103	Mr. Daniel Kalman, Sr.	2261 JoAnn Drive	Spring Hill	TN	37174
104	Mr. Joe Kappelmann	312 East Langsner Street	Englewood	FL	34223
105	Mr. Donald Kebler	906 W. McConnell Street	St. Johns	MI	48879
106	Mr. John Kebler	2616 Northwest Avenue	Lansing	MI	48906
107	Mr. Terrance Kent	839 Farrar Street	Cadillac	MI	49601

108 Mr. Joseph Kichak	305 South State Street	Reed City	MI	49677
109 Mr. Cary Kilbourne	7180 200th Avenue	Stanwood	MI	49346
110 Mr. Michael Korcal	11690 Hoskins	Cedar Springs	MI	49319
111 Mr. Daniel Korhonen	1065 Riverview Drive	Ishpeming	MI	49849
112 Mr. Mark Kresge	3450 Merlin Court NE	Grand Rapids	MI	49505
113 Mr. Terry Kuderik	29856 Red Cedar	Flat Rock	MI	48134
114 Mr. Craig Langmaid	4301 South Airport	Bridgeport	MI	48722
115 Mr. Derek Larson	326 17 Mile Road	Kent City	MI	49330
116 Mr. Paul Laugavitz	21211 Hitzemann Drive	Reed City	MI	49677
117 Mr. Christopher Loftis	54 West Forest Trail	Free Soil	MI	49411
118 Mr. Kenneth Lorincz	18505 7 Mile Road	Reed City	MI	49677
119 Mr. Daniel Mack	North 7226 County Hwy M	Springbrook	WI	54875
120 Mr. Craig Marshall	19610 Huntington Avenue	Harper Woods	MI	48225
121 Mr. Scott Mason	7525 East Navarro Avenue	Mesa	AZ	85208
122 Mr. Luke Matthews	Rte 2 Box 119	Hart	MI	49420
123 Mr. Christopher McConomy	2587 Bell Cir.	Stevensville	MI	49127
124 Mr. Darren Meeh.	62 Zellers Road	Long Valley	NJ	07853
125 Mr. Timothy Mendyk	5041 Commodore Lane	Walnut Cove	NC	27052
126 Mr. Joseph Meyer	685 9 Mile NE	Comstock Park	MI	49321
127 Mr. John Millard	410 Piney Road	Manistee	MI	49660
128 Mr. Ryan Miller	9314 East X Avenue	Vicksburg	MI	49097
129 Mr. William Miller	1634 South Banner Road	Sandusky	MI	48471
130 Mr. Timothy Mills	128 Fob Ln	Frierson	LA	71027
131 Mr. Kevin Mitchell	4032 Lehman Road	Laingsburg	MI	48848
132 Mr. Jeffrey Modica	7275 Parkland	Detroit	MI	48239
133 Mr. Drew Molitor	10114 Kohler Road	Howard City	MI	49329
134 Mr. Raymond Moody	4732 Pare Lane	Trenton	MI	48183
135 Mr. Stephen Morse	11283 Village Lane	Clinton	MI	49236
136 Mr. Bernard Murphy	1266 Evanston Avenue	Muskegon	MI	49442
137 Mr. George Naim	1905 Clover Trail	Richardson	TX	75081
138 Mr. Bruce Nelson	12751 Gloriette	Sand Lake	MI	49343
139 Mr. Lucas Nicholaou	4206 42nd Way	West Palm Beach	FL	33407
140 Mr. John Nurenberg	2465 Spaulding Road	Pewamo	MI	48873
141 Mr. Terry Nyland	A 6355 144th Avenue	Holland	MI	49423
142 Mr. Terrence Oldeck	6061 Birchview Drive	Saginaw	MI	48609
143 Mr. Matthew Pedler	7188 Sunset Avenue	Jenison	MI	49428

144 Mr. Jon Perry	317 South Warren	Big Rapids	MI	49307
145 Mr. Benjamin Peters	4155 Bedaki	Lowell	MI	49331
146 Mr. David Peters	9586 Steep Hollow Drive	White Lake	MI	48386
147 Mr. Richie Piatkowski	602 Hopkins Street	Mt. Pleasant	MI	48858
148 Mr. Colin Plater	2435 Linda	Saginaw	MI	48603
149 Mr. Daniel Platt	P.O. Box 416	Elk Rapids	MI	49629
150 Mr. Brad Poll	5044 136th Avenue	Hamilton	MI	49419
151 Mr. Rodney Polter	4312 Crestlane Drive	Hudsonville	MI	49426
152 Mr. Ryan Polter	7783 Lamplight Drive	Jenison	MI	49428
153 Mr. Michael Powers	373 Cedar	Cedar Springs	MI	49319
154 Mr. John Providenti	705 Ives	Big Rapids	MI	49307
155 Mr. Tim Pullen	18115 Craft Road	Hersey	MI	49639
156 Mr. John Pyatt	7793 Maple Grove Road	Berrien Center	MI	49102
157 Mr. Brian Quaderer	2194 East Hyde Road	St. Johns	MI	48879
158 Mr. John Quilitzsch	16501 Kent Avenue	Morley	MI	49336
159 Mr. Peter Rademaker	12597 136th Avenue	Grand Haven	MI	49417
160 Mr. Curtis Ray	18944 Milton Road	Big Rapids	MI	49307
161 Mr. Kevin Ritsen	6350 Tamara Drive	Flint	MI	48506
162 Mr. Timothy Roback	233 Purdy Drive	Alma	MI	48801
163 Mr. Adam Rogalla	7094 South Cooley Road	Fruitport	MI	49415
164 Mr. Jerry Roof	Bowen Refrigeration	Muskegon	MI	49442
165 Mr. Thomas Roos	1701 Gardenia Ave.	Royal Oak	MI	48067
166 Mr. Nicholas Ruehmeier	4511 Cypress Avenue	Newaygo	MI	49337
167 Mr. Barry Rutherford	4110 White Lake Road	White Lake	MI	48383
168 Mr. Gregory Salisbury	22089 20th Avenue	Marion	MI	49665
169 Ms. Bethany Sandelius	12414 Edgerton	Cedar Springs	MI	49319
170 Mr. William Schriver	2012 Wendover Road NW	Grand Rapids	MI	49504
171 Mr. Craig Schubert	P.O. Box 414	Auburn	MI	48611
172 Mr. Adam Schultz	3938 Macarthur Road	Muskegon	MI	49442
173 Mr. Daniel Schwab	777 Stevenson Road	Standish	MI	48658
174 Mr. David Shafer	4586 Nestrom	Whitehall	MI	49461
175 Mr. Charles Sieffert	5923 Pierce Road	Remus	MI	49340
176 Mr. Kevin Sieffert	4138 Pierce Road	Remus	MI	49340
177 Mr. Christopher Sikes	2393 Whites Bridge Road	Belding	MI	48809
178 Mr. Eric Simon	401 Feneis Street	Westphalia	MI	48894
179 Mr. Paul Sisovsky	200 Sunset Hills Ave, NW	Grand Rapids	MI	49544

180 Mr. Mark Siwik	5470 Lindenwood Drive	Kalamazoo	MI	49004
181 Mr. James Six	8052 Meade Street	Montague	MI	49437
182 Mr. Scott Smith	1421 104th Avenue	Zeeland	MI	49464
183 Mr. Mark Snider	931 St. Lawrence	Marysville	MI	48040
184 Mr. Robert Soriano, Jr.	5792 North Wyman Road	Lake	MI	48632
185 Mr. James Spero	4185 Mill Creek Dr.	Charleston	SC	29420
186 Mr. Michael Stahl	3160 Emberwood	Lowell	MI	49331
187 Mr. Eric Starke	806 N 3rd St	Saint Clair	MI	48079
188 Mr. Gregory Starke	20656 Marion Road	Brant	MI	48614
189 Mr. Richard Starr	1510 Yorkshire Drive	Howell	MI	48843
190 Mr. Gregory Stearns	871 Masters Road	Trufant	MI	49347
191 Mr. James Stevens	11401 Moscow	Hanover	MI	49241
192 Mr. Timothy Styma	6861 Grand Lake Rd	Posen	MI	49776
193 Mr. Stephen Sullivan	3765 Campbell Road	North Street	MI	48049
194 Mr. Daniel Susick	2185 Briar Court	Commerce Township	MI	48382
195 Mr. David Sweet, Jr.	904 Merrifield	Grand Rapids	MI	49507
196 Mr. Daniel Tasiemski	1863 Englewood Drive	Bay City	MI	48708
197 Mr. Joseph Theisen	739 Ruff Drive	Monroe	MI	48161
198 Mr. Jason Thelen	10991 Chadwick Road	Eagle	MI	48822
199 Mr. Michael Thorne	1935 Marion Avenue	Zanesville	OH	43701
200 Mr. Thomas Thorne	2137 Ridgecrest Rd, SE	Grand Rapids	MI	49546
201 Mr. Matthew Tighe	1448 Beach Street	Muskegon	MI	49441
202 Mr. Erik Townsend	1519 Oakwood Drive	Jenison	MI	49428
203 Mr. Kurt Trierweiler	9750 South Hinman Road	Eagle	MI	48822
204 Mr. Michael Troupe	12261 Harding Drive	Big Rapids	MI	49307
205 Mr. Robert Tudball	37868 Connaught Drive	Northville	MI	48167
206 Mr. Kevin Urbanczyk	10391 Timber Line Drive	Alto	MI	49302
207 Mr. John Vanbuskirk	9446 Lake Michigan Drive	Zeeland	MI	49464
208 Mr. Philip Vandenheuvel	7011 Hidden Hills Drive	Jenison	MI	49428
209 Mr. Michael Veltman	762 Larkwood Drive	Holland	MI	49423
210 Mr. Daniel Videtich	13341 Peach Ridge Avenue	Kent City	MI	49330
211 Mr. Joseph Wardie	709 South East Street	Fenton	MI	48430
212 Mr. Jeffrey Werle	3720 Edgewood Street SW	Grandville	MI	49418
213 Mr. Max Westphal	1042 West Hampton	Essexville	MI	48732
214 Mr. Harold Whitcomb	3169 Kings Brook Drive	Flushing	MI	48433
215 Mr. Steven Whitney	14191 South Oak Avenue	Kent City	MI	49330

216	Mr. Kurt Wilkes	13884 South Bayview Drive	Traverse City	MI	49684
217	Mr. Michael Willman	7210 Deborah Drive	Saginaw	MI	48603
218	Mr. Richard Wingeier	3261 Brooklyn Avenue SE	Grand Rapids	MI	49508
219	Mr. Kevin Winger	2700 14 Mile Road NE	Sparta	MI	49345
220	Mr. Christopher Winslow	41672 Sunnydale Lane	Northville	MI	48167
221	Mr. Charles Witt	200 Yoakum Parkway	Alexandria	VA	22304
222	Mr. Timothy Wright	518 North 2nd Street	Shepherd	MI	48883
223	Mr. John Young	1562 Timberlane Drive	Saint Joseph	MI	49085
224	Mr. Scott Zalucha	1373 East Linwood Road	Linwood	MI	48634
225	Mr. Christopher Zeiter	136 Brentwood	Gaylord	MI	49735
226	Mr. Charles Zimmerman	12345 183rd Avenue	Big Rapids	MI	49307
227	Mr. Richard Zink, Jr.	15551 22 1/2 Mile	Marshall	MI	49068

SCOPE & OVERVIEW

HVACR Engineering Technology graduate addresses were compiled from student records, alumni services and advisory committee help. A total of 158 past graduate names and address were compiled and sent a copy of the survey and cover letter. A total of 62 responses to the original 158 surveys were received corresponding to a 39% return rate. This rate of return was considered acceptable considering that the survey was sent out between Thanksgiving and Christmas. It was also found out later that a few months earlier an HVAC survey was sent out by the University Center for Extended Learning, which a number of past graduates complained of having to respond to so many surveys.

The survey instrument was constructed to look at a number of different areas. These areas include: success of core curriculum classes with job requirements, success of non-core curriculum classes with job requirements, the success of advising and placement services, the need for HVAC programs on the internet, the need to expand the program and facility, the overall demand for this degree by industry and the immediate productivity of our graduates. The diversity of job positions and starting /current salary information was also sought. The graduates would have the ability to respond to each of the questions in these areas on a five point scale. Response choices include: strongly disagree (DS), disagree (D), neutral (N), agree (A), strongly agree (SA). There was also a response category for not applicable (NA). The last page of the survey allowed for the students to comment on topics of their choice.

The information that can be derived from past graduates is immense. With the quantity of time and money that each graduate put into their degree, the possibility of getting frank answers to the above questions is high. Any short comings of the program would be vocalized by the graduates that are now applying the results of their degree. Serious consideration must and will be given to the results of this survey considering it's value.

FERRIS STATE UNIVERSITY
College of Technology
Construction Department
HVACR Programs

December 1, 1999

Dear Ferris HVACR Graduate:

Ferris State University Could Enhance the HVACR Programs
We Need Your Input!

The University's Academic Program review Committee is **reviewing** our HVACR Programs. As a graduate of Ferris State University HVACR program, we need your viewpoint! The result of this review can range from increasing our programs' resources, to placing the program in a probationary status. This process requires your **input**!

The value of your diploma from FSU varies with time and is determined by the reputation of the HVACR Programs. You can help us to enhance the value of your degree by simply completing and returning the enclosed survey by **December 15, 1999**.

In advance, we thank you for your quick response.

Sincerely,

Michael J. Korcal
Assistant Professor
HVACR Programs

Enclosed: Graduate Survey

Please take a few minutes to respond to the enclosed survey.

FERRIS STATE UNIVERSITY

1999/00

PURPOSE HVACR PROGRAM REVIEW

SURVEY AREA: **Graduate Perceptions of the HVACR Programs.**

Please complete the following, fold as indicated, tape and mail (no postage needed) by **December 15, 1999.**

A. Education:

Name: ____________________ Check the degree(s) earned at Ferris below.

☐ HVACR AAS Year ______ ☐ HVACR BS Year ______ ☐ Other ____________

B. Current Location Information:

Home Address (if it is incorrect): ______________________________

Home Phone: ______________________ Work Phone: ______________________

Company Name: ______________________________

Position Title: ______________________

Company Address: ______________________________

E-mail Address: ______________________

D. Initial Salary Range:

If you received and BS in HVAC from Ferris, and then got a job based on that degree, please mark the box corresponding to your initial salary range.

☐ Below $20k	☐ $25k to $30k	☐ $35k to $40k	☐ $45k to $50k
☐ $20k to $25k	☐ $30k to $35k	☐ $40k to $45k	☐ Above $50k

E. Current Salary Range:

☐ Below $20k	☐ $25k to $30k	☐ $35k to $40k	☐ $45k to $50k
☐ $20k to $25k	☐ $30k to $35k	☐ $40k to $45k	☐ Above $50k

F. Career Avenue Which Most Closely Describes Your Daily Activities (circle one):

☐ Bidding / Estimating	☐ Marketing / Sales	☐ HVAC design
☐ Company Management / Ownership	☐ Control engineering	☐ Control application engineer

☐ Other (Please describe)

____

OVER

SURVEY – Page 2:

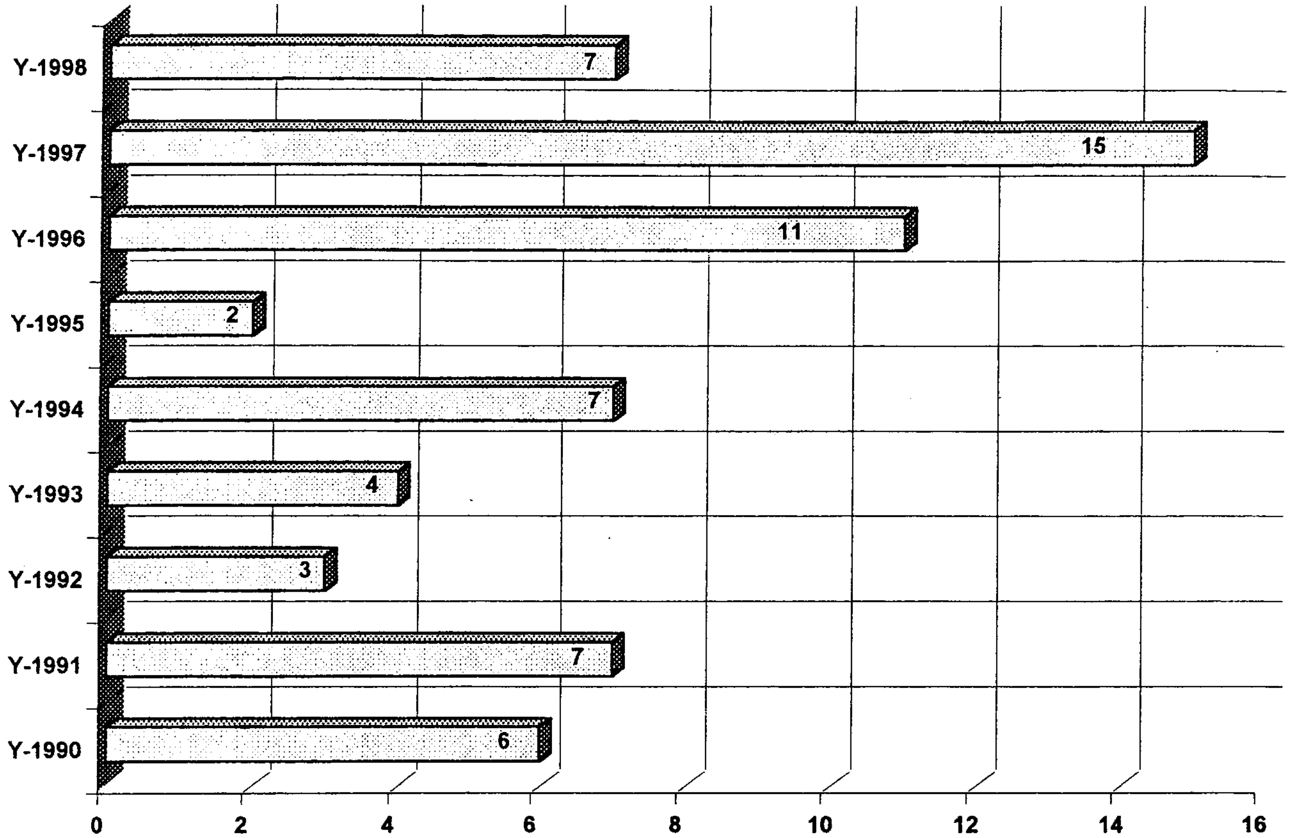
Respond to the following statements:

		Strongly Agree SA	Agree A	Neutral N	Disagree D	Strongly Disagree SD	Not Applicable NA
1	The HVAC design classes are important to your job.	5	4	3	2	1	NA
2	You were well prepared in the area of HVACR design.	5	4	3	2	1	NA
3	The use of CAD is important to your job.	5	4	3	2	1	NA
4	You were well prepared in the area of CAD.	5	4	3	2	1	NA
5	The ability to do a load calculation is important to your job.	5	4	3	2	1	NA
6	You were well prepared in the area of load calculations.	5	4	3	2	1	NA
7	Equipment selection is an important part of your job.	5	4	3	2	1	NA
8	You were well prepared in the area of equipment selection.	5	4	3	2	1	NA
9	Control theory is an important part of your job.	5	4	3	2	1	NA
10	You were well prepared in the area of control theory.	5	4	3	2	1	NA
11	Control application is an important part of your job.	5	4	3	2	1	NA
12	You were well prepared in the area of control application.	5	4	3	2	1	NA
13	The ability to read a blue print is an important part of your job.	5	4	3	2	1	NA
14	You were well prepared to read blue prints.	5	4	3	2	1	NA
15	The ability to understand job specs. is an important part of your job.	5	4	3	2	1	NA
16	You were well prepared to deal with job specifications.	5	4	3	2	1	NA
17	Math is an important part of your job.	5	4	3	2	1	NA
18	You were well prepared in the area of math.	5	4	3	2	1	NA
19	Written communication skills is an important part of your job.	5	4	3	2	1	NA
20	You were well prepared in the area of written communications.	5	4	3	2	1	NA
21	Verbal communication skills are an important part of your job.	5	4	3	2	1	NA
22	You were well prepared in the area of verbal communication.	5	4	3	2	1	NA
23	The ability to troubleshoot is an important part of your job.	5	4	3	2	1	NA
24	You were well prepared in the area of troubleshooting.	5	4	3	2	1	NA
25	The ability to develop electrical schematics is important to your job.	5	4	3	2	1	NA
26	You were well prepared to develop electrical schematics.	5	4	3	2	1	NA
27	The ability to commission an HVAC system is important to your job.	5	4	3	2	1	NA
28	You were well prepared to commission HVAC equipment.	5	4	3	2	1	NA
29	Overall you were well prepared for the job that you are doing.	5	4	3	2	1	NA
30	The HVAC classrooms at Ferris were adequate for instruction.	5	4	3	2	1	NA
31	The HVAC laboratories at Ferris were adequate for instruction.	5	4	3	2	1	NA
32	The advising was adequate in the HVAC program.	5	4	3	2	1	NA
33	The placement services were adequate at Ferris.	5	4	3	2	1	NA
34	The computer labs were adequate in the HVAC program.	5	4	3	2	1	NA
35	You had no problem finding a job after graduation.	5	4	3	2	1	NA
36	Would you have taken HVAC courses on the internet if available.	5	4	3	2	1	NA
37	You were able to be productive in your job right out of school.	5	4	3	2	1	NA
38	There is a high demand for the HVACR 4 year degree graduate.	5	4	3	2	1	NA
39	The Ferris HVACR Engineering Tech. Program should expand.	5	4	3	2	1	NA
40	The Ferris HVACR program should update the facility.	5	4	3	2	1	NA

SURVEY – Page 3:

In the space below, you can make detailed comments on the previous page of evaluation or add comments on specific program concerns including program strengths, weaknesses, areas for improvement, action required to achieve improvement, etc.

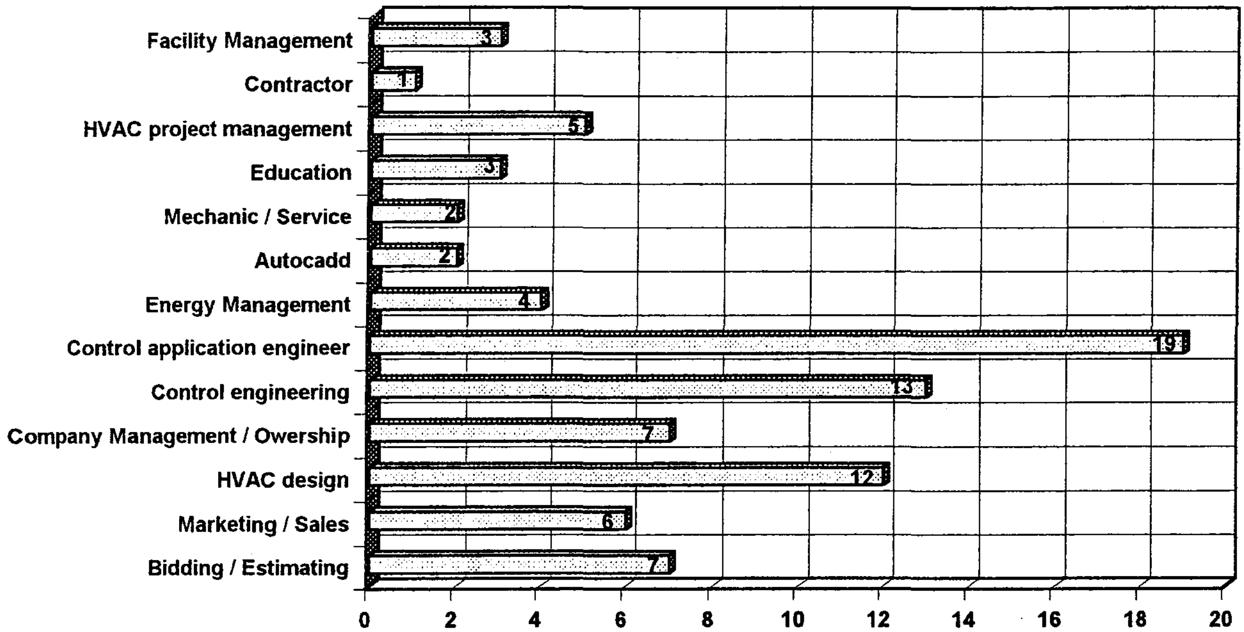
Number of Graduates Responding by Year Graduated



Y-1990	6
Y-1991	7
Y-1992	3
Y-1993	4
Y-1994	7
Y-1995	2
Y-1996	11
Y-1997	15
Y-1998	7
Total	62

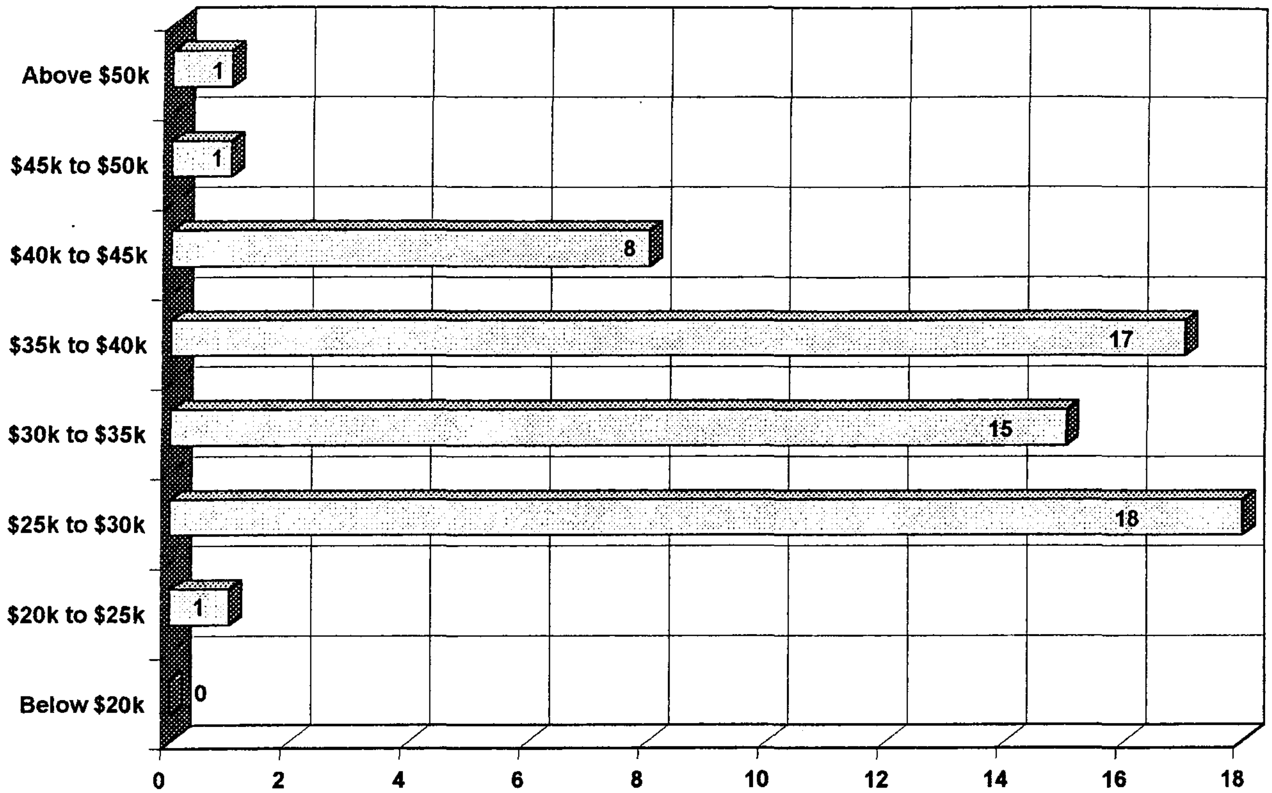
There was a reasonably good distribution of the 62 respondents over the years surveyed. Only 1995 was poorly represented compared to other responding years. A balanced survey response over this period of time should show if the HVACR Engineering Technology Program is heading in the right direction. It should also show if there has been curriculum responses to previous graduate concerns. Recent graduates should help us determine any corrections to the direction our program should be taking.

JOB TITLES OF RESPONDENTS



Bidding / Estimating	7
Marketing / Sales	6
HVAC design	12
Company Management / Ownership	7
Control engineering	13
Control application engineer	19
Energy Management	4
Autocadd	2
Mechanic / Service	2
Education	3
HVAC project management	5
Contractor	1
Facility Management	3
TOTAL	84

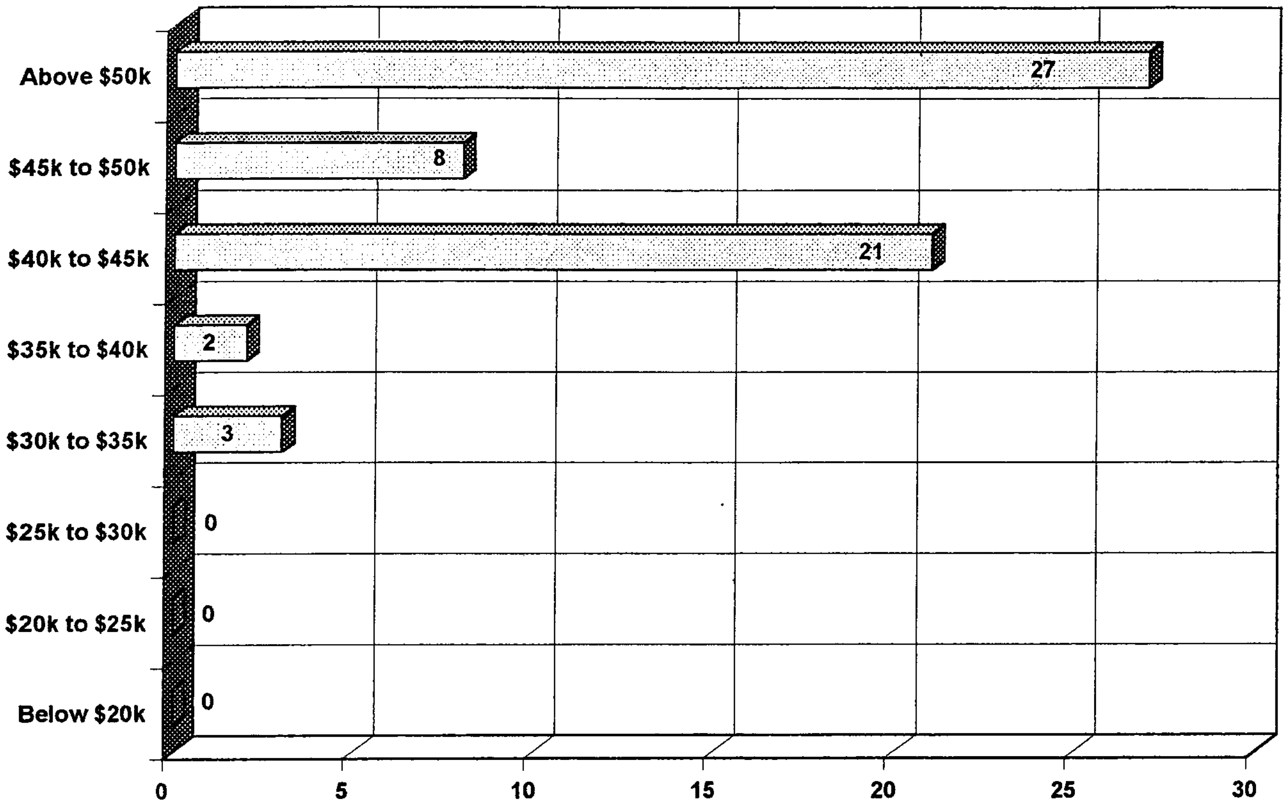
The graduates of the HVACR Engineering Technology Program are finding a wide range of job types. The majority of jobs are in the area of controls and HVAC design. Satisfaction and success are increased for each individual graduate because of this diversity in job descriptions. All areas appear to be increasing according to graduate comments with ample ability for both lateral and upward advancement within each area and between areas. NOTE: See student comments at the end of the section.



Below $20k	0
$20k to $25k	1
$25k to $30k	18
$30k to $35k	15
$35k to $40k	17
$40k to $45k	8
$45k to $50k	1
Above $50k	1
No Response	1
TOTAL	62

Starting salaries also have been good for the graduates of the HVACR Engineering Technology Program. Because of the 10 year response to the survey the rate of initial salaries vary over the range shown. Graduates from the past 3 years are starting at salaries from the high $30,000 to mid $40,000 range. This high initial salary is due to a number of factors including the high demand for the HVACR Engineering graduates and the ability of the graduates to be productive for the employer from the very first day. Senior students preparing to graduate are being offered starting salaries as high as the low $50,000 range.

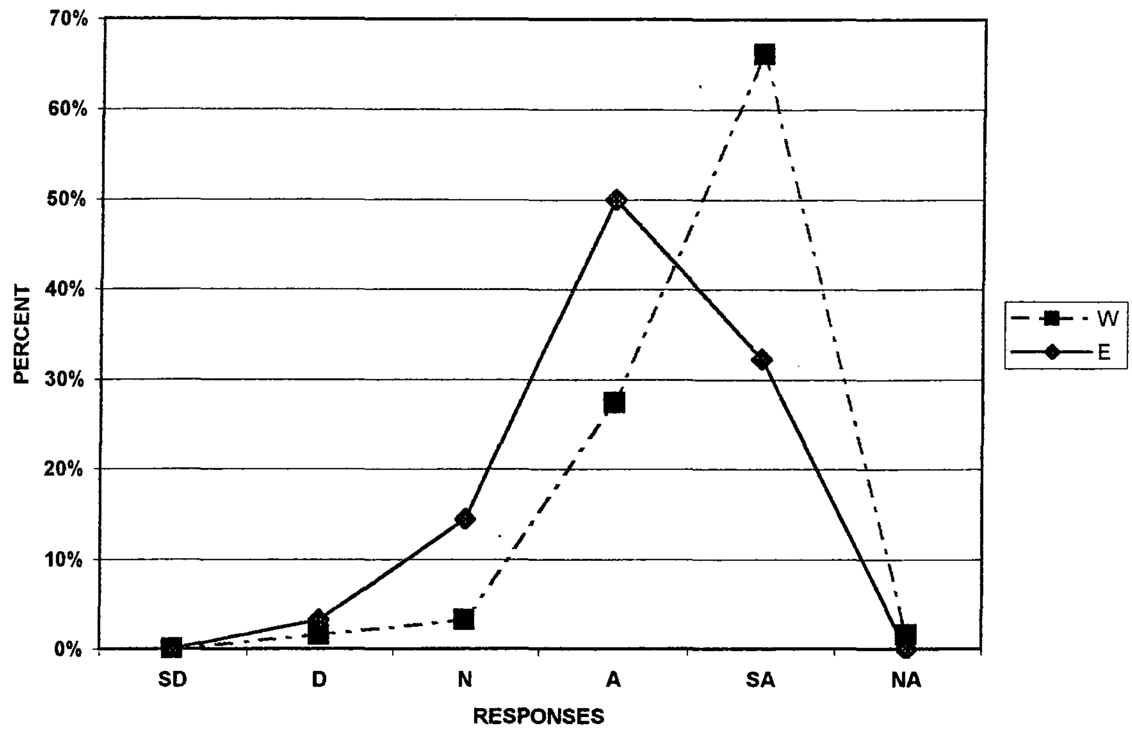
CURRENT SALARIES FOR 4-YEAR GRADUATES



Below $20k	0
$20k to $25k	0
$25k to $30k	0
$30k to $35k	3
$35k to $40k	2
$40k to $45k	21
$45k to $50k	8
Above $50k	27
No Response	1
TOTAL	62

There was a small problem with this question in the survey. The upper range was not high enough to get a good idea of the upper potential earnings for the HVACR Engineering Technology program. The highest category surveyed was above $50,000. 44% of the graduates responding to the survey are earning more than $50,000 per year. This degree absolutely allows for the graduate to earn a substantial living. No respondent in this survey is currently making less than $30,000 per year.

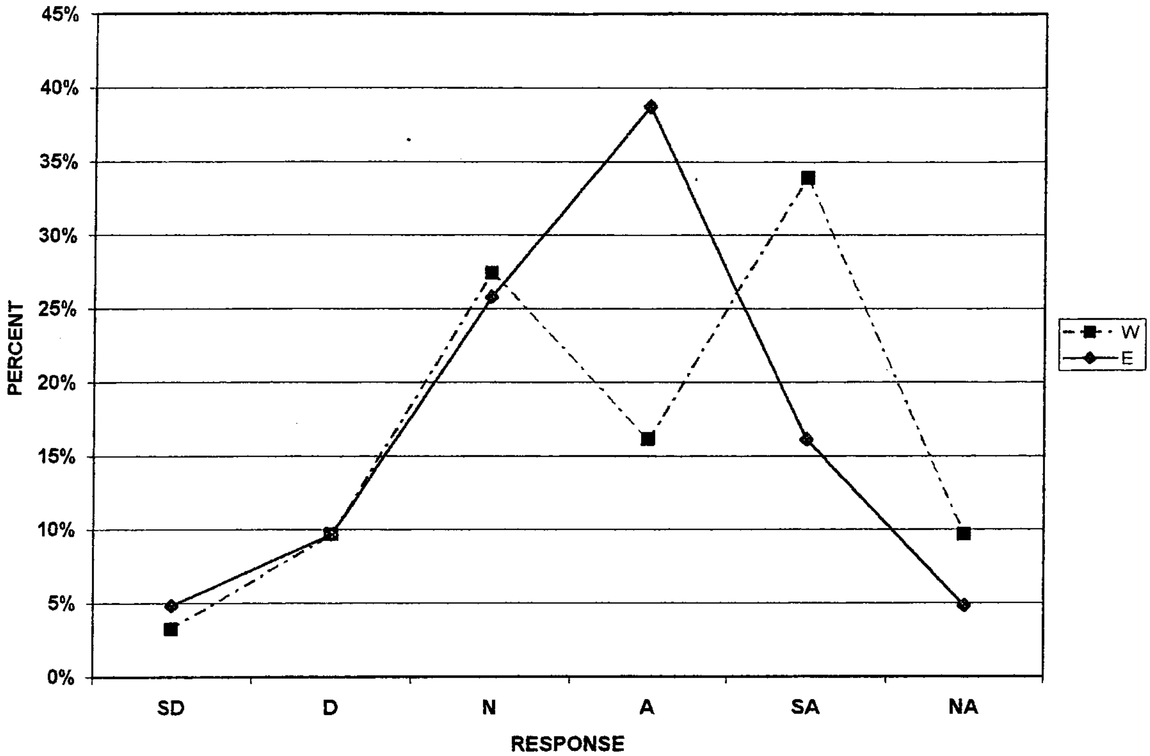
COMPARISON – HVAC DESIGN COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The HVAC design classes are important to your job. (W)	0%	2%	3%	27%	66%	2%	**4.58**
You were well prepared in the area of HVACR design (E)	0%	3%	15%	50%	32%	0%	**4.15**

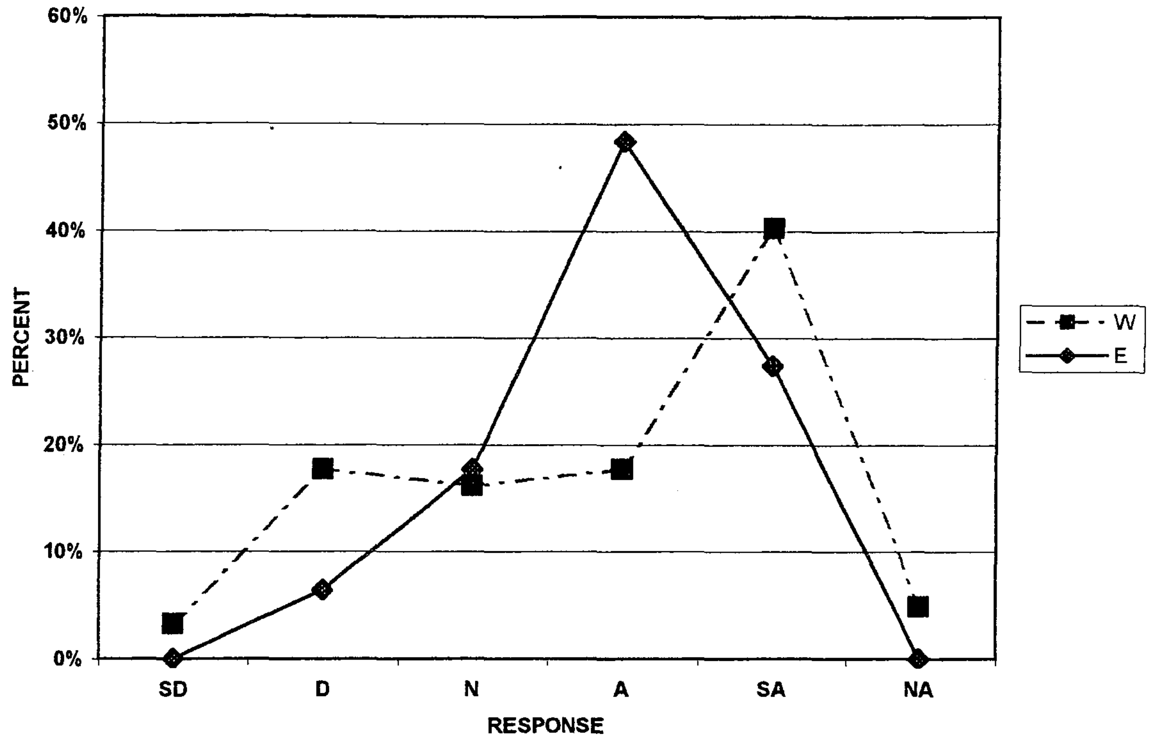
This question relates to HVAC 331. This courses is the most critical course in the curriculum. No matter what area the graduates work in, the ability to design and size HVAC systems is the foundation. The graduates agree, that HVAC design is critical to their job (93% agree or strongly agree). The students also feel that they are being well prepared in this area (82% agree or strongly agree). This part of the core curriculum is meeting or exceeding expectations.

COMPARISON – CAD COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The use of CAD is important to your job. (W)	3%	10%	27%	16%	34%	10%	**3.76**
You were well prepared in the area of CAD. (E)	5%	10%	26%	39%	16%	5%	**3.55**

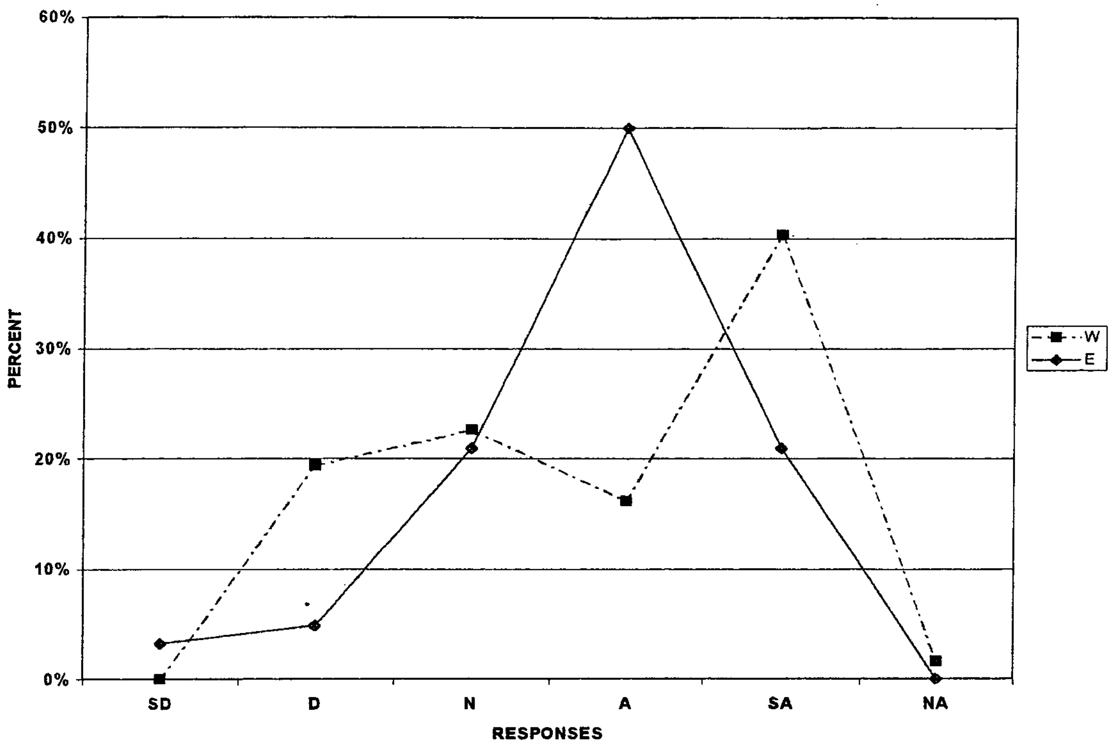
The use of CAD in the HVAC field is very important especially to those graduates that are going to work for design firms. The other potential areas of work will also use CAD but to lesser extents. 50% of the graduates agree or strongly agree that CAD is important to their job. The graduates that were neutral in their response indicate work areas that may use CAD less frequently or the graduates are no longer responsible for developing drawings. The ARCH 109 course is meeting the graduate needs in this area according to 55% of the respondents. Of the graduates responding in the disagree or strongly disagree area, the only comment from a graduate was the idea that it would have been better if the CAD class drawings were HVAC related. Some of this is being taken care of by the required use of CAD by the students in other courses after they take ARCH 109. Students end up having to do everything from schematics to duct and piping layouts in HVAC 312, HVAC 415, HVAC 499 etc.



	SD	D	N	A	SA	NA	AVE.
The ability to do a load calculation is important to your job. (W)	3%	18%	16%	18%	40%	5%	**3.70**
You were well prepared in the area of load calculations. (E)	0%	6%	18%	48%	27%	0%	**4.00**

This is another area that the need to do a load calculation is depending on what area the graduate decides to work. The ability to do a load calculation is still a very important part of the HVACR Engineering Technology program and the HVAC industry in general. 58% of the graduates agree or strongly agree that this area is important to their job. 75% of the graduates agree or strongly agree that they were well prepared in the area of load calculation. This area is on track according to the graduates but must be constantly monitored because of the changes in load calculation software. The program must continually monitor what load software is being used by employers and adjust accordingly.

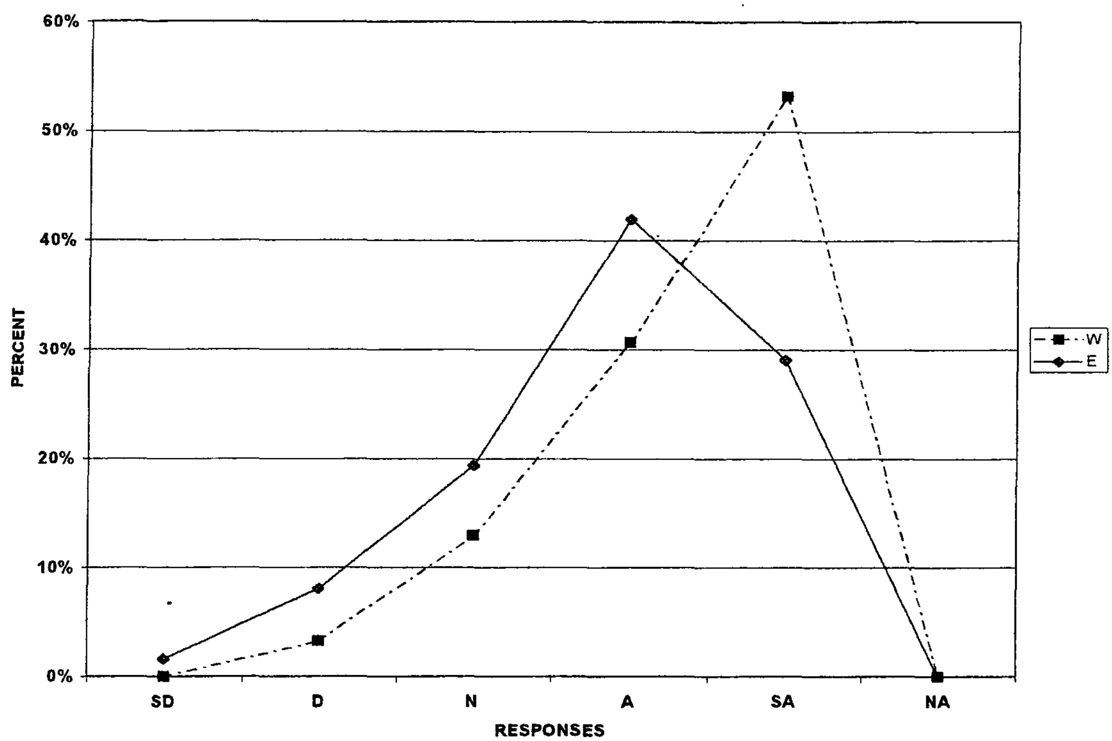
COMPARISON – EQUIPMENT SELECTION COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
Equipment selection is an important part of your job. (W)	0%	19%	23%	16%	40%	2%	**3.76**
You were well prepared in the area of equipment selection. (E)	3%	5%	21%	50%	21%	0%	**3.80**

Equipment selection is very dependant on the job the graduate works at. The survey demonstrates that this skill is either needed or not. 56% of the respondents agree or strongly agree that this is important to their job. 19% of the respondents disagree that this is an important part of their job. 71% of the graduates agree or strongly agree that they were well prepared in the area of equipment selection. This part of the curriculum is a very critical part of the design process in the field of HVAC. Those graduates that end up in an area of design strongly agree that this is a critical area of their job. This is another area that must be looked at continually to ensure that the course matches the needs of employers.

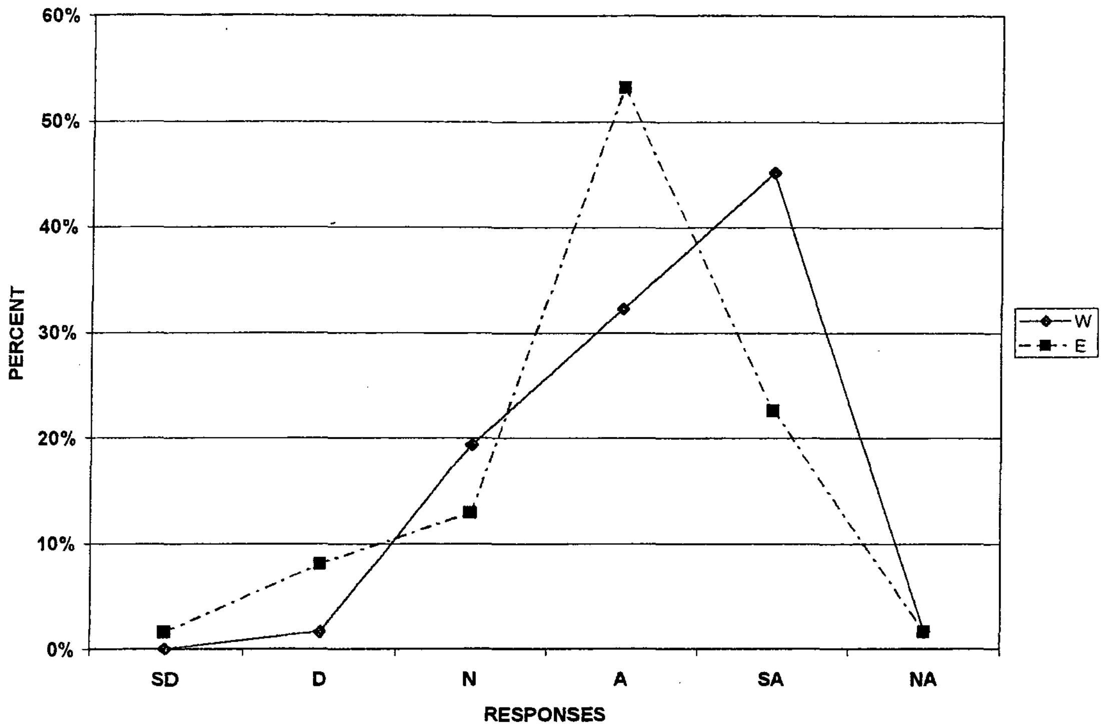
COMPARISON – CONTROL THEORY COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
Control theory is an important part of your job. (W)	0%	3%	13%	31%	53%	0%	**4.35**
You were well prepared in the area of control theory. (E)	2%	8%	19%	42%	29%	0%	**3.91**

The largest percentage of the graduates responding to the survey work in a control related area, so it is not surprising that the number of respondents that agree or strongly agree that control theory is important to their job is 84%. 71% agree or strongly agree that they were well prepared in the area of control theory. When considering all the different areas that the graduates can go into, controls are the fastest growing and most rapid changing of the areas. Controls are tied to the computer industry and as the computer field goes, so goes the control field. Control classes will be a difficult area to keep up with the most current technology. Because the technology is changing very rapidly and is expensive, it is difficult to keep current equipment in the lab. Also, 10% of the graduates disagree or strongly disagree that they were well prepared in the area of control theory. It should be noted, over the 10 years of graduates surveyed, there have been 4 different instructors teaching in this area. Consistency in any area is critical to it's success.

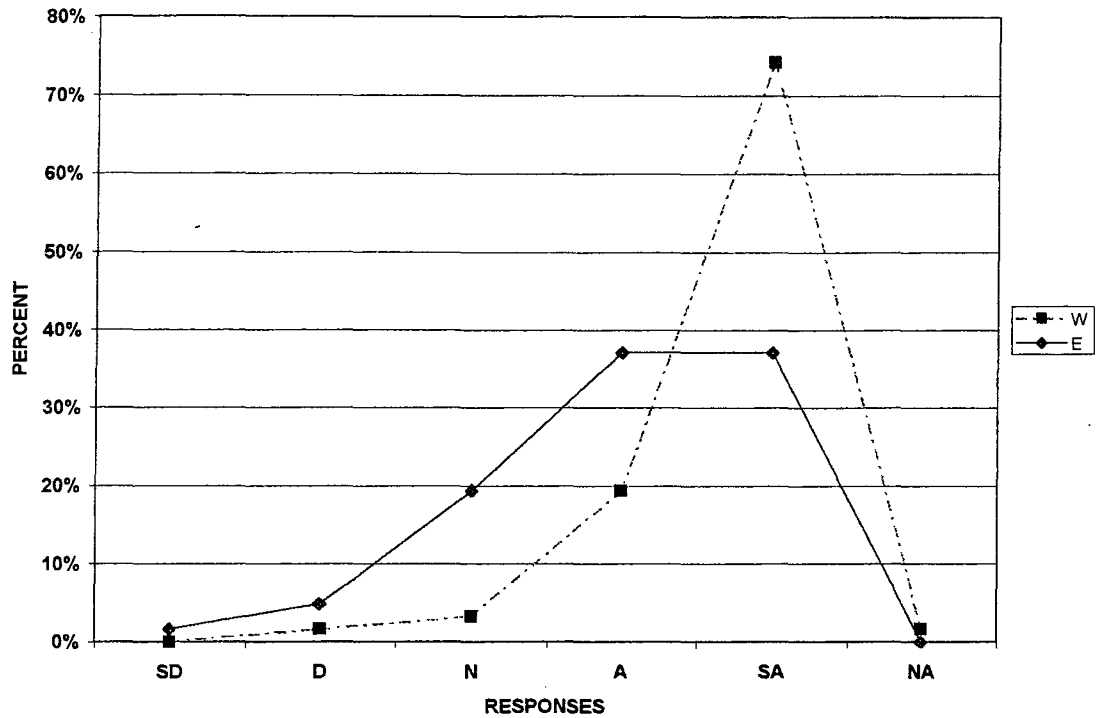
COMPARISON – CONTROL APPLICATION COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
Control application is an important part of your job. (W)	0%	2%	19%	32%	45%	2%	**4.27**
You were well prepared in the area of control application. (E)	2%	8%	13%	53%	23%	2%	**3.91**

76% of the graduates responded agree or strongly agree that they were well prepared in the area of control application. 77% of the graduates responded agree or strongly agree that control application is an important part their job. Control application is a key part of the majority of the graduates responding to the survey and a majority of the graduates feel that they were prepared by the program. 10% of the graduates responded disagree or strongly disagree that they were well prepared. Again, the survey covers over 10 years of graduates and during this time period the program changed professors in this area 4 times. Also during this time period the controls that were being taught on were rapidly becoming outdated. In the past year a number of donations from control companies have helped upgrade the type of controls being taught on. This, along with a consistent line of instruction, should increase the total satisfaction in this area. This area of the curriculum needs constant evaluation and feedback from graduates and industry due to the rapid changes in technology to continue a high level of success.

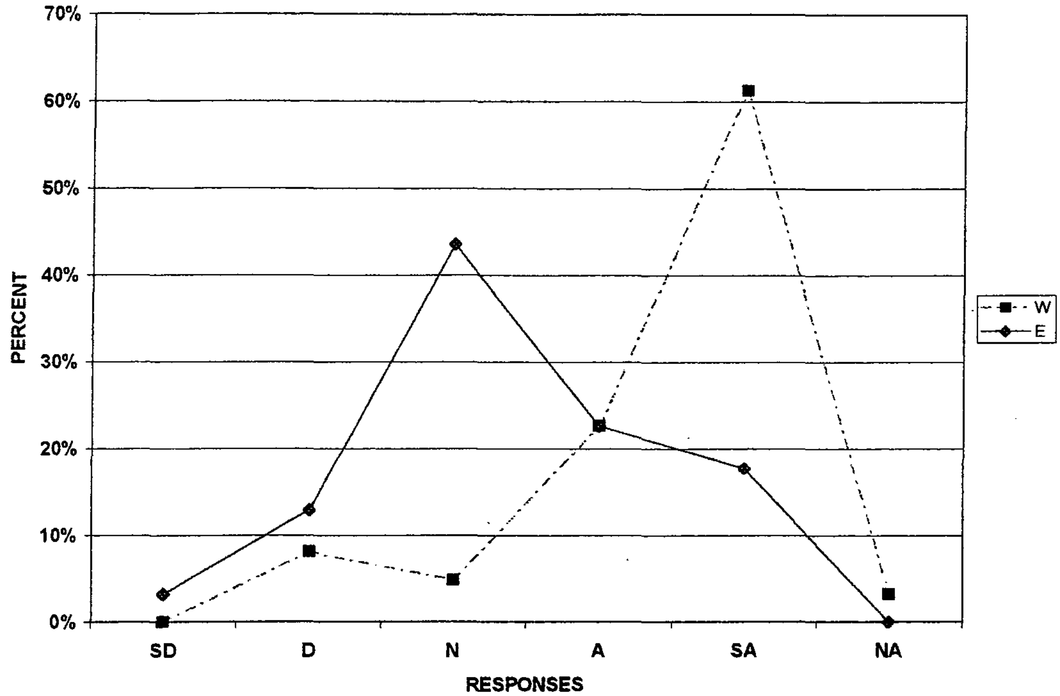
COMPARISON – BLUE PRINT ANALYSIS COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The ability to read a blue print is an important part of your job. (W)	0%	2%	3%	19%	74%	2%	**4.71**
You were well prepared to read blue prints. (E)	2%	5%	19%	37%	37%	0%	**4.00**

93% of the graduates agree or strongly agree that blue print reading is an important part of their job. 74% of the graduate agree or strongly agree that they are well prepared in the area of blue print reading. Steps have been taken in recent years to include more blue print work in all of the HVAC courses. In 1999, HVAC 499 was changed from a energy audit class to a complete design and analysis class. A majority of work in this class demands the use of blue prints and the ability to interpret them. More difficult blue prints are also being used in the control application course HVAC 415. Constant review of all the courses in the area of blue print analysis and usage must be done. An effort should be made to update blue prints on a regular basis. Many of the members of the HVAC advisory board are from the design area and can get the program current blue prints for analysis.

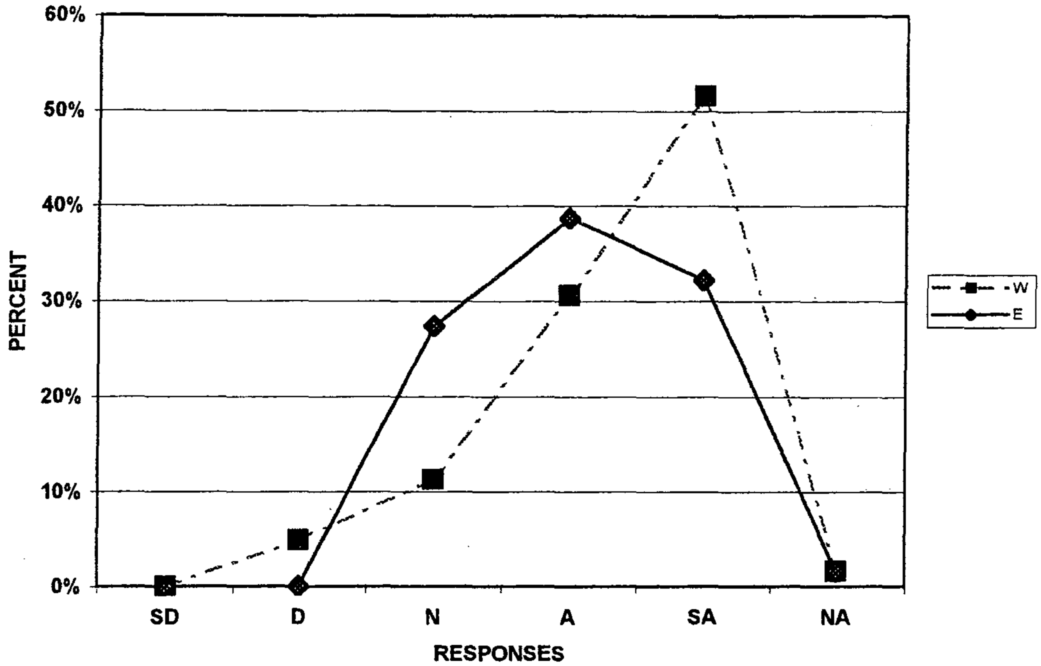
COMPARISON – JOB SPECIFICATION USAGE COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The ability to understand job specs. is an important part of your job. (W)	0%	8%	5%	23%	61%	3%	**4.44**
You were well prepared to deal with job specs. (E)	3%	13%	44%	23%	18%	0%	**3.41**

84% of the graduates agree or strongly agree that understanding job specifications are important to their job. Compare this with the number of graduates that feel that they were well prepared in this area, 41%. Although only 16% of the graduates disagree or strongly disagree that they were well prepared, this should still be an area of concern. This is the only area that did not get high marks regarding the programs ability to prepare. Analysis of all courses in the curriculum should be taken in regards to specification usage. One corrective action has been mentioned that might take care of this issue. HVAC 499 is now a complete design and application course and the use of blue prints and job specifications are crucial. Careful monitoring and feedback in this area is required and further steps should be taken to achieve high satisfaction marks similar to all other areas within the curriculum.

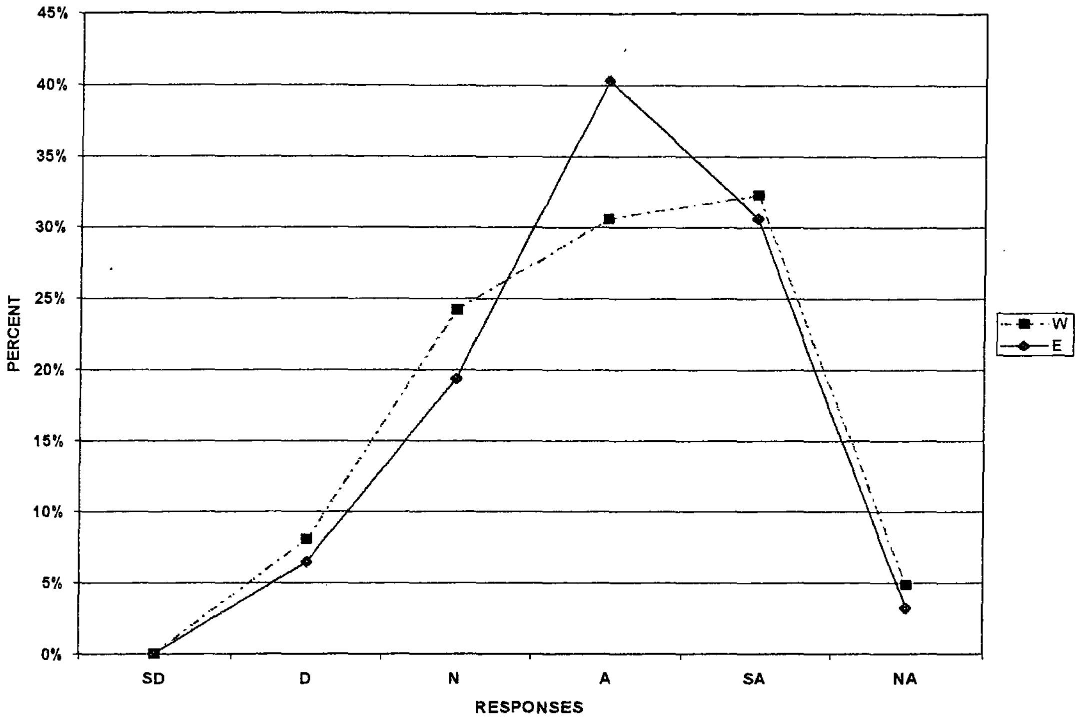
COMPARISON – TROUBLESHOOTING COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The ability to troubleshoot is an important part of your job. (W)	0%	5%	11%	31%	52%	2%	**4.31**
You were well prepared in the area of troubleshooting. (E)	0%	0%	27%	39%	32%	2%	**4.07**

83% of the graduate agree or strongly agree that troubleshooting is an important part of their job. 71% of the graduates agree or strongly agree that they were well prepared in the area of troubleshooting with no graduate disagreeing. The program is doing a good job in this area and always has been one of the programs strong suits.

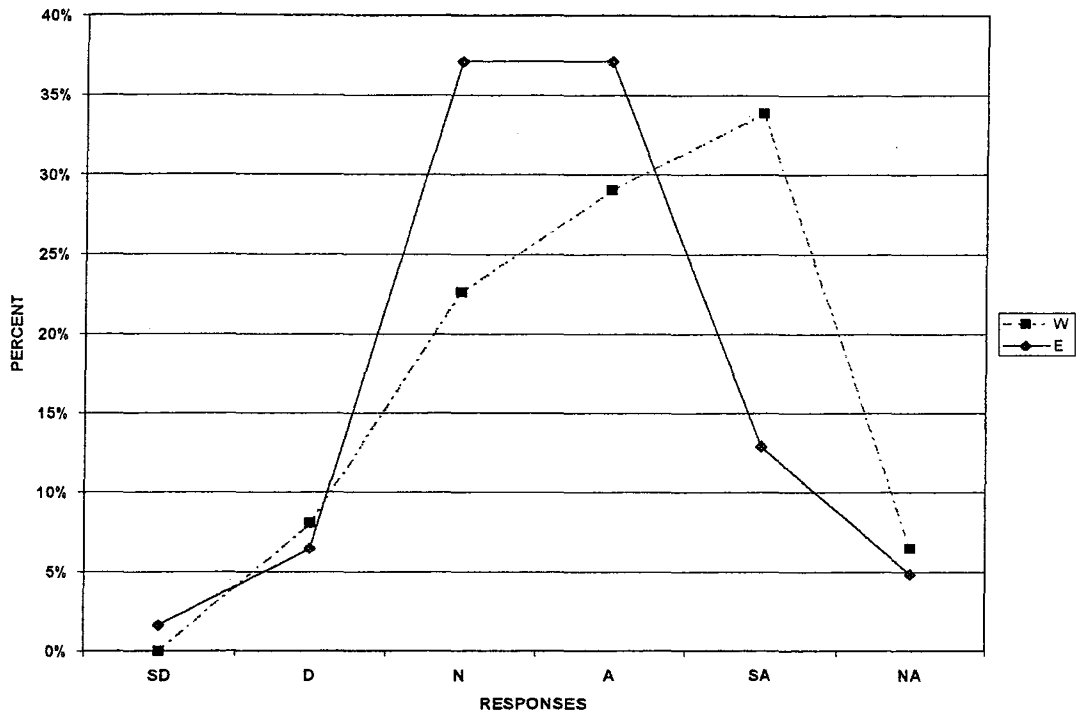
COMPARISON – ELEC. SCHEMATIC DEVELOPMENT COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The ability to develop electrical schematics is important to your job. (W)	0%	8%	24%	31%	32%	5%	**3.81**
You were well prepared to develop electrical schematics. (E)	0%	6%	19%	40%	31%	3%	**3.98**

63% of the graduates agree or strongly agree that the ability to develop electrical schematics is an important part of their job. 71% of the graduates agree or strongly agree that they were well prepared in this area. A large amount of time is spent in the program working on electrical schematics, both in developing them and the ability to use them in troubleshooting. Only 6% of the graduates disagree that they were well prepared in this area. One possible reason for this may be the portion of students that transfer into the four year program from other colleges. Our own two year program spends considerable time in electrical schematics. Further analysis must be done to decide why the 6% disagreement.

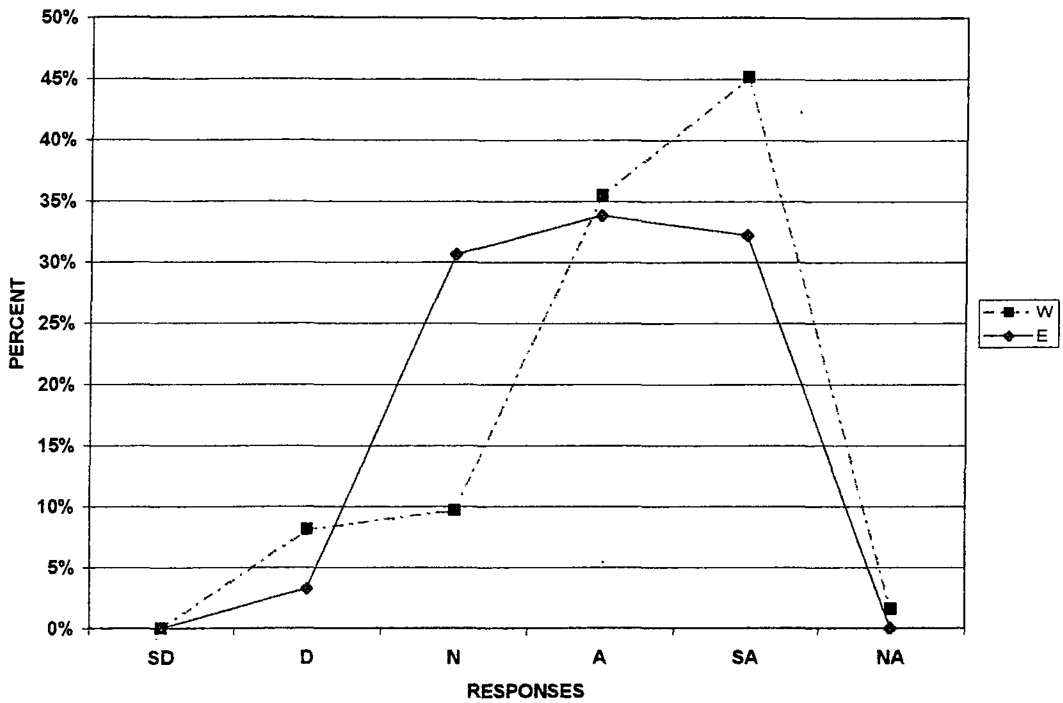
COMPARISON – SYSTEM COMMISSIONING COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
The ability to commission an HVAC system is important to your job. (W)	0%	8%	23%	29%	34%	6%	**3.88**
You were well prepared to commission HVAC equipment. (E)	2%	6%	37%	37%	13%	5%	**3.47**

63% of the graduates agree or strongly agree that commissioning systems is important to their job. 50% of the graduates agree or strongly agree that they were well prepared in the area of commissioning. 8% of the graduates disagree or strongly disagree that they were well prepared for commissioning HVAC systems. The term commissioning has only come into being in the last 5 years and the HVAC program has taken steps to incorporate this area into the curriculum. Commissioning will become increasingly important with the increased complexity of control systems.

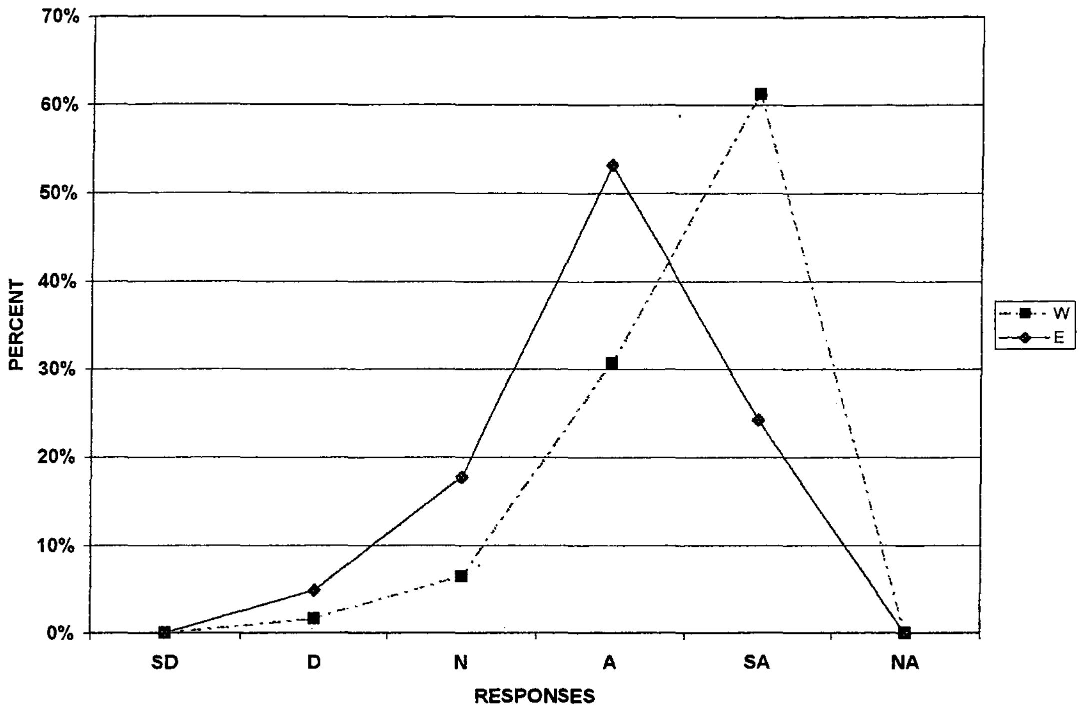
COMPARISON – MATH COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	Ave.
Math is an important part of your job. (W)	0%	8%	10%	35%	45%	2%	**4.18**
You were well prepared in the area of math. (E)	0%	3%	31%	34%	32%	0%	**3.98**

80% of graduates agree or strongly agree that math is an important part of their job. 66% of the graduates agree or strongly agree that they were well prepared in the math area. Only 3% of the graduates disagreed that they were well prepared. A large portion of graduates were in the neutral area which may reflect on their general ability to do math and not how much math they were exposed to. Students are required to take math courses through MATH 126. Students are required to use math in all the core classes in a practical or applied format. Attention must continue, emphasizing math and it's importance in the work environment.

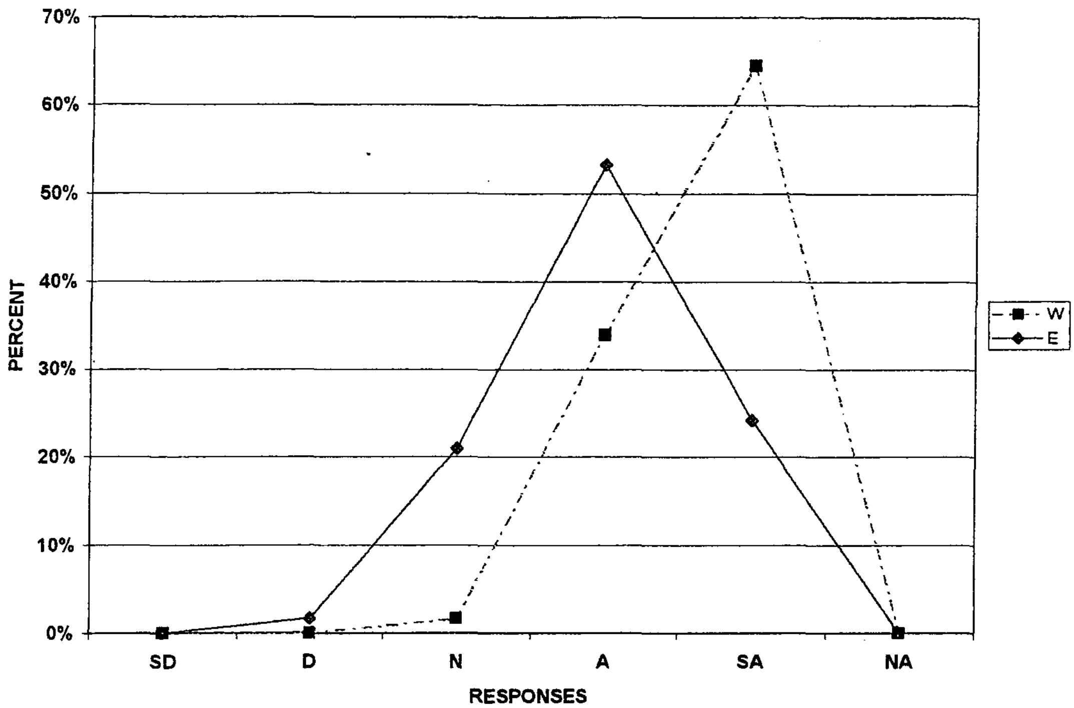
COMPARISON – WRITING INTENSIVE COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
Written communication skills is an important part of your job. (W)	0%	2%	6%	31%	61%	0%	**4.48**
You were well prepared in the area of written communications. (E)	0%	5%	18%	53%	24%	0%	**3.96**

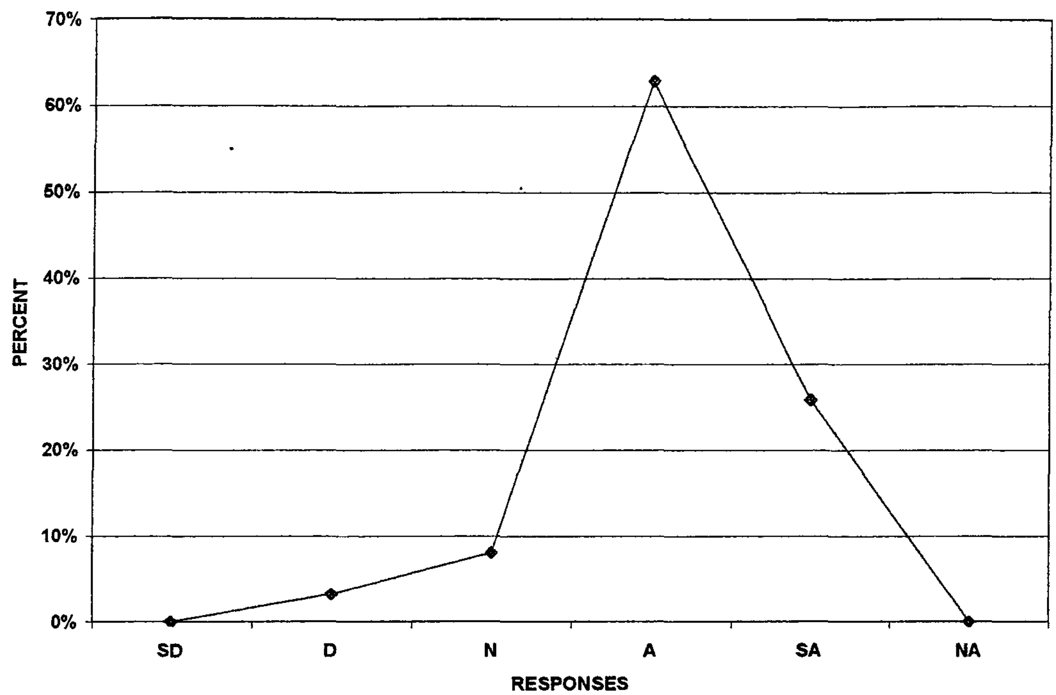
92% of the graduates agree or strongly agree that written skills are important in their job. 79% of the graduates agree or strongly agree that they were well prepared in the written skills area. Only 5% of the graduates disagree that they were well prepared in the written skills area. There have been some recent adjustments within our program to increase the amount of written material generated by the students in various courses. The graduates responded favorably to their preparation but this area must constantly be emphasized to the students.

COMPARISON – VERBAL COMMUNICATION COURSES WITH WORK REQUIREMENT



	SD	D	N	A	SA	NA	AVE.
Verbal communications skills are an important part of your job. (W)	0%	0%	2%	34%	65%	0%	**4.63**
You were well prepared in the area of verbal communications. (E)	0%	2%	21%	53%	24%	0%	**4.00**

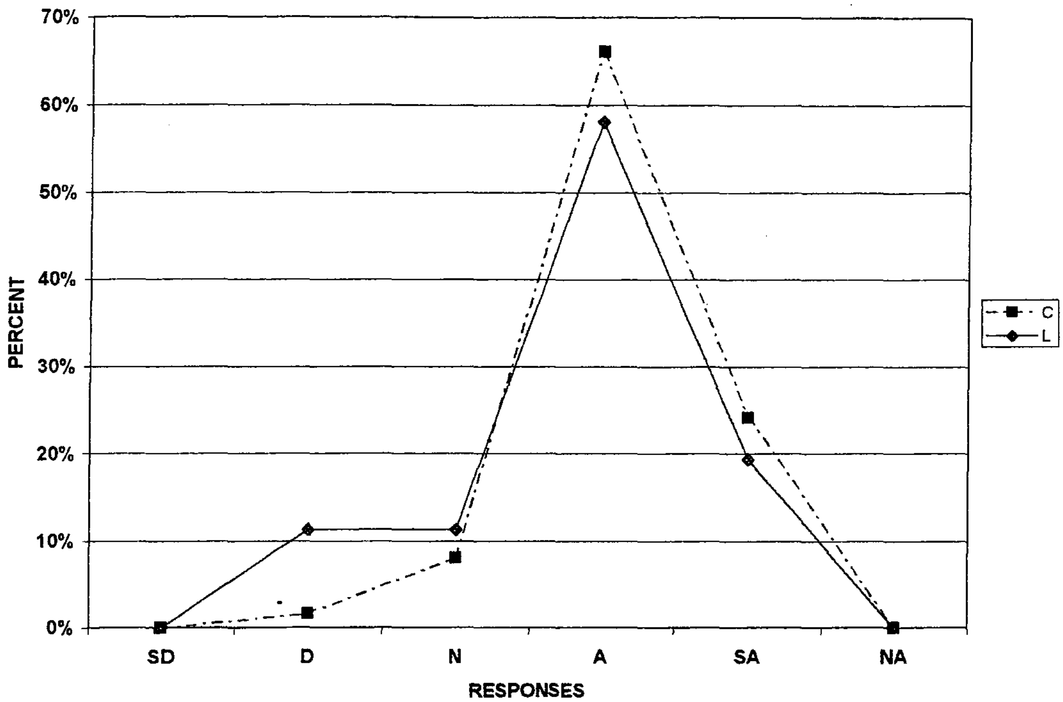
98% of the graduates agree and strongly agree that verbal communication skills are important to their job. 77% of the graduates agree and strongly agree that they were well prepared in this area. Only 2% of the graduates disagree that they were well prepared in the verbal communication area. Another critical area for the students to be strong in and the program is meeting the current need. Emphasis must continue in this area to continue serving this area.



	SD	D	N	A	SA	NA	AVE.
Overall you were well prepared for the job that you are doing.	0%	3%	8%	63%	26%	0%	4.13

89% of the graduates agree or strongly agree that they were well prepared for the job that they are doing. 3% of the graduates disagree that they were well prepared for the job that they are doing. Considering the wide diversity of areas that are students are trained in and the wide diversity of jobs that the students can find themselves in, the survey shows that the HVACR Engineering Technology program is accomplishing it's mission. Even though the results are strong, there is always room for improvement. A careful look at all the individual areas of the survey will help raise the results of this area to greater heights.

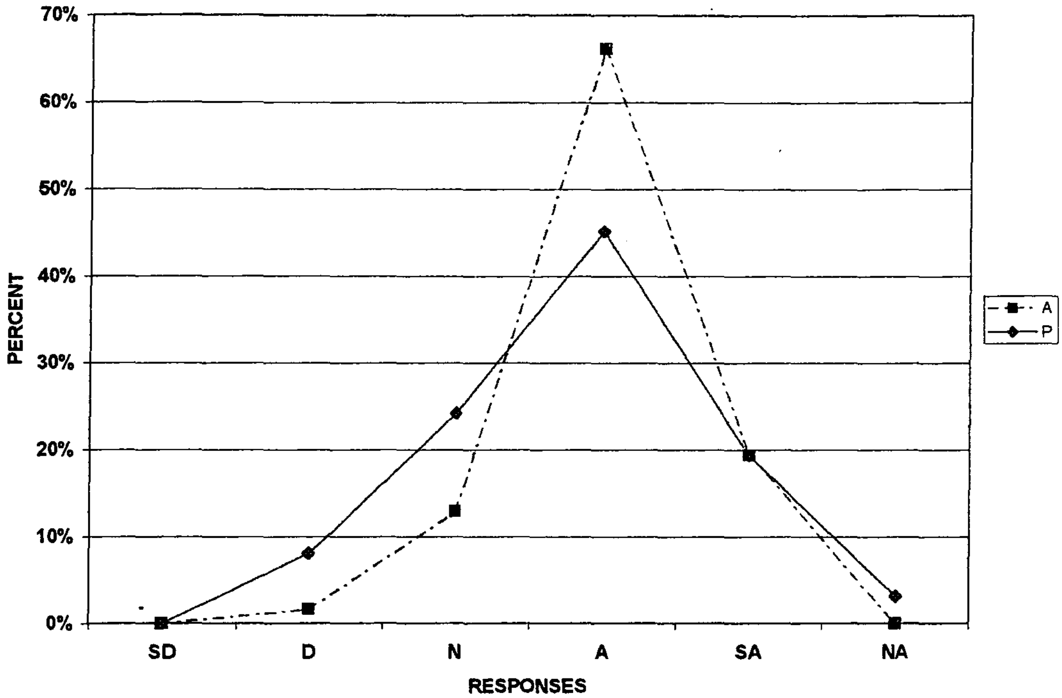
GRADUATES PERCEPTIONS OF THE FACILITIES



	SD	D	N	A	SA	NA	AVE.
The HVAC classrooms at Ferris were adequate for instruction. (C)	0%	2%	8%	66%	24%	0%	**4.11**
The HVAC laboratories at Ferris were adequate for instruction. (L)	0%	11%	11%	58%	19%	0%	**3.89**

90% of the graduates agree or strongly agree that the classrooms were adequate for instruction. Only 2% of the graduates disagree that the classrooms were adequate for instruction. As the class sizes increase this number will increase. In the past 2 years, lectures have been held in other facilities because of the size of the classes.

77% of the graduates agree or strongly agree that the laboratories were adequate for instruction. 11% of the graduates disagree that the laboratories were adequate for instruction. This number is higher because the labs are crowded due to the increased class sizes. Labs have strict size limits due to safety considerations. The program can no longer increase in size due to the lack of space.

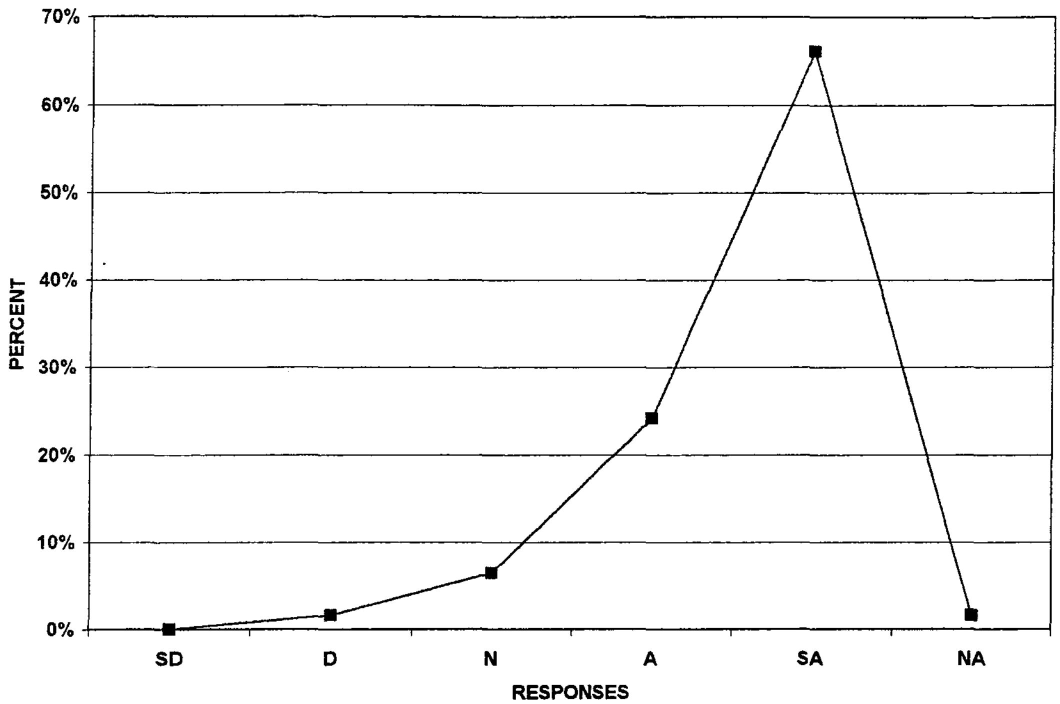


	SD	D	N	A	SA	NA	AVE.
The advising was adequate in the HVAC program. (A)	0%	2%	13%	66%	19%	0%	**4.04**
The placement services were adequate at Ferris. (P)	0%	8%	24%	45%	19%	3%	**3.80**

85% of the graduates agree or strongly agree that the advising was adequate. Only 2% of the graduates disagree that the advising was adequate. The program is doing a good job in this area.

64% of the graduates agree or strongly agree that the placement services were adequate at Ferris. 8% of the graduates disagree that the placement services were adequate. No reasons were given for the few negative responses to the placement services.

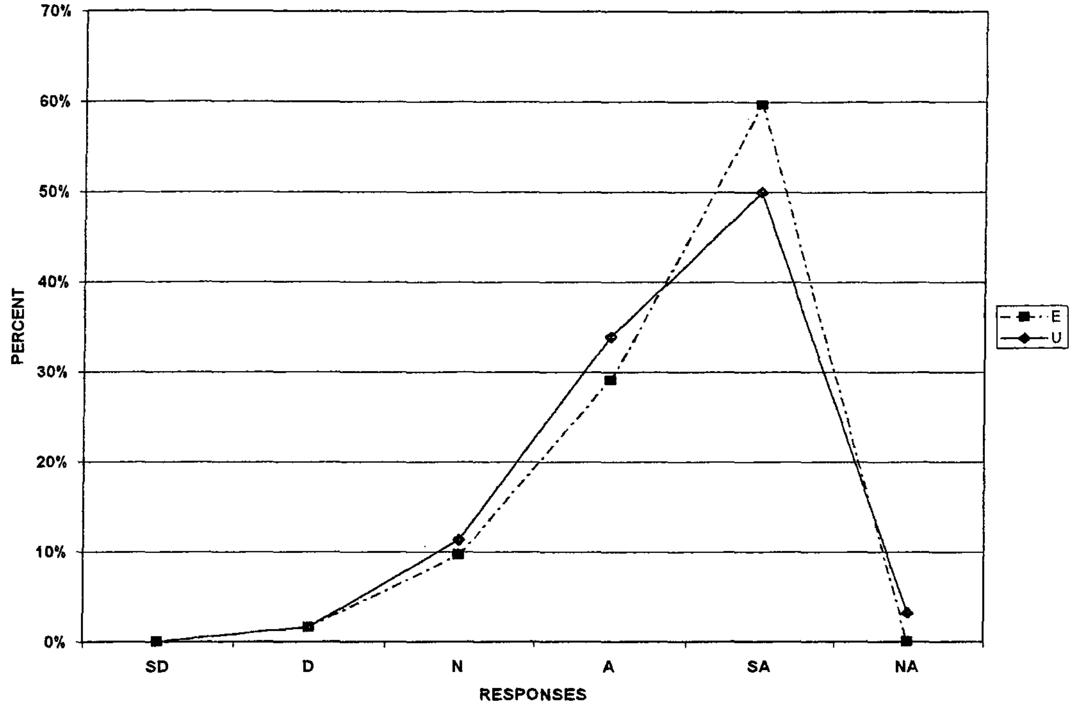
GRADUATES PERCEPTION OF DEGREE DEMAND



	SD	D	N	A	SA	NA	AVE.
There is a high demand for the HVACR 4 year degree graduate.	0%	2%	6%	24%	66%	2%	**4.58**

90% of the graduates agree or strongly agree that there is a high demand for the HVACR engineering technology degree. Only 2% disagree. This confirms the demand that the program is seeing from a number of other sources including trade shows, advisory board and industry itself.

Note: Siemans corporation, last semester, came to the program with 380 immediate openings for our graduates nation wide. We graduate, on average, 25 – 30 students per year. If Siemans hired all of our graduates it would not even satisfy 10% of the demand.



	SD	D	N	A	SA	NA	AVE.
The Ferris HVACR Engineering Tech. Program should expand. (E)	0%	2%	10%	29%	60%	0%	**4.41**
The Ferris HVACR program should update the facility. (U)	0%	2%	11%	34%	50%	3%	**4.34**

89% of the graduates agree or strongly agree that the program should expand. 84% of the graduates agree or strongly agree that the program should update the facility. Only 2% disagreed in both categories. Because of the state of the facility and the demand for the graduates this response to this question is not surprising.

STUDENT SURVEY COMMENTS

"For the most part, I am 100% pleased with my degree from Ferris State University. I feel as if I have complete job security with the degree. I fell if my job at GMB was ever in jeopardy I could easily find another job somewhere close to where I live now. There is no doubt in my mind, I would easily find another job in Michigan or the US. As I stated earlier in the Graduate Survey, I primarily design HVACR systems for commercial applications. Most of them are schools. I felt when I first started my job from college, I was well prepared. I could start being productive day one, of course there was much more to learn. I guess what my point is, I work with a lot of mechanical engineers. Some mechanical engineers are really driven on titles. They seem to think Ferris State people aren't up to their standards. With my degree from Ferris I feel I am to their standards if not better. When I first started my job out of college I was productive from the fist day on. A new mechanical engineer from college must be taught HVACR on the job and of course aren't productive right away. I can do anything pertaining to HVACR with my degree at work. I've designed a number of large HVACR and plumbing systems on my job just like all the other mechanical engineers. It just seems like we are lacking some respect from these engineers because of our degree. It would be nice to see the program become accredited through the State of Michigan as an Engineering Program. In closing, Ferris State graduates are prepared for the real world of HVACR. If I had to due it all over again, I would pursue my degree from Ferris State." - graduate 1997

". . . Overall, today I am in a very nice job position with a decent salary, in which without my education and degree from Ferris, this would not be possible." - graduate 1990

"People that have a 4 year degree in mechanical engineering usually only have one or two HVAC classes on HVAC design. My 4 year HVAC program put me way ahead of that person but in the long run, the registered engineer will always have more money, better positions, and advances in their career, in the design / engineering field." - graduate 1995

"The teachers were all very qualified and very nice. I was very lucky to have gone through such a great program with great support from all the teachers. The teachers that had the most impact included: Tomczyk, LeClair, Stephens, Nott and Lafferty. They were fantastic at teaching what we needed to know by providing very practical – real to life problems to solve. I am very impressed with where the program has gone and where it is heading. If I can ever be of any assistance by being on the advisory committee then please give me a call." graduate – 1993

". . . I graduated in 1993 at the top of my class. I had 8 different jobs to choose from and there is more need presently now in the industry than ever before." - graduate 1993

"I am very happy with the education I was able to take with me from FSU, Thank you so much!!!" - graduate 1998

"A student that has graduated from FSU could use more skills for working with a mechanical contracting company in the following areas: reading blueprints, estimating, microsoft schedule, reading specifications, management classes. Computer class that deals with things an HVAC student will use in everyday life, not what a CIS student will use." - graduate 1997

"The Ferris State HVAC engin. Tech. Program is excellent. There is a high demand in the 4 year degree graduates, especially in the computer HVAC applications." - graduate 1997

"courses in planning, time / schedule management and information co-ordination my be useful. Software tools like suretrak may be useful in this topic. Control companies employ a large percentage of the grads. I hope the lab has been updated with current software configurations and more time is being spent on software / programming engineering. I have seen a lot of fellow graduated struggle in this area." - graduate 1991

"I see where future ABET accreditation would be a huge benefit, as it is currently out of the grasp of graduates to earn a professional license in the state of Michigan without such accreditation. This, along with continued improvement of facilities ought to be among the foremost goals of the department. I realize this requires time and a significant commitment from the University, but it would be well worth the effort in the final analysis. Thanks for your interest! I hope in some small way I have been of assistance." - graduate 1992

"One thing I didn't realize until I started working in the industry was the lack of HVAC knowledge among people who had been in the business for a while. The program at Ferris should be expanded and promoted more. The demand is only getting bigger, and there are not many other schools trying to meet this need." - graduate 1997

"Blueprints and specifications are a must understand item in the construction industry. I wish I would have had some additional classes in this area, maybe an entire semester." - graduate 1996

"I was well prepared for my HVAC controls position!" - graduate 1990

" Over all I am pleased with program and felt that it opened a lot of opportunity. I started out a control engineer (DDC) and now I am working for an A/E firm. One area that I felt could have been covered in several classes at Ferris was AUTOCAD design. I learned enough, but struggled some after Ferris. I am also looking into the requirements need to be licensed thru the state for a PE. .... as I said previously I am very pleased with Ferris HVACR program and instructors like "Mitch LeClaire"." - graduate 1994

"I strongly feel that if the HVACR program wants to expand and move forward and with a large percentage of graduates with a 4 year degree working within the consulting / design engineering fields the certification of professional engineer status has to be addressed. Other than the certification issue I feel the program is in excellent shape and is highly respected." - graduate 1990

Note: Many comments were too long to be included but the key issues were included.

RAW SURVEY DATA

The HVAC design classes are important to your job.	5	4	4	5	5	4	5	4	5	2
You were well prepared in the area of HVACR design	5	3	3	5	4	4	4	4	5	3
The use of CAD is important to your job.	5	4	3	5	5	5	5	3	5	
You were well prepared in the area of CAD.	5	3	4	3	3	5	5	3	5	1
The ability to do a load calculation is important to your job.	5	4	4	5	5	3	5	3	5	5
You were well prepared in the area of load calculations.	5	2	4	5	3	3	5	4	5	4
Equipment selection is an important part of your job.	5	4	3	5	5	4	5	3	5	5
You were well prepared in the area of equipment selection.	4	3	3	4	3	4	5	4	5	4
Control theory is an important part of your job.	5	4	4	4	4	5	4	5	5	2
You were well prepared in the area of control theory.	5	4	3	4	2	5	3	4	4	3
Control application is an important part of your job.	5	3	3	4	4	5	4	5	5	3
You were well prepared in the area of control application.	5	4	3	4	2	5	3	4	4	3
The ability to read a blue print is an important part of your job.	5	4	4	5	5	4	5	5	5	4
You were well prepared to read blue prints.	5	4	4	5	5	5	4	4	5	4
The ability to understand job specs. is an important part of your job.	5	2	2	5	5	4	5	5	5	4
You were well prepared to deal with job specs.	5	3	3	3	3	5	4	3	4	4
Math is an important part of your job.	5	3	4	5	5	2	5	4	5	4
You were well prepared in the area of math.	3	3	3	5	5	3	5	3	5	4
Written communication skills is an important part of your job.	5	3	5	5	5	5	4	4	5	5
You were well prepared in the area of written communications.	5	3	4	5	5	4	3	4	5	3
Verbal communications skills are an important part of your job.	5	4	4	5	5	4	5	4	5	5
You were well prepared in the area of verbal communications.	5	3	4	4	5	4	4	4	5	3
The ability to troubleshoot is an important part of your job.	5	5	4	5	5	5	3	4	5	5
You were well prepared in the area of troubleshooting.	5	4	4	5	3	4	3	4	3	5
The ability to develop electrical schematics is important to your job.	5	4	3	2		5	3	4	5	5
You were well prepared to develop electrical schematics.	5	4	4	5		5	3	4	4	5
The ability to commission an HVAC system is important to your job.	5	3	3	4		4	3	4	5	3
You were well prepared to commission HVAC equipment.	3	3	3	5		4	4	4	5	3
Overall you were well prepared for the job that you are doing.	4	4	4	5	4	5	4	4	4	4
The HVAC classrooms at Ferris were adequate for instruction.	4	2	4	4	5	3	5	4	4	5
The HVAC laboratories at Ferris were adequate for instruction.	4	2	3	4	5	3	4	4	2	5
The advising was adequate in the HVAC program.	4	3	4	5	3	3	4	4	3	3
The placement services were adequate at Ferris.	4	3	5	5		2	5	3	2	5
The computer labs were adequate in the HVAC program.	5	3	3	5	4	3	5	4	4	5
You had no problem finding a job after graduation.	5		5	5	5	4	5	4	5	5
Would you have taken HVAC courses on the internet if available.	3	2	1	1	1	3	3	2	5	1
You were able to be productive in your job right out of school.	5	4	5	5	4	5	4	4	5	4
There is a high demand for the HVACR 4 year degree graduate.	5		5	5	5	5	5	3	5	5
The Ferris HVACR Engineering Tech. Program should expand.	5	3	4	5	5	5	5	3	5	5
The Ferris HVACR program should update the facility.	5	4	4	5		5	4	3	5	5

The HVAC design classes are important to your job.		5	5	5	5	4	5	4	4	5
You were well prepared in the area of HVACR design	3	5	4	4	4	4	5	4	4	4
The use of CAD is important to your job.		3	4	3	4	4	3		5	
You were well prepared in the area of CAD.	2	4	2	4	3	4	4	4	5	
The ability to do a load calculation is important to your job.		2	5	2	5	2	3	2	5	5
You were well prepared in the area of load calculations.	3	4	4	4	4	4	4	4	5	5
Equipment selection is an important part of your job.		2	5	2	5	2	5	5	5	5
You were well prepared in the area of equipment selection.	1	4	4	3	3	4	5	3	4	4
Control theory is an important part of your job.	5	5	3	5	5	5	5	3	5	3
You were well prepared in the area of control theory.	1	5	5	4	3	5	4	4	5	4
Control application is an important part of your job.	5	5	3	4	5	5	4	2	5	3
You were well prepared in the area of control application.	1	5	5	4	3	5	4	4	5	3
The ability to read a blue print is an important part of your job.	5	5	5	5	5	5	5	5	5	
You were well prepared to read blue prints.	1	4	3	3	4	5	2	3	5	4
The ability to understand job specs. is an important part of your job.	5	5	5	5	5	5	3	5	3	5
You were well prepared to deal with job specs.	1	3	3	2	3	4	2	1	3	5
Math is an important part of your job.	5	4	4	3	4	4	5	4	5	5
You were well prepared in the area of math.	3	4	5	4	4	4	5	4	3	5
Written communication skills is an important part of your job.	5	5	3	5	4	5	5	5	5	4
You were well prepared in the area of written communications.	3	5	3	4	4	4	5	4	5	4
Verbal communications skills are an important part of your job.	5	5	4	5	4	5	5	5	5	4
You were well prepared in the area of verbal communications.	3	5	4	4	3	4	5	4	5	4
The ability to troubleshoot is an important part of your job.	4	2	3	5	5	2	5	4	5	5
You were well prepared in the area of troubleshooting.	3	5	5	3	3	3	5	4	5	4
The ability to develop electrical schematics is important to your job.	4	5	2	4	5	4	5		4	4
You were well prepared to develop electrical schematics.	2	5	5	3	3	2	5	4	4	5
The ability to commission an HVAC system is important to your job.	5	2	3	5	4	2	5	3		5
You were well prepared to commission HVAC equipment	1	4	3	2	3	3	5	3		5
Overall you were well prepared for the job that you are doing.	2	4	5	4	4	4	4	3	5	5
The HVAC classrooms at Ferris were adequate for instruction.	4	5	4	4	4	4	4	4	4	5
The HVAC laboratories at Ferris were adequate for instruction.	2	5	4	4	4	4	4	4	4	3
The advising was adequate in the HVAC program.	5	4	4	5	4	4	2	4	4	4
The placement services were adequate at Ferris.	4	4	4	5	3	3	3	4	4	4
The computer labs were adequate in the HVAC program.	4	4	5	5	4	4	2	4	5	5
You had no problem finding a job after graduation.	5	5	5	5	4	4	5	4	5	5
Would you have taken HVAC courses on the internet if available.	4	3	4	3	5	2	2	4	4	1
You were able to be productive in your job right out of school.	2	5	5	5	4	4	5	2	4	5
There is a high demand for the HVACR 4 year degree graduate.	4	5	5	5	5	5	5	4	4	5
The Ferris HVACR Engineering Tech. Program should expand.	5	5	5	5	4	3	5	4	4	5
The Ferris HVACR program should update the facility.	4	5	4	5	4	4	5	3		5

RAW SURVEY DATA (cont.)

The HVAC design classes are important to your job.	3	5	5	5	5	4	4	4	4	5
You were well prepared in the area of HVACR design	4	5	5	5	4	4	4	4	4	5
The use of CAD is important to your job.	2	1	3	5	3	2	3	2	4	5
You were well prepared in the area of CAD.	4	4		5	4	3	4	4	4	3
The ability to do a load calculation is important to your job.	2	1	5	2	5	3	4	2	3	4
You were well prepared in the area of load calculations.	4	4	5	4	5	4	4	3	4	5
Equipment selection is an important part of your job.	3	2	5	2	4	2	2	4	2	5
You were well prepared in the area of equipment selection.	5	4	5	4	4	1	4	3	4	5
Control theory is an important part of your job.	5	5	4	5	3	4	3	4	5	4
You were well prepared in the area of control theory.	5	4	3	5	4	4	4	3	5	4
Control application is an important part of your job.	4	5	4	5	4	4	3		5	4
You were well prepared in the area of control application.	4	4	4	5	4	4	4		5	4
The ability to read a blue print is an important part of your job.	3	4	5	5	5	5	4	4	5	5
You were well prepared to read blue prints.	3	3	4	4	5	4	4	3	5	4
The ability to understand job specs. is an important part of your job.		4	5	5	4	5	4	3	5	4
You were well prepared to deal with job specs.	3	3	5	2	3	4	4	3	4	3
Math is an important part of your job.		4	5	4	5	3	4	3	5	4
You were well prepared in the area of math.	4	5	5	4	5	4	4	3	4	3
Written communication skills is an important part of your job.	5	4	5	5	4	5	4	4	5	4
You were well prepared in the area of written communications.	4	3	5	2	4	2	4	3	4	4
Verbal communications skills are an important part of your job.	5	5	5	5	4	5	4	4	5	4
You were well prepared in the area of verbal communications.	4	4	5	2	4	3	4	3	4	4
The ability to troubleshoot is an important part of your job.	5	5	3	5	4	4	4	4	5	3
You were well prepared in the area of troubleshooting.	5	4	4	5	4	4	4	4	5	4
The ability to develop electrical schematics is important to your job.	5	3	2	5	3	3	3	4	5	3
You were well prepared to develop electrical schematics.	5	3	5	4	4	4	4	4	5	4
The ability to commission an HVAC system is important to your job.		5	2	5	3	4	3	4	5	3
You were well prepared to commission HVAC equipment	3	4	4	2	3	4	3	4	3	3
Overall you were well prepared for the job that you are doing.	4	4	5	4	4	4	4	3	4	5
The HVAC classrooms at Ferris were adequate for instruction.	4	4	4	4	3	3	4	4	4	4
The HVAC laboratories at Ferris were adequate for instruction.	4	4	4	4	3	3	4	4	4	4
The advising was adequate in the HVAC program.	4	4	4	4	4	4	4	4	4	4
The placement services were adequate at Ferris.	4	4		4	4	3	4	4	4	4
The computer labs were adequate in the HVAC program.	4	4	5	4	3	4	4		2	4
You had no problem finding a job after graduation.	5	5	5	4	4	4	4	4	4	5
Would you have taken HVAC courses on the internet if available.	3	1	2	3	4	4	2	2	2	
You were able to be productive in your job right out of school.	5	4	5	4	4	4	3	4	4	5
There is a high demand for the HVACR 4 year degree graduate.	5	5	5	5	5	4	5	3	5	4
The Ferris HVACR Engineering Tech. Program should expand.	3	5	4	5	5	5	3	4	5	4
The Ferris HVACR program should update the facility.	4	5	5	5	4	5	2	3	5	4

RAW SURVEY DATA (cont.)

The HVAC design classes are important to your job.	4	5	5	4	5	5	5	5	5	5
You were well prepared in the area of HVACR design	4	5	5	5	4	4	4	2	3	4
The use of CAD is important to your job.	2	4	3	5	5	3	3		4	5
You were well prepared in the area of CAD.	4	4	3	4	4	3	3	1	4	2
The ability to do a load calculation is important to your job.	2	3	5	3	4	4	5		5	5
You were well prepared in the area of load calculations.	4	4	5	4	3	4	4	2	3	5
Equipment selection is an important part of your job.	2	4	5	3	3	3	5	3	4	5
You were well prepared in the area of equipment selection.	4	4	5	4	3	3	5	2	4	4
Control theory is an important part of your job.	2	5	4	5	5	3	4	5	5	4
You were well prepared in the area of control theory.	2	4	4	4	4	3	4	2	4	3
Control application is an important part of your job.	4	5	4	5	4	3	4	5	5	3
You were well prepared in the area of control application.	2	4	4	5	4	3	4	2	4	4
The ability to read a blue print is an important part of your job.	2	4	5	5	5	5	5	5	5	5
You were well prepared to read blue prints.	4	4	5	4	3	5	2	3	5	4
The ability to understand job specs. is an important part of your job.	2	4	5	4	5	5	5	5	4	5
You were well prepared to deal with job specs.	4	4	5	4	3	5	2	2	3	3
Math is an important part of your job.	2	3	5	4	5	5	4	2	5	5
You were well prepared in the area of math.	5	3	5	4	4	4	5	2	3	3
Written communication skills is an important part of your job.	2	3	5	4	5	4	5	5	4	5
You were well prepared in the area of written communications.	5	4	5	4	3	4	4	4	4	4
Verbal communications skills are an important part of your job.	4	3	5	4	5	5	5	5	5	5
You were well prepared in the area of verbal communications.	4	4	5	4	4	4	5	3	3	4
The ability to troubleshoot is an important part of your job.	4	4	4	4	4		5	5	5	3
You were well prepared in the area of troubleshooting.	3	4	4	4	3		5	4	4	3
The ability to develop electrical schematics is important to your job.	2	3	3	5	4		3	3	3	3
You were well prepared to develop electrical schematics.	3	3	4	4	4		4	2	4	3
The ability to commission an HVAC system is important to your job.	2	4		4	4		5	4	3	3
You were well prepared to commission HVAC equipment	3	4	2	4	3		3	3	4	3
Overall you were well prepared for the job that you are doing.	3	5	5	5	4	4	4	3	3	4
The HVAC classrooms at Ferris were adequate for instruction.	4	4	5	4	5	4	4	4	4	4
The HVAC laboratories at Ferris were adequate for instruction.	4	4	5	4	5	4	4	4	4	4
The advising was adequate in the HVAC program.	4	4	5	5	4	5	5	4	4	4
The placement services were adequate at Ferris.	4	4	4	4	3	4	4	2	4	4
The computer labs were adequate in the HVAC program.	5	4	4	4	5	3	5	2	5	4
You had no problem finding a job after graduation.	5	5	5	4	3	5	5	2	4	5
Would you have taken HVAC courses on the internet if available.	3	5	4	3	2	4	3	4	2	5
You were able to be productive in your job right out of school.	2	5	4	4	3	4	4	2	2	4
There is a high demand for the HVACR 4 year degree graduate.	5	5	5	5	4	4	5	2	3	5
The Ferris HVACR Engineering Tech. Program should expand.	5	5	5	5	2	4	4	4	4	5
The Ferris HVACR program should update the facility.	4	5	4	5	3	5	4	4	4	5

RAW SURVEY DATA (cont.)

The HVAC design classes are important to your job.	5	5	5	5	4	5	5	4	4	5
You were well prepared in the area of HVACR design	5	4	5	3	4	5	5	3	3	5
The use of CAD is important to your job.	5	2	5	5	4	3	5	4	3	5
You were well prepared in the area of CAD.	2	4	2	5	4	3	5	3	4	3
The ability to do a load calculation is important to your job.	5	2	3	3	4	4	5	4	4	5
You were well prepared in the area of load calculations.	5	4	3	3	4	4	5	2	4	5
Equipment selection is an important part of your job.	5	3	5	2	3	3	5	4	3	5
You were well prepared in the area of equipment selection.	5	4	5	2	4	4	4	3	3	4
Control theory is an important part of your job.	5	5	5	5	5	5	5	4	4	4
You were well prepared in the area of control theory.	4	5	5	4	5	5	5	4	3	4
Control application is an important part of your job.	5	5	5	5	5	5	5	3	3	4
You were well prepared in the area of control application.	4	4	4	4	5	5	5	4	3	4
The ability to read a blue print is an important part of your job.	5	5	5	5	5	5	5	4	4	5
You were well prepared to read blue prints.	4	5	3	5	5	5	5	4	4	5
The ability to understand job specs. is an important part of your job.	4	5	5	5	5	5	5	2	2	5
You were well prepared to deal with job specs.	4	4	3	4	5	4	5	3	3	3
Math is an important part of your job.	5	4	4	4	4	5	5	3	4	5
You were well prepared in the area of math.	3	4	4	4	4	5	3	3	3	5
Written communication skills is an important part of your job.	5	4	5	4	4	5	5	3	5	5
You were well prepared in the area of written communications.	3	4	4	4	4	5	5	3	4	5
Verbal communications skills are an important part of your job.	5	4	5	5	4	5	5	5	4	5
You were well prepared in the area of verbal communications.	3	4	5	4	4	5	3	5	4	4
The ability to troubleshoot is an important part of your job.	4	5	5	5	4	5	4	2	3	5
You were well prepared in the area of troubleshooting.	4	5	3	5	4	5	3	5	5	3
The ability to develop electrical schematics is important to your job.	4	4	5	4	4	5	4	5	2	4
You were well prepared to develop electrical schematics.	4	5	3	4	4	5	2	5	5	3
The ability to commission an HVAC system is important to your job.	5	4	5	5	4	5	5	2	3	5
You were well prepared to commission HVAC equipment	4	4	3	4	4	5	1	4	3	2
Overall you were well prepared for the job that you are doing.	5	4	5	4	4	5	2	4	5	4
The HVAC classrooms at Ferris were adequate for instruction.	5	4	4	4	5	5	4	5	4	4
The HVAC laboratories at Ferris were adequate for instruction.	5	4	2	4	5	5	2	5	4	4
The advising was adequate in the HVAC program.	5	4	4	4	4	5	5	4	4	5
The placement services were adequate at Ferris.	3	5	3	3	4	5	4	4	4	5
The computer labs were adequate in the HVAC program.	5	4	2	5	4	5	4	4	5	5
You had no problem finding a job after graduation.	4	5	5	5	4	5	5	5	5	5
Would you have taken HVAC courses on the internet if available.	5	4	5	2	4	3	4	3	4	3
You were able to be productive in your job right out of school.	5	4	4	4	5	5	2	5	5	5
There is a high demand for the HVACR 4 year degree graduate.	5	4	5	4	4	5	4	5	5	5
The Ferris HVACR Engineering Tech. Program should expand.	5	4	5	5	4	4	5	5	5	5
The Ferris HVACR program should update the facility.	5	5	5	5	4	3	4	5	4	5

RAW SURVEY DATA (cont.)

The HVAC design classes are important to your job.	5	3	5	5	5	5	5	5	5	5	5	4
You were well prepared in the area of HVACR design	4	4	5	5	5	4	4	4	2	3	4	4
The use of CAD is important to your job.	5	2	1	3	5	3	3	3		4	5	5
You were well prepared in the area of CAD.	3	4	4		5	4	3	3	1	4	2	5
The ability to do a load calculation is important to your job.	5	2	1	5	2	5	4	5		5	5	3
You were well prepared in the area of load calculations.	3	4	4	5	4	5	4	4	2	3	5	3
Equipment selection is an important part of your job.	5	3	2	5	2	4	3	5	3	4	5	4
You were well prepared in the area of equipment selection.	3	5	4	5	4	4	3	5	2	4	4	4
Control theory is an important part of your job.	4	5	5	4	5	3	3	4	5	5	4	5
You were well prepared in the area of control theory.	2	5	4	3	5	4	3	4	2	4	3	5
Control application is an important part of your job.	4	4	5	4	5	4	3	4	5	5	3	5
You were well prepared in the area of control application.	2	4	4	4	5	4	3	4	2	4	4	5
The ability to read a blue print is an important part of your job.	5	3	4	5	5	5	5	5	5	5	5	4
You were well prepared to read blue prints.	5	3	3	4	4	5	5	2	3	5	4	5
The ability to understand job specs. is an important part of your job.	5		4	5	5	4	5	5	5	4	5	4
You were well prepared to deal with job specs.	3	3	3	5	2	3	5	2	2	3	3	5
Math is an important part of your job.	5		4	5	4	5	5	4	2	5	5	2
You were well prepared in the area of math.	5	4	5	5	4	5	4	5	2	3	3	3
Written communication skills is an important part of your job.	5	5	4	5	5	4	4	5	5	4	5	5
You were well prepared in the area of written communications.	5	4	3	5	2	4	4	4	4	4	4	4
Verbal communications skills are an important part of your job.	4	4	5	4	5	5	4	5	5	4	5	5
You were well prepared in the area of verbal communications.	3	4	4	4	5	3	4	5	4	4	5	3
The ability to troubleshoot is an important part of your job.	5	5	3	4	5	5	5	5	5	4	5	4
You were well prepared in the area of troubleshooting.	3	4	3	4	3	5	5	3	5	4	5	4
The ability to develop electrical schematics is important to your job.	5	5	3	4	5	5	4	5	4	4	5	3
You were well prepared to develop electrical schematics.	3	5	3	4	4	5	5	3	4	4	5	4
The ability to commission an HVAC system is important to your job.	4	4	3	4	5	3	4	5	5	4	5	4
You were well prepared to commission HVAC equipment	3	4	4	4	5	3	4	3	4	4	5	4
Overall you were well prepared for the job that you are doing.	4	5	4	4	4	4	4	5	4	4	5	4
The HVAC classrooms at Ferris were adequate for instruction.	4	3	5	4	4	5	4	4	4	5	5	3
The HVAC laboratories at Ferris were adequate for instruction.	4	3	4	4	2	5	4	2	4	5	5	3
The advising was adequate in the HVAC program.	4	3	4	4	3	3	4	4	4	4	5	4
The placement services were adequate at Ferris.	3	2	5	3	2	5	5	3	3	4	5	3
The computer labs were adequate in the HVAC program.	4	3	5	4	4	5	4	2	5	4	5	4
You had no problem finding a job after graduation.	4	4	5	4	5	5	5	5	5	4	5	4
Would you have taken HVAC courses on the internet if available.	5	3	3	2	5	1	4	5	2	4	3	4
You were able to be productive in your job right out of school.	4	5	4	4	5	4	4	4	4	5	5	4
There is a high demand for the HVACR 4 year degree graduate.	5	5	5	3	5	5	4	5	4	4	5	4
The Ferris HVACR Engineering Tech. Program should expand.	4	5	5	3	5	5	4	5	5	4	4	5
The Ferris HVACR program should update the facility.	4	5	4	3	5	5	5	5	5	4	3	5

RAW SURVEY DATA (cont.)

	Tot.	Tot.	Tot.	Tot.	Tot.	Tot.		Tot.		
	SD	D	N	A	SA	NA				AVE
The HVAC design classes are important to your job.	0	1	2	17	41	1		62		4.58
You were well prepared in the area of HVACR design	0	2	9	31	20	0		62		4.15
The use of CAD is important to your job.	2	6	17	10	21	6		62		3.76
You were well prepared in the area of CAD.	3	6	16	24	10	3		62		3.55
The ability to do a load calculation is important to your job.	2	11	10	11	25	3		62		3.70
You were well prepared in the area of load calculations.	0	4	11	30	17	0		62		4.00
Equipment selection is an important part of your job.	0	12	14	10	25	1		62		3.76
You were well prepared in the area of equipment selection.	2	3	13	31	13	0		62		3.80
Control theory is an important part of your job.	0	2	8	19	33	0		62		4.35
You were well prepared in the area of control theory.	1	5	12	26	18	0		62		3.91
Control application is an important part of your job.	0	1	12	20	28	1		62		4.27
You were well prepared in the area of control application.	1	5	8	33	14	1		62		3.91
The ability to read a blue print is an important part of your job.	0	1	2	12	46	1		62		4.71
You were well prepared to read blue prints.	1	3	12	23	23	0		62		4.00
The ability to understand job specs. is an important part of your job.	0	5	3	14	38	2		62		4.44
You were well prepared to deal with job specs.	2	8	27	14	11	0		62		3.41
Math is an important part of your job.	0	5	6	22	28	1		62		4.18
You were well prepared in the area of math.	0	2	19	21	20	0		62		3.98
Written communication skills is an important part of your job.	0	1	4	19	38	0		62		4.48
You were well prepared in the area of written communications.	0	3	11	33	15	0		62		3.96
Verbal communications skills are an important part of your job.	0	0	1	21	40	0		62		4.63
You were well prepared in the area of verbal communications.	0	1	13	33	15	0		62		4.00
The ability to troubleshoot is an important part of your job.	0	3	7	19	32	1		62		4.31
You were well prepared in the area of troubleshooting.	0	0	17	24	20	1		62		4.07
The ability to develop electrical schematics is important to your job.	0	5	15	19	20	3		62		3.81
You were well prepared to develop electrical schematics.	0	4	12	25	19	2		62		3.98
The ability to commission an HVAC system is important to your job.	0	5	14	18	21	4		62		3.88
You were well prepared to commission HVAC equipment	1	4	23	23	8	3		62		3.47
Overall you were well prepared for the job that you are doing.	0	2	5	39	16	0		62		4.13
The HVAC classrooms at Ferris were adequate for instruction.	0	1	5	41	15	0		62		4.11
The HVAC laboratories at Ferris were adequate for instruction.	0	7	7	36	12	0		62		3.89
The advising was adequate in the HVAC program.	0	1	8	41	12	0		62		4.04
The placement services were adequate at Ferris.	0	5	15	28	12	2		62		3.80
The computer labs were adequate in the HVAC program.	0	5	6	28	22	1		62		4.07
You had no problem finding a job after graduation.	0	2	1	20	38	1		62		4.56
Would you have taken HVAC courses on the internet if available.	7	13	16	16	9	1		62		3.00
You were able to be productive in your job right out of school.	0	6	2	30	24	0		62		4.11
There is a high demand for the HVACR 4 year degree graduate.	0	1	4	15	41	1		62		4.58
The Ferris HVACR Engineering Tech. Program should expand.	0	1	6	18	37	0		62		4.41
The Ferris HVACR program should update the facility.	0	1	7	21	31	2		62		4.34

	NAME	ADDRESS	CITY	STATE	ZIP
1	Mr. Justin Allen	394 Village Green Boulevard	Ann Arbor	MI	48105
2	Mr. Bruce Alling	112 Church Street	Horton	MI	49246
3	Mr. Chris Anderson	1988 North Setterbo Road	Suttons Bay	MI	49682
4	Mr. Peter Angel	12443 Lyford Drive	Sterling Heights	MI	48312
5	Mr. David Antonopoulos	100 CV Avenue	Waynesboro	PA	17268
6	Mr. Greg Armock	312 Maizie Lane	Sparta	MI	49345
7	Mr. Jason Armstrong	5636 Lakeshore Drive	Weidman	MI	48893
8	Mr. John Barnett	29106 Clarita	Livonia	MI	48152
9	Mr. Robert Bernardi	8268 Long Island Court	Fair Haven	MI	48023
10	Mr. Russell Borst	5981 40th Avenue	Hudsonville	MI	49426
11	Mr. Andrew Brandt	25241 Mintdale Road	Sturgis	MI	49091
12	Mr. Keith Bretl	2001 23rd Avenue	Menominee	MI	49858
13	Mr. Kevin Brown	31103 Oranglawn	Livonia	MI	48150
14	Mr. Broc Buczolich	51807 North Mayflower Rd.	South Bend	IN	46628
15	Mr. Brian Bullock	2235 California Street	Mountain View	CA	94040
16	Mr. Jason Burkholder	7067 Willow Highway	Grand Ledge	MI	48837
17	Mr. Todd Burns	6801 Golfview Lane	Palos Heights	IL	60463
18	Mr. Mark Buzzell	Point West Place	Framingham	MA	01701
19	Mr. Richard Carley	20135 23 Mile Road	Paris	MI	49338
20	Mr. Chih Chen	512 B Darlene Lane	Glendale Hts	IL	60139
21	Mr. Josh Clark	Precision Air	Midland	MI	48642
22	Mr. Joseph Compton	911 Cherry Avenue	Big Rapids	MI	49307
23	Mr. Nicholas Conway	399 Shorewood Court	Valparaiso	IN	46383
24	Mr. Timothy Conzemius	3265 N. Riverwood Drive	Twin Lake	MI	49457
25	Mr. Donald Coon	312 Paradise Ave.	Sellersburg	IN	47172
26	Mr. Mark Crabtree	825 Summer Creek Ct. SE	Kentwood	MI	49508
27	Mr. Charles Day	707 Hoyt St SE	Grand Rapids	MI	49507
28	Mr. Matthew Delay	1418 Ready Avenue	Burton	MI	48529
29	Mr. Donovan Denlinger	1311 Village Road	Strasburg	PA	17579
30	Mr. Andrew Doe	56 Scenic Drive	Holden	MA	01520
31	Mr. Gregory Donakowski	845 Aplin Beach	Bay City	MI	48706
32	Mr. Jeffrey Doran	3776 Mariner	Waterford	MI	48329
33	Mr. Daniel Dorn	878 State Highway M35	Bark River	MI	49807
34	Mr. Robert Dragoo	2163 East Walton Blvd.	Auburn Hills	MI	48326
35	Mr. Daniel Drys	11620 Weiman Drive	Pinckney	MI	48169

36	Mr. Jason Eaton	2910 Foster Avenue NE	Grand Rapids	MI	49505
37	Mr. Andrew Estes	8527 Honor Court	Galloway	OH	43119
38	Mr. David Evancho	4551 Hatherly Place	Sterling Heights	MI	48310
39	Mr. Jonathan Fairall	P.O. Box 225	Nokesville	VA	20182
40	Mr. Michael Feutz	2665 Ashville	Grand Rapids	MI	49505
41	Mr. Mark Fisher	3634 Illinois SW	Wyoming	MI	49509
42	Mr. Timothy Fleet	4191 Westbrook Road	Memphis	TN	38135
43	Mr. Michael Flory	33543 Fernwood Street	Westland	MI	48186
44	Mr. Michael Forshaw	2046 Dana St.	Toledo	OH	43609
45	Mr. Alexander Gifford	2930 Gardentown Road	Grand Rapids	MI	49509
46	Mr. Stephan Gillette	4371 11 Mile Road	Bear Lake	MI	49614
47	Mr. Paul Girard	15 Conestoga Trl	Brookfield	MA	1506
48	Mr. Arthur Guzowski	16725 Heim Road	Chelsea	MI	48118
49	Mr. Joseph Hancock	11146 Gilbert Road	Memphis	MI	48041
50	Mr. Paul Havrella	4331 Tuller Avenue	Culver City	CA	90230
51	Mr. David Hearth	216 Gilbertson	Big Rapids	MI	49307
52	Mr. Aaron Helman	223 East Washington	Ionia	MI	48846
53	Mr. Brian Hornbeck	4719 Cape May Avenue	San Diego	CA	92107
54	Mr. Chad House	8797 Burneth Drive	Milan	MI	48160
55	Mr. Patrick Howlett	408 Woodward Ave, #A	Big Rapids	MI	49307
56	Mr. Don Hudgens	6778 Cline Road	Jeddo	MI	48032
57	Mr. Christopher Janda	1221 East Cross Street	Ypsilanti	MI	48198
58	Mr. Kevin Jay	704 South Lynn Street	Bryan	OH	43506
59	Mr. Steven Jewell	214 East State Street	Cheboygan	MI	49721
60	Mr. Joseph John	49 A Brighton 10 Court	Brooklyn	NY	11235
61	Mr. James Jossman	6417 Pleasant River Drive	Dimondale	MI	48821
62	Mr. Robert Kaufmann	7484 Townline Road	Bridgeport	MI	48722
63	Mr. Donald Kebler	906 W. McConnell Street	St. Johns	MI	48879
64	Mr. Ryan Koda	6002 Powells Landing Rd.	Burke	VA	22015
65	Mr. Michael Korcal	11690 Hoskins	Cedar Springs	MI	49319
66	Mr. Daniel Korhonen	1065 Riverview Drive	Ishpeming	MI	49849
67	Mr. Mark Kresge	3450 Merlin Court NE	Grand Rapids	MI	49505
68	Mr. Craig Langmaid	4301 South Airport	Bridgeport	MI	48722
69	Mr. Yu-Kit Lau	526 South Michigan Avenue	Big Rapids	MI	49307
70	Mr. Scott Leach	P.O. Box 220	Big Rapids	MI	49307
71	Mr. Duane Lee	2053 Fawn Avenue	Middleville	MI	49333

72	Mr. Todd Maggini	1552 Stockington Path	Zeeland	MI	49464
73	Mr. Craig Marshall	19610 Huntington Avenue	Harper Woods	MI	48225
74	Mr. Scott Mason	7525 East Navarro Avenue	Mesa	AZ	85208
75	Mr. Scott McKay	2880 E. Baseline Road	Plainwell	MI	49080
76	Mr. Daniel McPherson	628 Red Robin Rd	Seffner	FL	33584
77	Mr. Darren Meeh	62 Zellers Road	Long Valley	NJ	07853
78	Mr. Timothy Mendyk	5041 Commodore Lane	Walnut Cove	NC	27052
79	Mr. Norith Mey	12930 Riley Street	Holland	MI	49424
80	Mr. William Miller	1634 South Banner Road	Sandusky	MI	48471
81	Mr. James Modigell, Jr.	8103 Van Buren Avenue	Munster	IN	46321
82	Mr. Raymond Moody	4732 Pare Lane	Trenton	MI	48183
83	Mr. Jerimy Moran	1842 Rock Springs Circle	Denver	NC	28037
84	Mr. Stephen Morse	11283 Village Lane	Clinton	MI	49236
85	Mr. Anthony Musinski	910 West Hampton Road	Essexville	MI	48732
86	Mr. George Naim	1905 Clover Trail	Richardson	TX	75081
87	Mr. Bruce Nelson	12751 Gloriette	Sand Lake	MI	49343
88	Mr. Khanh Nguyen	13055 James Street	Holland	MI	49424
89	Mr. Terry Nyland	A 6355 144th Avenue	Holland	MI	49423
90	Mr. Stanley Owusu	3605 Robert E Lee Pl	Alexandria	VA	22306
91	Mr. Joseph Pappas	1432 11th	Wyandotte	MI	48192
92	Mr. Kamlesh Parmar	500 Pinebrook Drive	Lombard	IL	60148
93	Mr. Nicholas Pasquini	P.O. Box 685	Island Lake	IL	60042
94	Mr. Kim Pattee	4768 Brookside Drive SW	Grandville	MI	49418
95	Mr. Jason Pencek	228 North Main	Moscow	PA	18444
96	Mr. Jon Perry	317 South Warren	Big Rapids	MI	49307
97	Mr. Ryan Polter	7783 Lamplight Drive	Jenison	MI	49428
98	Mr. Thomas Polyzois	46123 Sterritt Street	Utica	MI	48317
99	Mr. Michael Powers	373 Cedar	Cedar Springs	MI	49319
100	Mr. Meraj Ramnarine	436 W 52nd Street	New York	NY	10019
101	Mr. Curtis Ray	18944 Milton Road	Big Rapids	MI	49307
102	Mr. Adam Rogalla	7094 South Cooley Road	Fruitport	MI	49415
103	Mr. Terrence Rollins	108 Morris Drive	Laurel	MD	20707
104	Mr. Nicholas Ruehmeier	4511 Cypress Avenue	Newaygo	MI	49337
105	Mr. Christopher Russell	22475 Nancy Avenue	Southfield	MI	48034
106	Mr. Gregory Salisbury	22089 20th Avenue	Marion	MI	49665
107	Miss Lorraine Sanborn	3902 W. Walton Blvd.	Waterford	MI	48329

108	Mr. Craig Schubert	P.O. Box 414	Auburn	MI	48611
109	Mr. Adam Schultz	3938 Macarthur Road	Muskegon	MI	49442
110	Mr. Daniel Schwab	777 Stevenson Road	Standish	MI	48658
111	Mr. David Shafer	4586 Nestrom	Whitehall	MI	49461
112	Mr. James Shearer	1900 O'Brien	Jackson	MI	49201
113	Mr. Robert Shepard	7575 South Leaton Road	Shepherd	MI	48883
114	Mr. Jeffrey Simerl	148 Madeira Avenue	Chillicothe	OH	45601
115	Mr. Eric Simon	401 Feneis Street	Westphalia	MI	48894
116	Mr. Paul Sisovsky	200 Sunset Hills Ave, NW	Grand Rapids	MI	49544
117	Mr. James Six	8052 Meade Street	Montague	MI	49437
118	Mr. David Slevin	24 Passway 5	Worcester	MA	01602
119	Mr. William Smeda	177 Suncrest Court SW	Grandville	MI	49418
120	Mr. Darin Smith	31365 Morlock Street	Livonia	MI	48152
121	Mr. Jeffrey Smith	3 North 42nd Street	Belleville	IL	62226
122	Mr. Michael Smith	28546 Cleveland Street	Livonia	MI	48150
123	Mr. Scott Smith	1421 104th Avenue	Zeeland	MI	49464
124	Mr. Steven Smith	1018 Leeward Lane	St. Helen	MI	48656
125	Mr. Mark Snider	931 St. Lawrence	Marysville	MI	48040
126	Mr. Mark Sorensen	5890 Ponteluma Road	Fruitport	MI	49415
127	Mr. Joseph Soucie	1786 Carlisle Highway	Charlotte	MI	48813
128	Mr. Eric Starke	806 N 3rd St	Saint Clair	MI	48079
129	Mr. Gregory Starke	20656 Marion Road	Brant	MI	48614
130	Mr. Donald Steeby	4540 Patterson Road	Caledonia	MI	49316
131	Mr. Joseph Stube	1918 Dale Road	Beaverton	MI	48612
132	Mr. Mark Tanner	731 Holly Road	Cadillac	MI	49601
133	Mr. Jason Thelen	10991 Chadwick Road	Eagle	MI	48822
134	Mr. Michael Thorne	1935 Marion Avenue	Zanesville	OH	43701
135	Mr. Matthew Tighe	1448 Beach Street	Muskegon	MI	49441
136	Mr. Thomas Torkko	3636 Lilac	Wayland	MI	49348
137	Mr. Kurt Trierweiler	9750 South Hinman Road	Eagle	MI	48822
138	Mr. Michael Troupe	12261 Harding Drive	Big Rapids	MI	49307
139	Mr. William Underwood	34423 School Street	Westland	MI	48185
140	Mr. Philip Vandenheuvel	7011 Hidden Hills Drive	Jenison	MI	49428
141	Mr. Douglas VanNest	11 Catalina Drive	Somerville	NJ	08876
142	Mr. Alberto Vasquez, Jr.	9415 Rocker Avenue	Plymouth	MI	48170
143	Mr. Ronald Vittitow	1812 Ashmun Street	Sault Ste. Marie	MI	49783

144	Mr. Michael Walton	1524 South Winn Road	Mt. Pleasant	MI	48858
145	Mr. Joseph Wardie	709 South East Street	Fenton	MI	48430
146	Mr. Michael Way	1511 Garfield	Marne	MI	49435
147	Mr. Peter Weible	5658 S Fox Cir #B	Littleton	CO	80120
148	Mr. Jeffrey Werle	3720 Edgewood Street SW	Grandville	MI	49418
149	Mr. Harold Whitcomb	3169 Kings Brook Drive	Flushing	MI	48433
150	Mr. Steven Whitney	14191 South Oak Avenue	Kent City	MI	49330
151	Mr. Kurt Wilkes	13884 South Bayview Drive	Traverse City	MI	49684
152	Mr. Michael Williamson	1218 North Garfield Road	Linwood	MI	48634
153	Mr. Richard Wingeier	3261 Brooklyn Avenue SE	Grand Rapids	MI	49508
154	Mr. Kevin Winger	2700 14 Mile Road NE	Sparta	MI	49345
155	Mr. Christopher Winslow	41672 Sunnydale Lane	Northville	MI	48167
156	Mr. William Witchell	210 Church Street	St. Johns	MI	48879
157	Mr. Charles Witt	200 Yoakum Parkway	Alexandria	VA	22304
158	Mr. Brian Zimmerman	3296 West Higgins Lake	Roscommon	MI	48653

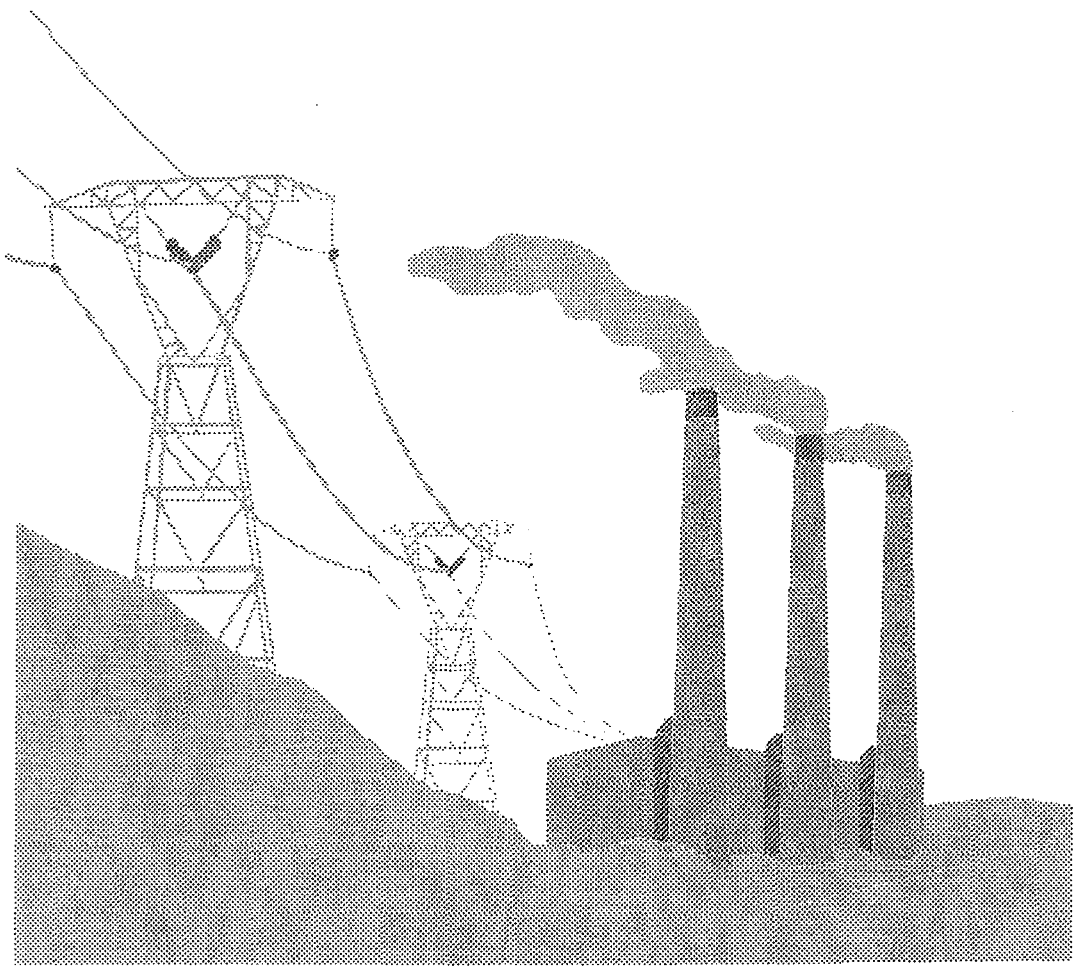
3

EMPLOYER FOLLOW-UP SURVEY

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



2000

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The employers list was formed from the placement service, alumni services, advisory committee and employers themselves. A total of 74 current employers were sent a copy of the survey and cover letter. A total of 34 responses to the original 74 surveys were received corresponding to a 46% return rate. The rate of return was considered acceptable considering that the survey was sent out between Thanksgiving and Christmas.

The survey instrument was constructed to look at a number of different areas. These areas include: technical expertise, communication skills, critical thinking skills, productivity, work ethics, management and codes. The survey instrument allowed the employer to respond to each statement in the following ways: (5) Excellent, (4) Good, (3) Acceptable, (2) Below Expectations, (1) Poor, (NA) Not Applicable. The last page of the survey allowed for the employers to comment on topics of their choice.

The survey also had a spot for the employer to indicate how many graduates they employed and what type of graduate (B.S. or A.A.S.). The employer would also indicate on the survey what type of graduate they were responding to. The following data was divided into responses to the A.A.S. graduates and responses to the B.S. graduates.

Information from employers are a critical source of feedback. This is the ultimate goal of the HVACR programs, to supply employers with a highly skilled, quality and productive graduate. If the employer is not satisfied with the HVACR program's graduate then the program is not meeting it's mission and must change accordingly.

College of Technology
Construction Department
HVACR Programs

December 1, 1999

Dear Ferris HVACR Graduate Employer:

Ferris State University Could Enhance the HVACR Programs
We Need Your Input!

The University's Academic Program review Committee is **reviewing** our HVACR Programs. As an employer of Ferris State University HVACR graduates, we need your viewpoint. The result of this review can range from increasing our programs' resources, to placing the program in a probationary status. This process requires your **input!**

This review process is also important in making changes to the HVACR curriculum in order to improve the quality of the graduate we turn out. You can help us keep the HVACR programs at a high level of quality by completing the enclosed survey and returning it by **December 15, 1999.** Again, your input regarding the HVACR programs and its' graduates is vital to the continued success of this program. Note: Two surveys were included so that one could be filled out relating to a two year graduate and one survey could be filled out regarding a four year graduate if you employ both. Please note on the survey which type of graduate you are responding to.

In advance, we thank you for your quick response.

Sincerely,

Michael J. Korcal

Michael J. Korcal
Assistant Professor
HVACR Programs

HVACR PROGRAMS

1999/00

PURPOSE: HVACR PROGRAM REVIEW

SURVEY AREA: Advisory Board Perceptions of the HVACR Programs.

Name ______________________

Title ______________________

Please indicate the following:

What type of Ferris HVACR Graduate do you employ?
Associate Degree ☐
Bachelor Degree ☐

Indicate the current number of Ferris HVACR graduate employed by your company. ______________

	Competencies & Foundation Skills	Excellent	Good	Acceptable	Below Expectation	Poor	Not Applicable
1	Uses written and oral communication skills effectively	5	4	3	2	1	NA
2	Possesses adequate overall technical skills in HVACR	5	4	3	2	1	NA
3	Possesses adequate mathematical skills	5	4	3	2	1	NA
4	Uses critical thinking, problem solving and decision making skills	5	4	3	2	1	NA
5	Exhibits an appropriate level of responsibility and self management	5	4	3	2	1	NA
6	Chooses ethical courses of action	5	4	3	2	1	NA
7	Identifies, organizes, plans, and allocates resources	5	4	3	2	1	NA
8	Participates as a team player	5	4	3	2	1	NA
9	Works well with individuals from diverse backgrounds	5	4	3	2	1	NA
10	Acquires, interprets and uses information effectively	5	4	3	2	1	NA
11	Possesses the ability to gain rapport with clients	5	4	3	2	1	NA
12	Uses technologies effectively (computers, telecommunications, etc.)	5	4	3	2	1	NA
13	Possesses leadership and negotiation skills	5	4	3	2	1	NA
14	Ability to read and interpret blueprints	5	4	3	2	1	NA
15	Ability to use and apply job specifications	5	4	3	2	1	NA
16	Recognize and understand all HVACR systems	5	4	3	2	1	NA
17	Knowledge of control theory and terminology	5	4	3	2	1	NA
18	Understand and develop electrical and control schematics	5	4	3	2	1	NA
19	Ability to troubleshoot a single simple HVACR system	5	4	3	2	1	NA
20	Ability to troubleshoot a complex or multiple HVACR systems	5	4	3	2	1	NA
21	Understand HVACR safety sequences	5	4	3	2	1	NA
22	Ability to work on CAD	5	4	3	2	1	NA
23	Ability to develop an HVACR bid	5	4	3	2	1	NA
24	Ability to commission an HVACR system after install or repair	5	4	3	2	1	NA
25	Ability to install HVACR components or systems	5	4	3	2	1	NA
26	Understands the importance of time management	5	4	3	2	1	NA
27	Completes a job with minimal re-work	5	4	3	2	1	NA
28	Understands HVACR codes and regulations	5	4	3	2	1	NA

OVER

In the space below, you can make detailed comments on the previous page of evaluation or add comments on specific program concerns including program strengths, weaknesses, areas for improvement, action required to achieve improvement, etc.

		P	BE	A	G	E	NA	AVE.
1	Uses written and oral communication skills effectively	0	1	7	7	3	0	3.67
2	Possesses adequate overall technical skills in HVACR	0	0	2	8	8	0	4.33
3	Possesses adequate mathematical skills	0	0	8	6	4	0	3.78
4	Uses critical thinking, problem solving and decision making skills	0	0	4	10	4	0	4.00
5	Exhibits an appropriate level of responsibility and self management	0	0	10	6	2	0	3.56
6	Chooses ethical courses of action	0	0	3	12	3	0	4.00
7	Identifies, organizes, plans, and allocates resources	0	0	9	8	1	0	3.56
8	Participates as a team player	0	1	3	10	4	0	3.94
9	Works well with individuals from diverse backgrounds	0	0	4	11	3	0	3.94
10	Acquires, interprets and uses information effectively	0	0	5	11	2	0	3.83
11	Possesses the ability to gain rapport with clients	0	1	4	12	1	0	3.72
12	Uses technologies effectively (computers, telecommunications, etc.)	0	2	8	7	1	0	3.39
13	Possesses leadership and negotiation skills	0	0	8	8	2	0	3.67
14	Ability to read and interpret blueprints	0	1	8	6	1	2	3.44
15	Ability to use and apply job specifications	0	0	9	5	1	3	3.47
16	Recognize and understand all HVACR systems	0	1	6	8	3	0	3.72
17	Knowledge of control theory and terminology	0	1	9	5	3	0	3.56
18	Understand and develop electrical and control schematics	0	1	3	11	3	0	3.89
19	Ability to troubleshoot a single simple HVACR system	0	0	1	10	7	0	4.33
20	Ability to troubleshoot a complex or multiple HVACR systems	0	1	11	3	3	0	3.44
21	Understand HVACR safety sequences	0	0	6	9	3	0	3.83
22	Ability to work on CAD	1	1	3	0	0	13	2.40
23	Ability to develop an HVACR bid	0	2	1	5	0	10	3.38
24	Ability to commission an HVACR system after install or repair	0	1	7	7	3	0	3.67
25	Ability to install HVACR components or systems	0	2	3	11	1	1	3.65
26	Understands the importance of time management	0	2	10	5	0	1	3.18
27	Completes a job with minimal re-work	0	0	8	7	3	0	3.72
28	Understands HVACR codes and regulations	0	1	13	4	0	0	3.17

POOR = P
BELOW EXPECTATION = BE
ACCEPTABLE = A
GOOD = G
EXCELLENT = E
NOT APPLICABLE = NA

EMPLOYER RESPONSES TO BS GRADUATE EMPLOYEES

		P	BE	A	G	E	NA	AVE.
1	Uses written and oral communication skills effectively	0	0	1	14	1	0	**4.00**
2	Possesses adequate overall technical skills in HVACR	0	0	0	8	8	0	**4.50**
3	Possesses adequate mathematical skills	0	0	3	12	1	0	**3.88**
4	Uses critical thinking, problem solving and decision making skills	0	0	7	9	0	0	**3.56**
5	Exhibits an appropriate level of responsibility and self management	0	0	5	9	2	0	**3.81**
6	Chooses ethical courses of action	0	0	1	8	7	0	**4.38**
7	Identifies, organizes, plans, and allocates resources	0	0	4	12	0	0	**3.75**
8	Participates as a team player	0	0	0	9	7	0	**4.44**
9	Works well with individuals from diverse backgrounds	0	0	0	11	5	0	**4.31**
10	Acquires, interprets and uses information effectively	0	0	1	15	0	0	**3.94**
11	Possesses the ability to gain rapport with clients	0	0	3	12	1	0	**3.88**
12	Uses technologies effectively (computers, telecommunications, etc.)	0	0	0	4	12	0	**4.75**
13	Possesses leadership and negotiation skills	0	0	7	9	0	0	**3.56**
14	Ability to read and interpret blueprints	0	0	3	10	3	0	**4.00**
15	Ability to use and apply job specifications	0	0	12	3	1	0	**3.31**
16	Recognize and understand all HVACR systems	0	0	1	3	12	0	**4.69**
17	Knowledge of control theory and terminology	0	0	1	9	6	0	**4.31**
18	Understand and develop electrical and control schematics	0	1	0	13	2	0	**4.00**
19	Ability to troubleshoot a single simple HVACR system	0	0	0	0	14	2	**5.00**
20	Ability to troubleshoot a complex or multiple HVACR systems	0	0	0	11	4	1	**4.27**
21	Understand HVACR safety sequences	0	0	3	12	1	0	**3.88**
22	Ability to work on CAD	0	0	1	12	3	0	**4.13**
23	Ability to develop an HVACR bid	0	5	11	0	0	0	**2.69**
24	Ability to commission an HVACR system after install or repair	0	0	7	8	0	1	**3.53**
25	Ability to install HVACR components or systems	0	0	0	0	1	15	**5.00**
26	Understands the importance of time management	0	1	10	5	0	0	**3.25**
27	Completes a job with minimal re-work	0	0	4	12	0	0	**3.75**
28	Understands HVACR codes and regulations	0	0	12	4	0	0	**3.25**

POOR = P
BELOW EXPECTATION = BE
ACCEPTABLE = A
GOOD = G
EXCELLENT = E
NOT APPLICABLE = NA

EMPLOYER COMMENTS

NOTE: Most surveys were returned without the comment page! Very few comments for the number of surveys.

- More time should be given to Sales / Marketing & controls. More computer programming is essential in respect to the way the HVACR industry is heading. Examples are ODBC, OPC, MS Access and visual basic.

- We need more 2 year techs in the field.

- Both of our Ferris Graduates went thru FSU in the late 1970's The thing I look at as most important that Ferris taught is the strong emphasis on understanding controls and wiring. The school did a great job. Also, I am glad that the professors did a great job in the area of critical thinking and problem solving. (troubleshooting) - Keep up the good work.

- I would like to see more construction / industrial equipment for students to work on Examples: boilers (setup), AHU, PM controls, VAV, chillers, ect. Need a sales class. These guys are our sales force. Ya, it's great they can fix things, but if they can't sell, talk. They are not much good. – The four year guys: Marketing class?, newer control systems, not just one kind., Does the equipment run?, can it run by means of PN, DDC. – How can you teach? Work ethic, attitude, being responsible.

- Our company has had several ferris grad. In the past. The main thing found is grads prior to 1985 have much more knowlage of hands on mechanical ability. Those after 1985 have to much theroy and less mechanical ability. Another thing is that grads are told they will be making a lot more money than can be paid to someone with no experience. They need to understand that they are entry level people and will have to prove them selves. You may want to consider some psyc classes to show how to deal with customers. The main thing I can stress is more hands on work.

- Not enough BS grads to meet current need.

	Company Name	Street	City	State	Zip
1	Tecumseh	1120 Tecumseh-Clinton Rd.	Clinton	MI	49236
2	Kentwood Public Schools	1679 68th Street SE	Caledonia	MI	49316
3	Energy System Solutions	400 W. Main St.	Rose City	MI	48654
4	Visser	0-2062 Leonard NW	Grand Rapids	MI	49544
5	Dainoviec Mech. Service	8524 Mink Rd.	Harbor Springs	MI	49740
6	A-1 Refrigeration	6461 Valley Industrial Drive	Kalamazoo	MI	49009
7	York International Corp.	8930 Bash Street, Suite L	Indianapolis	IN	46256
8	Kidder Heating And A/C				
9	Rapid	1100 7 Mile Rd. NW	Comstock Park	MI	49321
10	Stafford-Smith	3414 S. Burdick St.	Kalamazoo	MI	49001
11	EnerTemp	3961 Eastern Ave. SE	Grand Rapids	MI	49508
12	MEC	24300 Catherine Industrial Rd.	Novi	MI	48375
13	DRS	38170 Executive Dr. North	Westland	MI	48185
14	F.C. Moran and Son, Inc.	Suite C9 27280 Haggerty	Farmington Hills	MI	48331
15	Climatec	10802 N. 23rd Ave.	Pheonix	AZ	85029
16	Slasor Heating and Cooling	14165 Marie	Livonia	MI	48154
17	Landis & Staefa	31623 Industrial Rd.	Livonia	MI	48150
18	O'Hara Corp.	33254 Groesbeck Hwy.	Fraser	MI	48026
19	Behler-Young	3225 Enterprise	Saginaw	MI	48603
20	Envirotronics	3427 Kraft SE	Grand Rapids	MI	49512
21	Hankwitz Htg.	109 E. Filler St.	Ludington	MI	49431
22	Avila	225 Reinekers Lane	Alexandria	VA	22314
23	Process Engineering and Equipment Co.	571 6 Mile Rd. NW	Comstock Park	MI	49321
24	Bel-aire	8324 Shaver Rd	Portage	MI	49024
25	Carrier Great Lakes	PO Box 2970	Livonia	MI	48151
26	Siemens	31623 Industrial Rd.	Livonia	MI	48150
27	Thermal-Works Software	PO Box 7605	Grand Rapids	MI	49510
28	Carrier	4110 Butler Pike, Suite A104	Plymouth Meeting	PA	19462
29	PSEG	499 Thornall St. 5th Floor	Edison	NJ	8837
30	Nordyne	1801 Park 270 Drive	St. Louis	MO	63146
31	Design Comfort	4023 Old US 23	Brighton	MI	48114
32	Airco Mechanical Inc.	5720 Alder Ave.	Sacramento	CA	95828
33	Sunrise Inc.	4413 Beech-Daily	Dearborn Heights	MI	48125
34	McQuay Services	11938 Farmington Rd.	Livonia	MI	48150
35	J.E. Johnson Contracting	318 Cavanaugh	Alpena	MI	49707
36	Engineered Air	32050 West 53rd Street	Desoto	KS	66018

37	Geo Source One	9021-B Heritage Dr.	Plain City	OH	43064
38	Eaton Heating & A/C	19081 14 Mile Rd.	Big Rapids	MI	49307
39	Siemen's Building Technologies	1000 Deerfield Parkway	Buffalo Grove	IL	60089
40	Quality Air	3395 Kraft SE	Grand Rapids	MI	49512
41	Air Comfort	1340 Water St.	Port Huron	MI	
42	Johnson Controls	2875 High Meadow Circle	Auburn Hill	MI	48326
43	Progressive A.E.P.	1811 4 Mile Rd. NE	Grand Rapids	MI	49525
44	Monroe	506 Cooper St.	Monroe	MI	48161
45	Precision Air	15 W. Central Ave.	Delaware	OH	43015
46	Hedrick Associates	424 Plymouth NE	Grand Rapids	MI	49505
47	Department of Management and Budget	PO Box 300260	Lansing	MI	48909
48	Calvary Church	PO Box 1600	Grand Rapids	MI	49501
49	Lanier	2225 Oak Industrial Dr. NE	Grand Rapids	MI	49505
50	Van Dyken	1250 Buterworh SW	Grand Rapids	MI	49504
51	Rupp	3700 W. Preserve Blvd.	Burnsville	MN	55337
52	Noresco	Point W. Place 111 Speen Street	Framingham	MA	1701
53	Meijer, Inc	45001 Ford Rd.	Canton	MI	48187
54	Behler-Young	PO Box 946	Grand Rapids	MI	49509
55	TCI	320 W. 31st Street	New York	NY	10001
56	Site Support Systems	11408 Cronridge Dr. Suite L	Owings Mills	MD	21117
57	Ferris State University	605 S. Warren Ave.	Big Rapids	MI	49307
58	HPM	2020 Airway Ave.	Ft. Collins	CO	80524
59	Benner	2141 Dana Ave.	Cincinnati	OH	45207
60	CMS Marketing, Services and Trading	29647 Spoon	Madison Heights	MI	48071
61	Temprite	1555 Hawthorne Lane	West Chicago	IL	60185
62	Tempair	One Rupp Plaza,3700 W. Preserve Blvd.	Burnsville	MN	55337
63	Holwerda-Huizinga Co.	3777 44th SE	Grand Rapids	MI	49518
64	Plumbers and Pipefiters	5300 W. Michigan Ave.	Ypsilanti	MI	48197
65	Arizona Heating and Air Conditioning Inc.				
66	New Construction AC	1900 Cedar St.	Holt	MI	48842
67	Danavay Plumbing and Heating Co.	2630 Lippincott Blvd.	Flint	Mi	48507
68	GW Berkheimer	3460 Taft St.	Gary	IN	46408
69	Skipper	3524 Green Street	Muskegon	MI	49444
70	MASA	475 Frontage Rd. Suite 105	Burr Ridge	IL	60521
71	Climate Tech	3551 Rogues Edge Dr.	Rockford	MI	49341
72	Lakeshore	1587 M-32	West Alpena		
73	Grand Valley State	Service Building 1 Campus Dr.	Allendale	MI	49401

74	Blodgett	1840 Wealthy SE	Grand Rapids	MI	49506
75	Planned Service	1905 N. Michigan Ave.	Saginaw	MI	48602
76	W. Smith Refrigeration	271 W. Hume Ave.	Muskegon	MI	49444

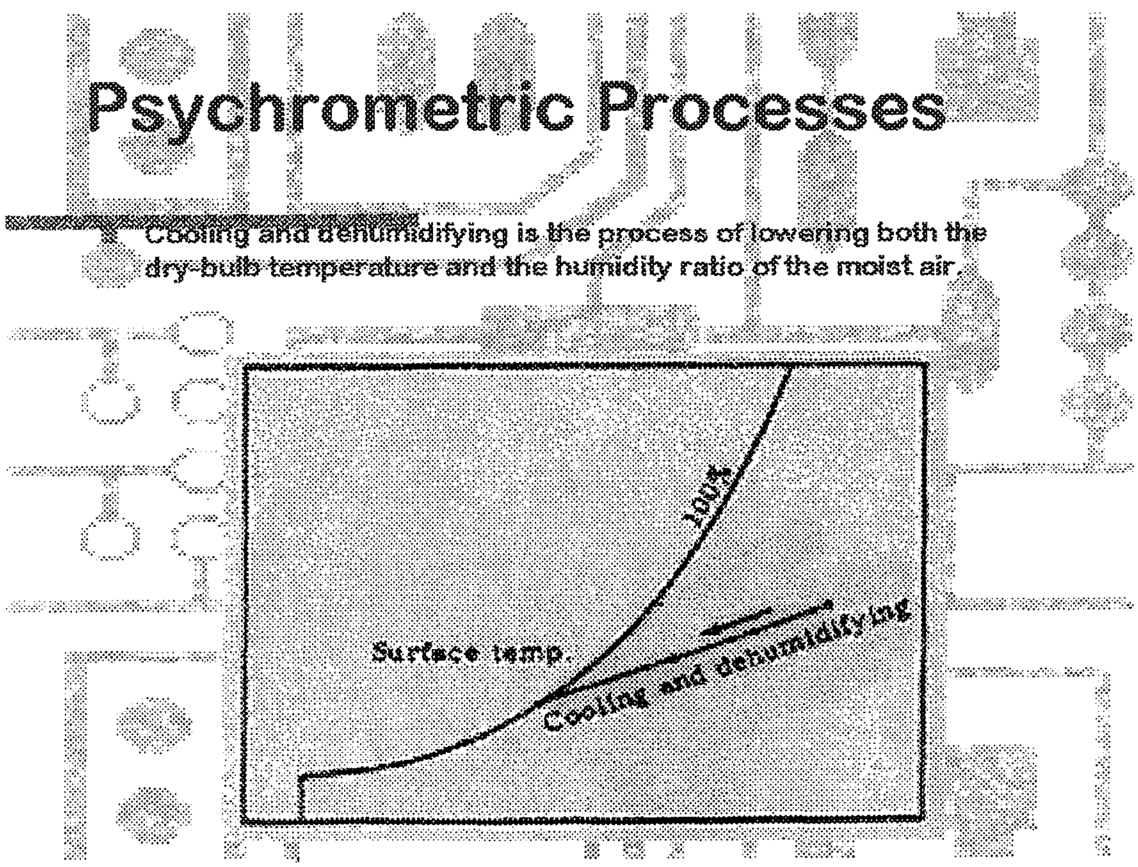
4

STUDENT PROGRAM EVALUATION SURVEY

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



2000

INDEX

FERRIS STATE UNIVERSITY 1999/00

HVACR PROGRAMS

PURPOSE HVACR PROGRAM REVIEW

SURVEY AREA: **Student Evaluation of the HVACR Programs.**

Please Rate the Following:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
	COURSES IN YOUR PROGRAM AREA ARE:						
1	available and conveniently located.	5	4	3	2	1	?
2	based on realistic prerequisites.	5	4	3	2	1	?
	WRITTEN OBJECTIVES FOR COURSES IN YOUR PROGRAM:						
3	are available to students.	5	4	3	2	1	?
4	describe what you will learn in the course.	5	4	3	2	1	?
5	are used by the instructor to keep you aware of your progress.	5	4	3	2	1	?
	TEACHING METHODS, PROCEDURES & COURSE CONTENT:						
6	meet your projected career needs, interests and objectives.	5	4	3	2	1	?
7	provide supervised practice for skill development.	5	4	3	2	1	?
	PROGRAM FACULTY:						
8	know the subject matter and occupational requirements.	5	4	3	2	1	?
9	are available to provide help when needed.	5	4	3	2	1	?
10	provide instruction so it is interesting and understandable.	5	4	3	2	1	?
	RELATED COURSE FACULTY:						
11	know the subject matter and occupational requirements.	5	4	3	2	1	?
12	are available to provide help when needed.	5	4	3	2	1	?
13	provide instruction so it is interesting and understandable.	5	4	3	2	1	?
	PROGRAM COMPUTER LABORATORIES:						
14	provide adequate lighting, ventilation, etc.	5	4	3	2	1	?
15	include enough work stations for students enrolled.	5	4	3	2	1	?
16	are safe, functional, and well maintained.	5	4	3	2	1	?
17	are available on an equal basis for all students.	5	4	3	2	1	?
	OTHER PROGRAM LABORATORIES:						
18	provide adequate lighting, ventilation, etc.	5	4	3	2	1	?
19	include enough work stations for students enrolled.	5	4	3	2	1	?
20	are safe, functional, and well maintained.	5	4	3	2	1	?
21	are available on an equal basis for all students.	5	4	3	2	1	?
	CLASS ROOMS:						
22	provide adequate lighting, ventilation, etc.	5	4	3	2	1	?
23	include enough seats / tables for students enrolled.	5	4	3	2	1	?
24	are safe, functional, and well maintained.	5	4	3	2	1	?
25	are available on an equal basis for all students.	5	4	3	2	1	?
	PROGRAM INSTRUCTIONAL EQUIPMENT IS:						
26	current and representative of the industry.	5	4	3	2	1	?
27	in sufficient quantity to avoid long delays in use.	5	4	3	2	1	?
28	safe and good condition.	5	4	3	2	1	?

What year in the program are you?

- First
- Second
- Third
- Forth

Please Rate the Following:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
	INSTRUCTIONAL MATERIALS ARE:						
29	current and meaningful to the subject.	5	4	3	2	1	?
30	available and conveniently located for use.	5	4	3	2	1	?
	INSTRUCTIONAL SUPPORT SERVICES (tutoring) ARE:						
31	available to meet your needs and interests.	5	4	3	2	1	?
32	provided by knowledgeable, interested staff..	5	4	3	2	1	?
	PLACEMENT SERVICES ARE AVAILABLE TO:						
33	help you find employment opportunities..	5	4	3	2	1	?
34	prepare you to apply for a job.	5	4	3	2	1	?

ANSWER THE FOLLOWING:

35. What are the HVACR programs greatest strengths?

36. What are the HVACR programs greatest weakness?

37. Which course would you consider least valuable in the HVACR Program and Why?

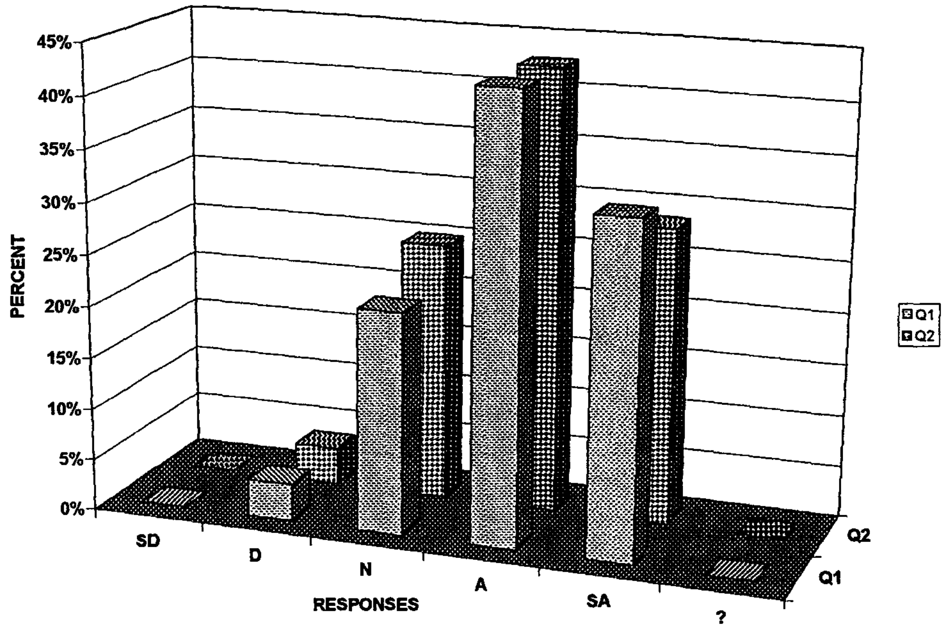
over

38. Are you a transfer student? YES NO

39. If you are a transfer student from what school and curriculum?

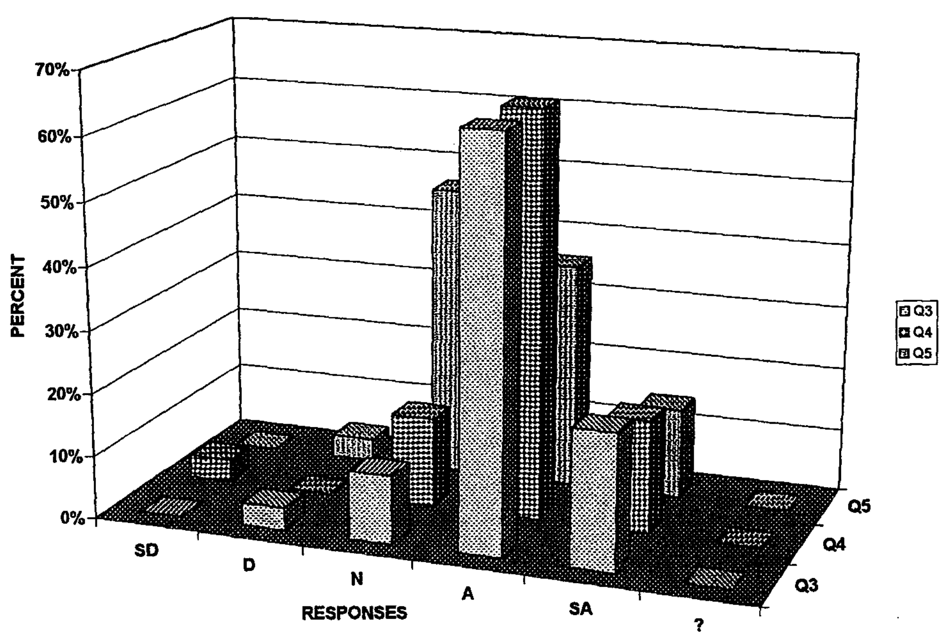
40. Use the remaining space below to add any additional comments that would be helpful in evaluating the HVACR program:

FRESHMAN RESPONSES TO QUESTIONS 1 & 2



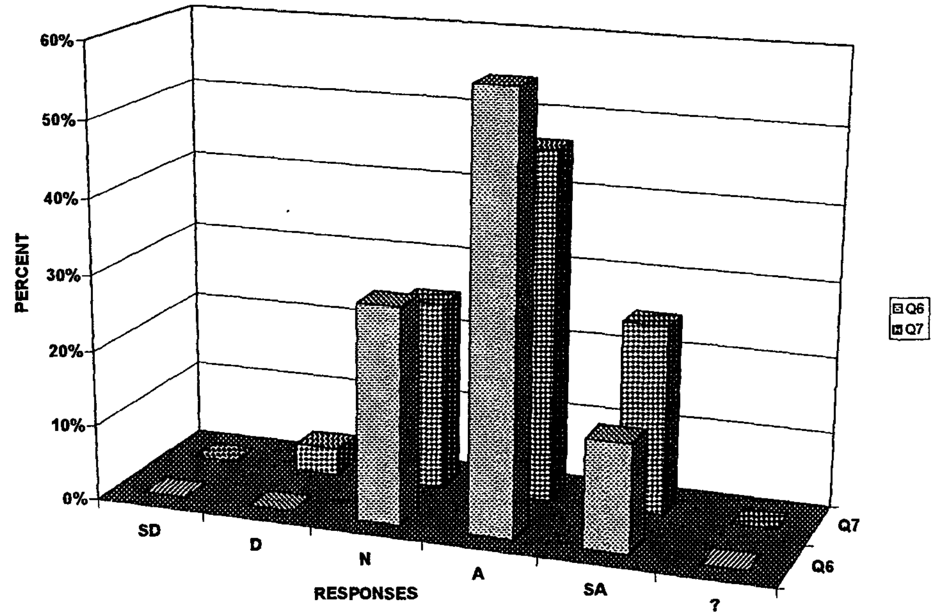
		SD	D	N	A	SA	?	AVE.
	COURSES IN YOUR PROGRAM AREA ARE:							
1	available and conveniently located.	0	1	6	12	9	0	**4.04**
2	based on realistic prerequisites.	0	1	7	12	8	0	**3.96**

FRESHMAN RESPONSES TO QUESTIONS 3, 4 & 5



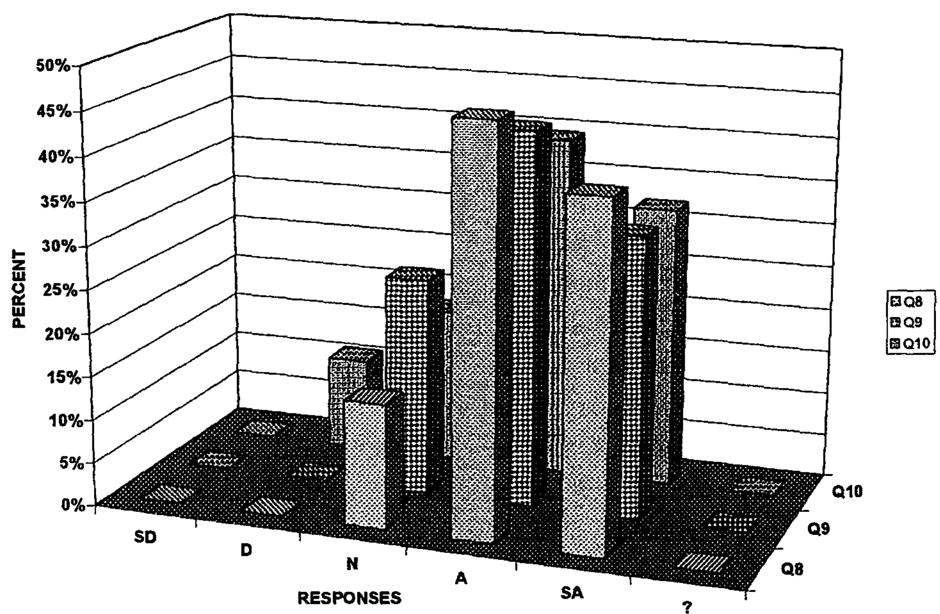
		SD	D	N	A	SA	?	AVE.
	WRITTEN OBJECTIVES FOR COURSES IN YOUR PROGRAM:							
3	are available to students.	0	1	3	18	6	0	**4.04**
4	describe what you will learn in the course.	1	0	4	18	5	0	**3.93**
5	are used by the instructor to keep you aware of your progress.	0	1	13	10	4	0	**3.61**

FRESHMAN RESPONSES TO QUESTIONS 6 & 7



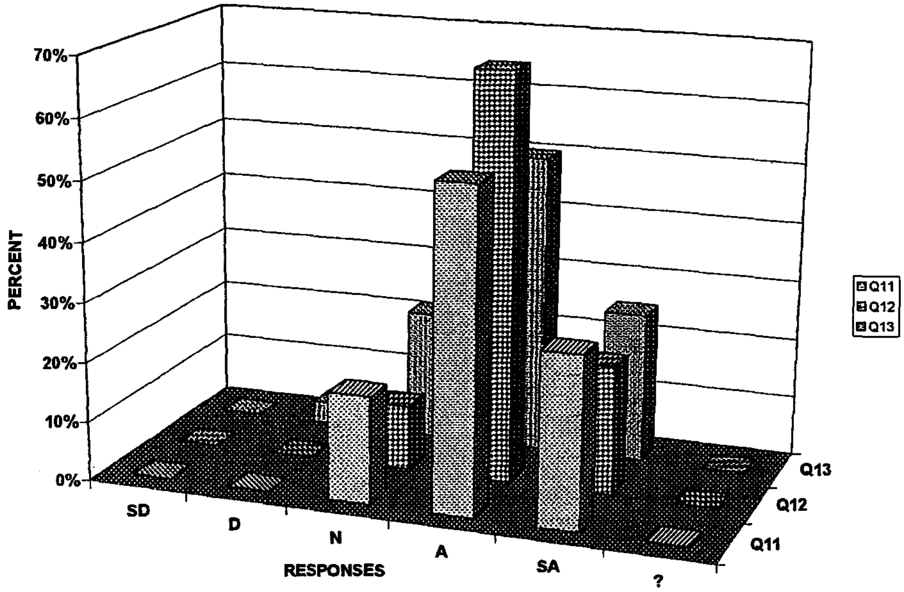
		SD	D	N	A	SA	?	AVE.
	TEACHING METHODS, PROCEDURES & COURSE CONTENT:							
6	meet your projected career needs, interests and objectives.	0	0	8	16	4	0	**3.86**
7	provide supervised practice for skill development.	0	1	7	13	7	0	**3.93**

FRESHMAN RESPONSES TO QUESTIONS 8, 9 & 10



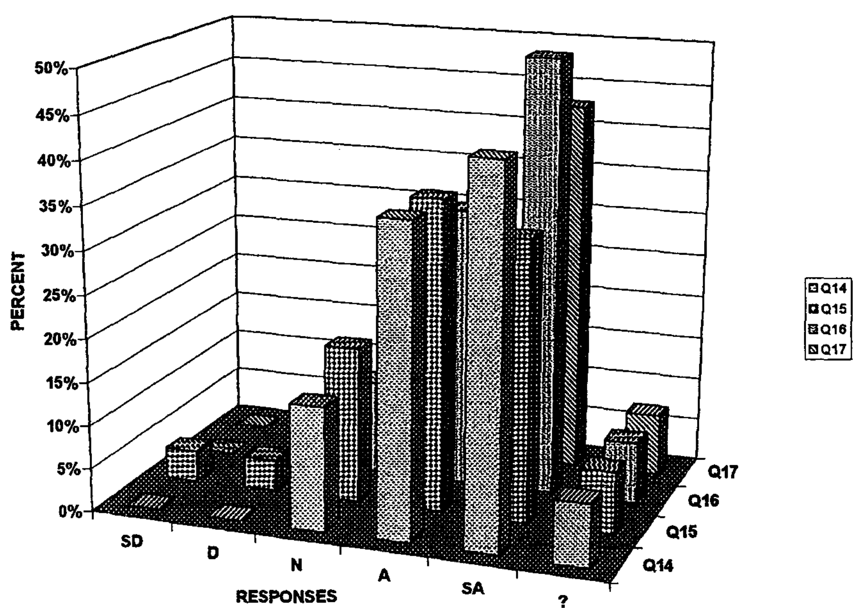
		SD	D	N	A	SA	?	AVE.
	PROGRAM FACULTY:							
8	know the subject matter and occupational requirements.	0	0	4	13	11	0	**4.25**
9	are available to provide help when needed.	0	0	7	12	9	0	**4.07**
10	provide instruction so it is interesting and understandable.	0	3	5	11	9	0	**3.93**

FRESHMAN RESPONSES TO QUESTIONS 11,12 & 13



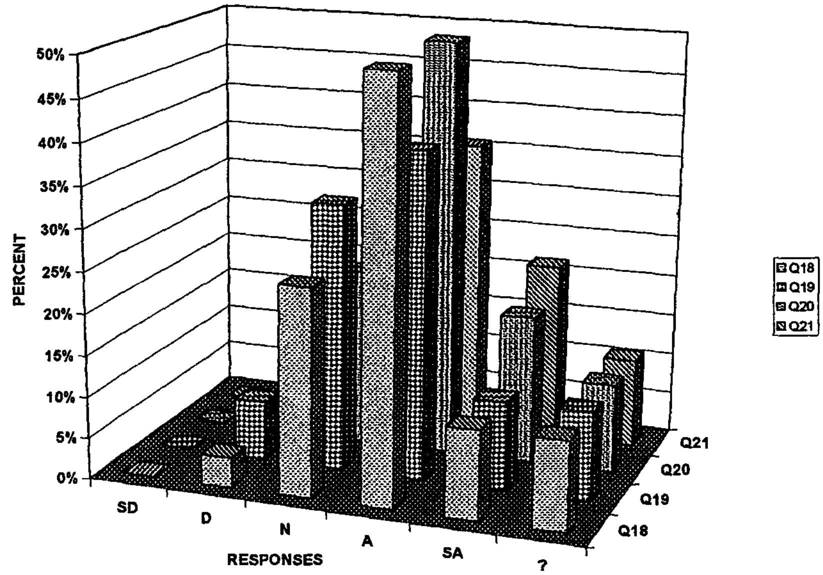
		SD	D	N	A	SA	?	AVE.
	RELATED COURSE FACULTY:							
11	know the subject matter and occupational requirements.	0	0	5	15	8	0	**4.11**
12	are available to provide help when needed.	0	0	3	19	6	0	**4.11**
13	provide instruction so it is interesting and understandable.	0	1	6	14	7	0	**3.96**

FRESHMAN RESPONSES TO QUESTIONS 14,15,16 & 17



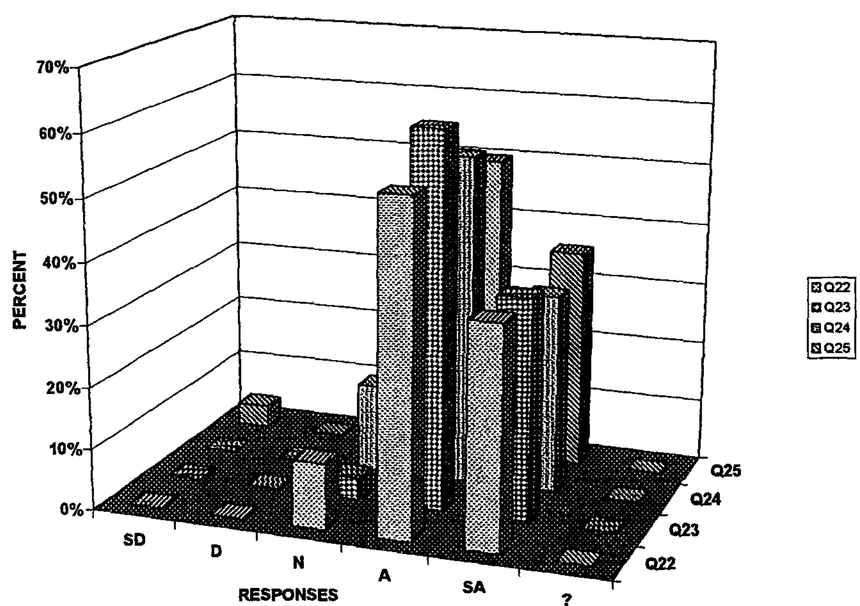
		SD	D	N	A	SA	?	AVE.
	PROGRAM COMPUTER LABORATORIES:							
14	provide adequate lighting, ventilation, etc.	0	0	4	10	12	2	**4.00**
15	include enough work stations for students enrolled.	1	1	5	10	9	2	**3.68**
16	are safe, functional, and well maintained.	0	0	3	9	14	2	**4.11**
17	are available on an equal basis for all students.	0	0	5	9	12	2	**3.96**

FRESHMAN RESPONSES TO QUESTIONS 18,19,20 & 21



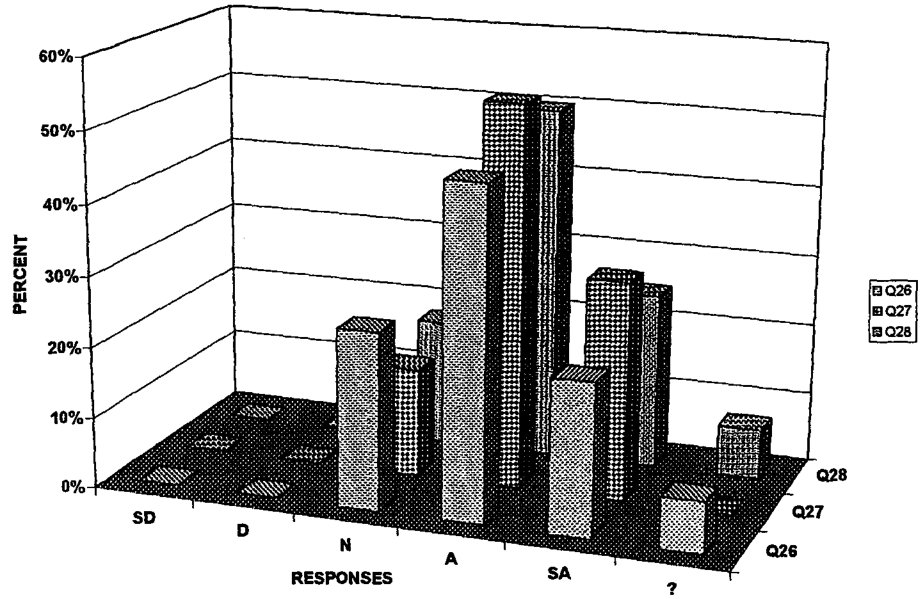
		SD	D	N	A	SA	?	AVE.
	OTHER PROGRAM LABORATORIES:							
18	provide adequate lighting, ventilation, etc.	0	1	7	14	3	3	**3.36**
19	include enough work stations for students enrolled.	0	2	9	11	3	3	**3.21**
20	are safe, functional, and well maintained.	0	0	6	14	5	3	**3.54**
21	are available on an equal basis for all students.	0	1	8	10	6	3	**3.43**

FRESHMAN RESPONSES TO QUESTIONS 22,23,24 & 25



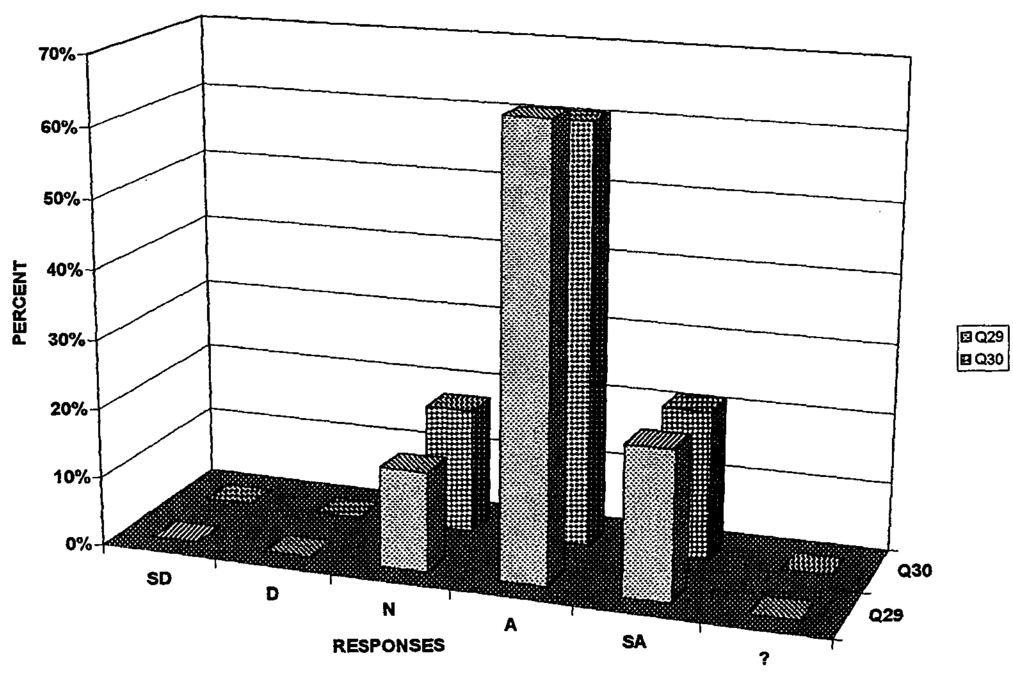
		SD	D	N	A	SA	?	AVE.
	CLASS ROOMS:							
22	provide adequate lighting, ventilation, etc.	0	0	3	15	10	0	**4.25**
23	include enough seats / tables for students enrolled.	0	0	1	17	10	0	**4.32**
24	are safe, functional, and well maintained.	0	0	4	15	9	0	**4.18**
25	are available on an equal basis for all students.	1	0	3	14	10	0	**4.14**

FRESHMAN RESPONSES TO QUESTIONS 26,27 &28



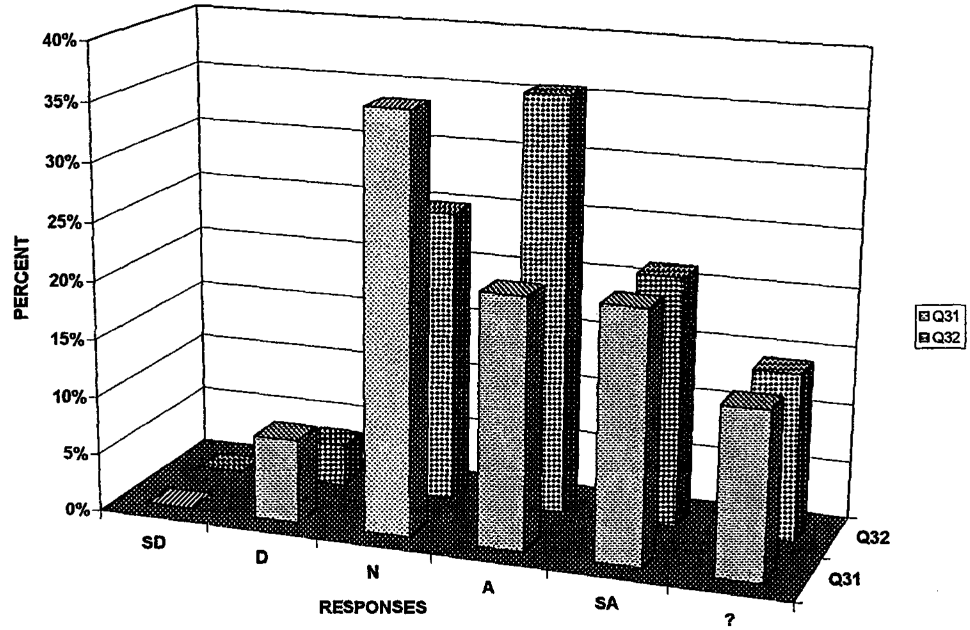
		SD	D	N	A	SA	?	AVE.
	PROGRAM INSTRUCTIONAL EQUIPMENT IS:							
26	current and representative of the industry.	0	0	7	13	6	2	**3.68**
27	in sufficient quantity to avoid long delays in use.	0	0	4	14	8	0	**3.86**
28	safe and good condition.	0	0	5	14	7	2	**3.79**

FRESHMAN RESPONSES TO QUESTIONS 29 & 30



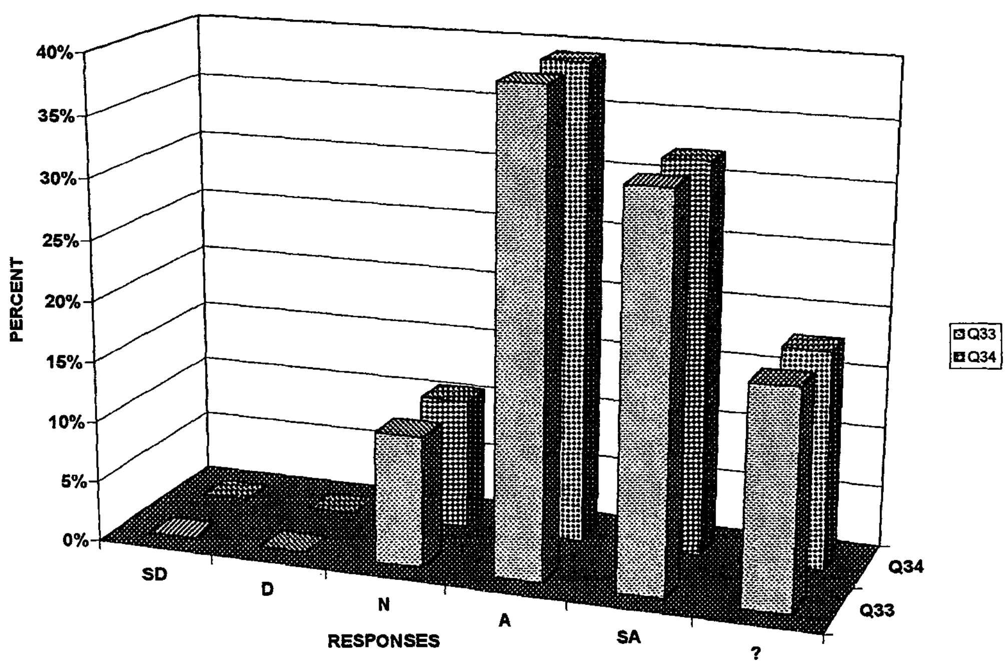
		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL MATERIALS ARE:							
29	current and meaningful to the subject.	0	0	4	18	6	0	**4.07**
30	available and conveniently located for use.	0	0	5	17	6	0	**4.04**

FRESHMAN RESPONSES TO QUESTIONS 31 & 32



		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL SUPPORT SERVICES (tutoring) ARE:							
31	available to meet your needs and interests.	0	2	10	6	6	4	**3.14**
32	provided by knowledgeable, interested staff..	0	1	7	10	6	4	**3.32**

FRESHMAN RESPONSES TO QUESTIONS 33 & 34



		SD	D	N	A	SA	?	AVE.
	PLACEMENT SERVICES ARE AVAILABLE TO:							
33	help you find employment opportunities..	0	0	3	11	9	5	**3.50**
34	prepare you to apply for a job.	0	0	3	11	9	5	**3.50**

35Good instructors, good classrooms.
Don't know.
A lot.
They help a student prepare for the real world.
I believe that they have great professors. They make the material very interesting and fun. The professors are also willing to help after class hours.
The strength of the HVACR program are its program material and its instructors.
The equipment.
The classes offered seem to be applicable to the industry.
It's labs.
Getting the hands on experience of working in the lab and with a group.
Great equipment to work on and with.
The greatest is the faculty and staff, & job opportunities.
Very good job opportunities.
Instructors know the field and are good instructors.
The good hands on approach in lab. We learn more in on lab than three hours of lecture.
Learning in the labs.
There practicality.
Amounts & quality of lab equipment available to students.
Being hands on, directory board.
Their reputation, and their facilities.
The labs have good equipment and the instructors have worked in the field.
Job placement opportunities.
Good job placement.
National recognition, great career placement, and strong outlook.

36Limited class time choices, too early.
Not enough lab time.
Few.
I believe that the greatest weakness is that there is not enough lab time.
The availability of the class and how some are only offered 1 or 2 times a day.
Short lab hours.
Not enough lab time or exciting activities.
I really think we need more lab time.
It's compatibility with the students.
Don't know I have only been here one semester.
Is that in the HVAC 101 class there need to be more labs. More than once a week, Need to re-cruit
more women to the program.
HVAC 101 need to have more hands on learning.
I think that in some instances such as bad class average the instructor should slow up and clar-ify.
Not enough lab time.
More labs needed for each course.
It's not the most exciting field.
Not enough time in lab for 101.
Not enough lab time.
Old, small building.
Not very glamorous, Does not cater to good students. Need to project a more professional im-age.
There is to much time spent on elective classes like social awareness or cultural enrichment.
Outdated, no room to grow.

37The scientific understanding course because it is a waste of time/money for anyone in HVACR .
Eng. 211.
I feel that they are all equally valuable.
None. All of the courses build upon each other, so it helps you better understand what's going on
in each class that you take as you go along.
ISYS, because it is basic stuff and material should have been taught in high school .
Only been here one semester.
Math 126, we won't use it.
I really don't know.
Don't know.
Don't know, I have only been hear one semester.
EEET 115 need to better prepare you for next class.
English, math, scientific electives, and other stupid no-sense classes.
English, math, music, art, humanities and other classes that don't relate to the HVAC industry.
At the moment I find no class in the HVACR program to be useless.
I'm not sure.
First year, wouldn't really know.
None right now.
Ductwork class, nobody really makes their own ductwork anymore.
Comm 121, I don't believe this course will be useful, maybe it could be substituted with another more useful communication class, or offer the option of taking another class in place of it.
I don't have enough experience to accurately answer.
I found all courses to be valuable, but the sheet metal class should be a requirement for all 2 year
students. The guys going out in the field to install should know a little about sheet metal fabricating
Cultural enrichment, because there are more important things to learn about.

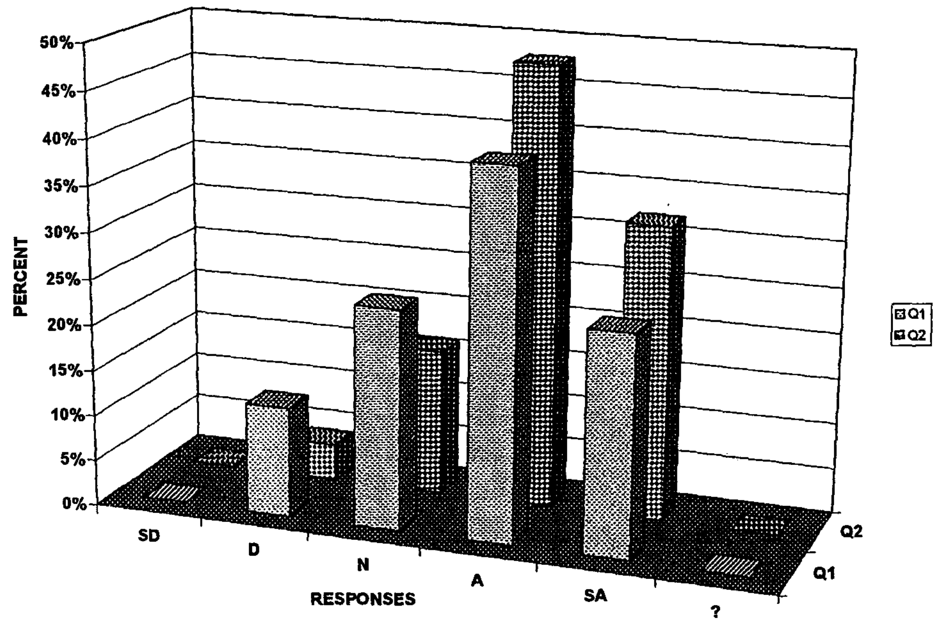
38

Yes/11	No/17	Blank/0

39CMU-ME
CMU
U of M - Flint
Mid Michigan and Delta - Criminal Justice
Greatlakes - Applied computer tech
Park College
Community College
Muskegon Community
Valdesta State University
Grand Rapids Community College
Bay De Noc Community College

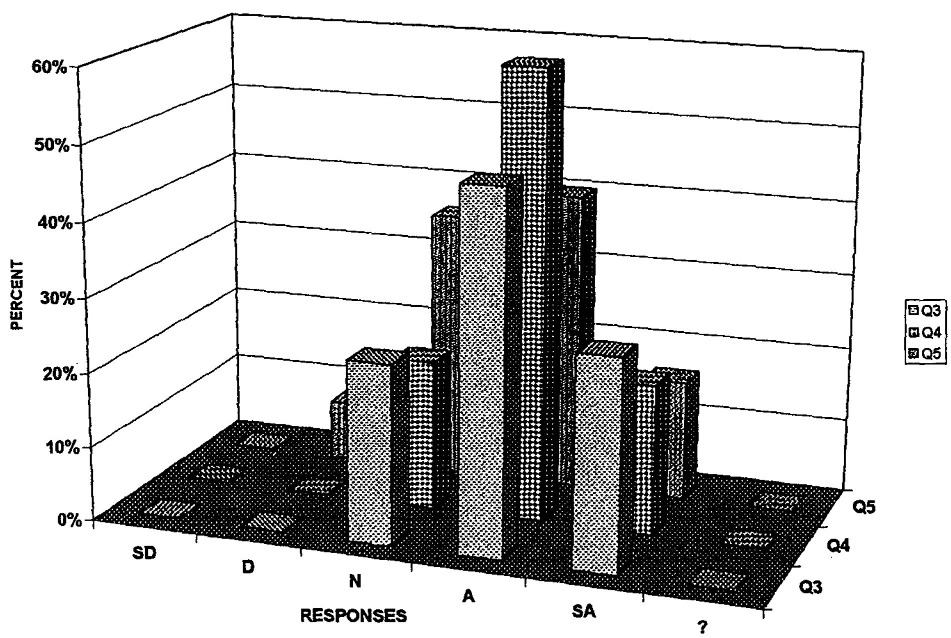
40Don't waste my time with these stupid surveys. Are they really helpful?
I think that this is a great program, but I believe that we should get a new building, this one is old.
It is hard for students such as myself to comprehend the material with only one 3 hour lab day a week. This seems to be the general thought among all the students I have talked to.
Teach professors to be more helpful to students in explaining things. Also how to be better advisors.
Can't think of any.
No comments.
The staff and teachers here are very good. The fact that they have been out in the work force helps
in them teaching us because they can give us real-life scenarios, not just book examples.
I believe this is a very good program.
I feel that there should be more time for lab work. Hands on is the best way to learn in this program.
The HVAC program should market to students other than at tech school. A new facility would greatly improve student moral.
Expand and prosper and good will happen.

SOPHOMORE RESPONSES TO QUESTIONS 1 & 2



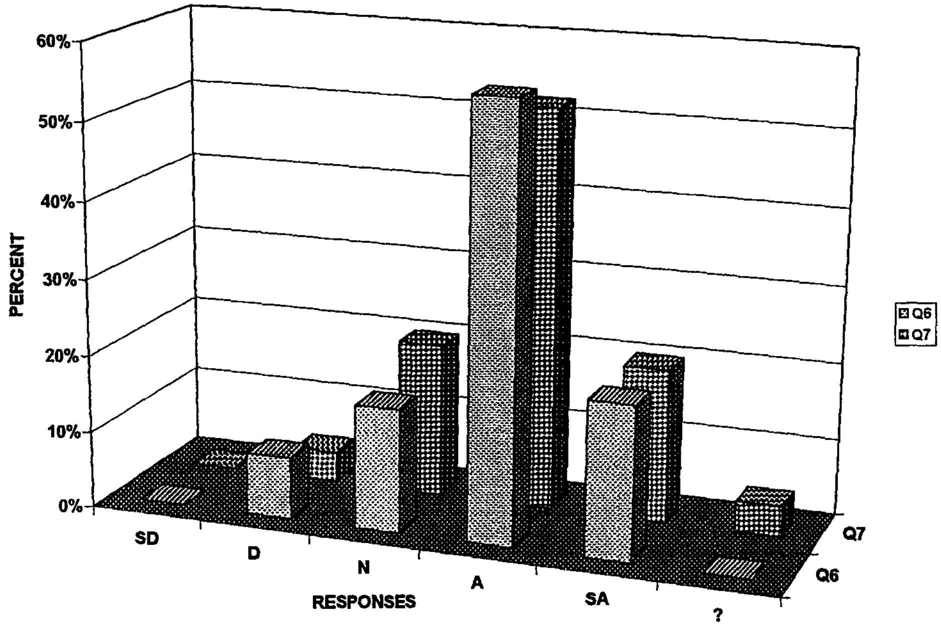
		SD	D	N	A	SA	?	AVE.
	COURSES IN YOUR PROGRAM AREA ARE:							
1	available and conveniently located.	0	3	6	10	6	0	**3.76**
2	based on realistic prerequisites.	0	1	4	12	8	0	**4.08**

SOPHOMORE RESPONSES TO QUESTIONS 3, 4 & 5



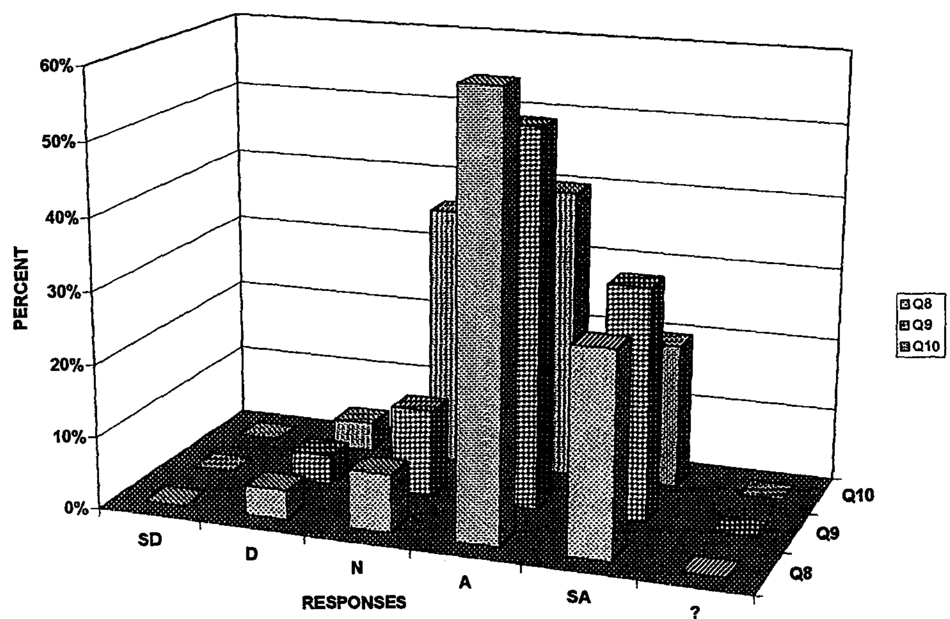
		SD	D	N	A	SA	?	AVE.
	WRITTEN OBJECTIVES FOR COURSES IN YOUR PROGRAM:							
3	are available to students.	0	0	6	12	7	0	**4.04**
4	describe what you will learn in the course.	0	0	5	15	5	0	**4.00**
5	are used by the instructor to keep you aware of your progress.	0	2	9	10	4	0	**3.64**

SOPHOMORE RESPONSES TO QUESTIONS 6 & 7



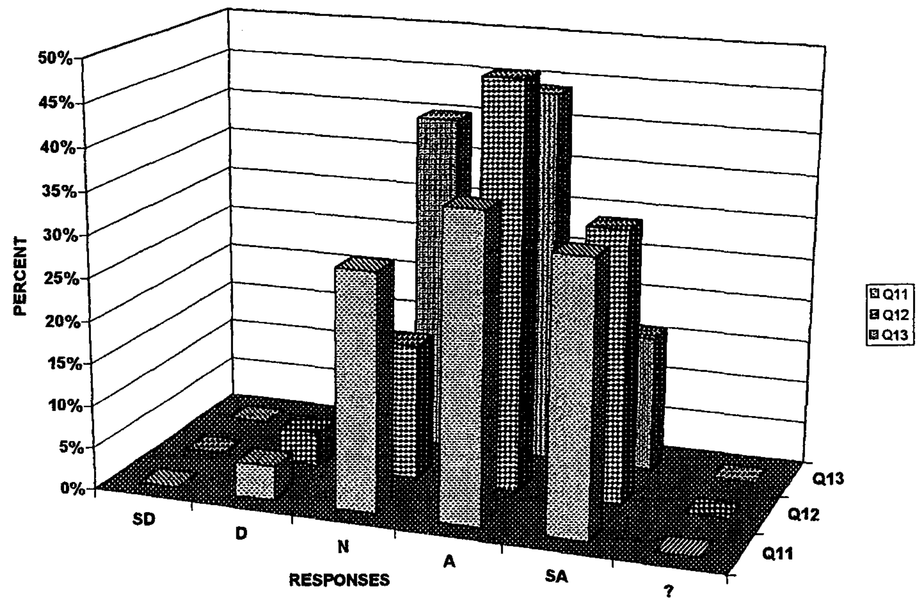
		SD	D	N	A	SA	?	AVE.
	TEACHING METHODS, PROCEDURES & COURSE CONTENT:							
6	meet your projected career needs, interests and objectives.	0	2	4	14	5	0	**3.88**
7	provide supervised practice for skill development.	0	1	5	13	5	1	**3.76**

SOPHOMORE RESPONSES TO QUESTIONS 8, 9 & 10



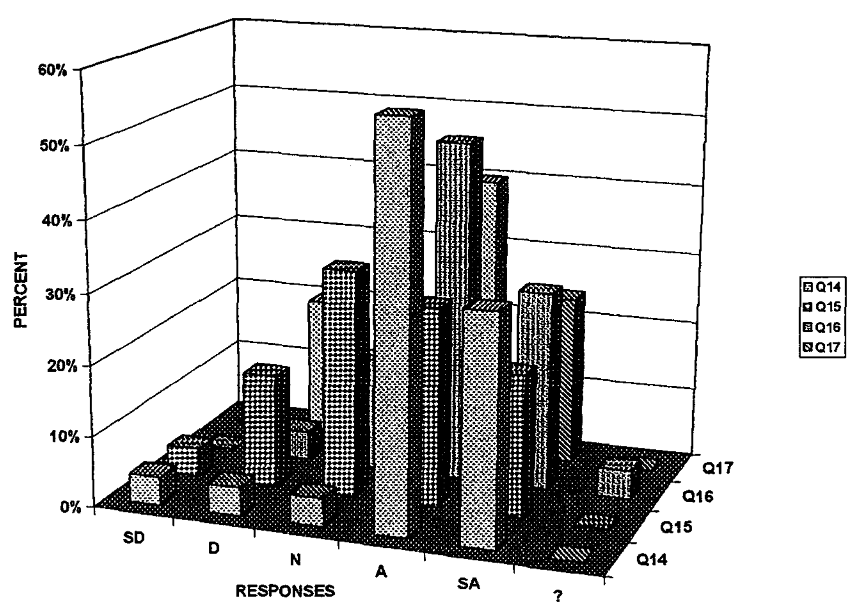
		SD	D	N	A	SA	?	AVE.
	PROGRAM FACULTY:							
8	know the subject matter and occupational requirements.	0	1	2	15	7	0	**4.12**
9	are available to provide help when needed.	0	1	3	13	8	0	**4.12**
10	provide instruction so it is interesting and understandable.	0	1	9	10	5	0	**3.76**

SOPHOMORE RESPONSES TO QUESTIONS 11,12 & 13



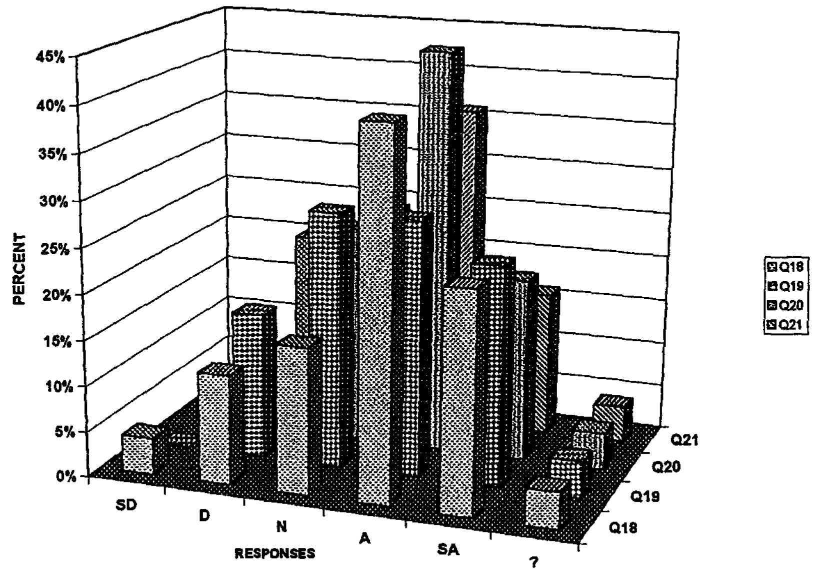
		SD	D	N	A	SA	?	AVE.
	RELATED COURSE FACULTY:							
11	know the subject matter and occupational requirements.	0	1	7	9	8	0	**3.96**
12	are available to provide help when needed.	0	1	4	12	8	0	**4.08**
13	provide instruction so it is interesting and understandable.	0	0	10	11	4	0	**3.76**

SOPHOMORE RESPONSES TO QUESTIONS 14,15,16 & 17



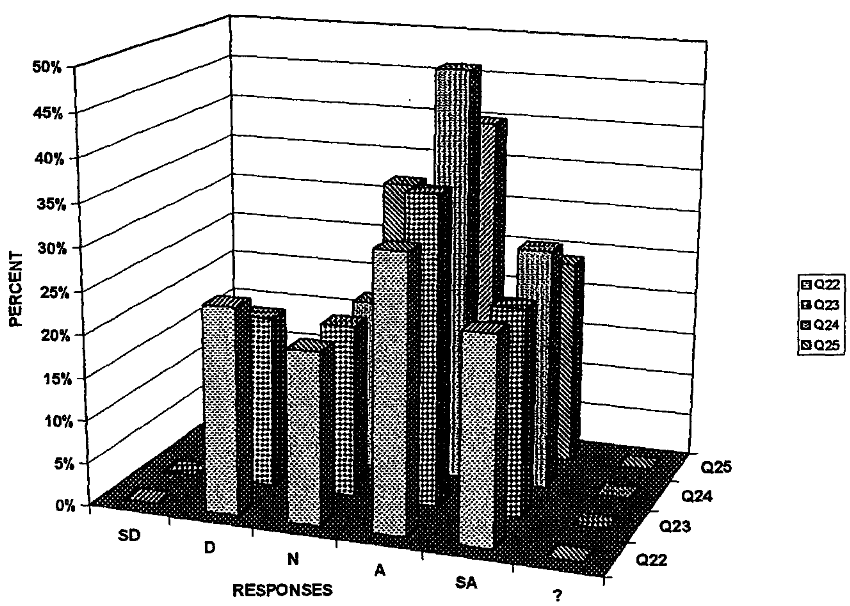
		SD	D	N	A	SA	?	AVE.
	PROGRAM COMPUTER LABORATORIES:							
14	provide adequate lighting, ventilation, etc.	1	1	1	14	8	0	**4.08**
15	include enough work stations for students enrolled.	1	4	8	7	5	0	**3.44**
16	are safe, functional, and well maintained.	0	1	4	12	7	1	**3.88**
17	are available on an equal basis for all students.	0	5	4	10	6	0	**3.68**

SOPHOMORE RESPONSES TO QUESTIONS 18,19,20 & 21



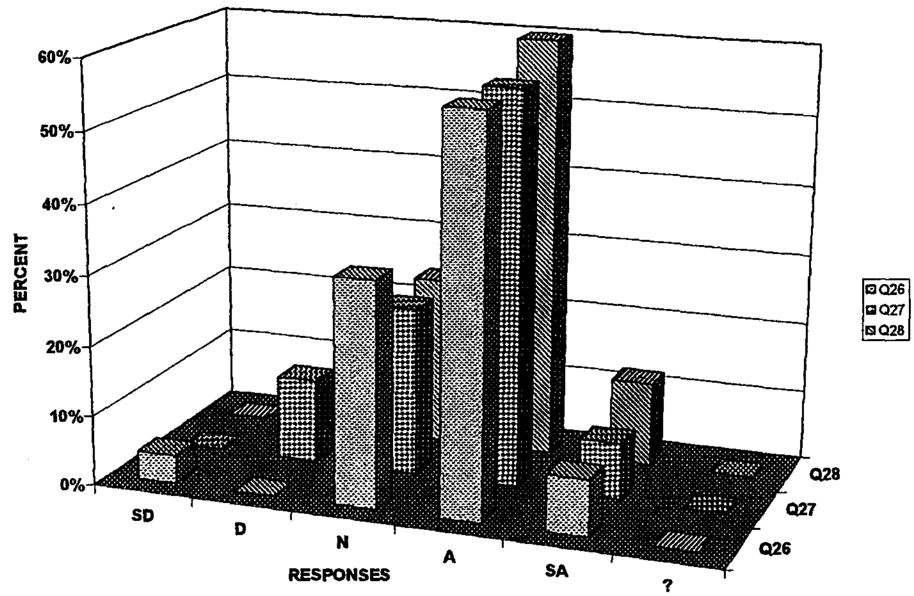
		SD	D	N	A	SA	?	AVE.
	OTHER PROGRAM LABORATORIES:							
18	provide adequate lighting, ventilation, etc.	1	3	4	10	6	1	**3.56**
19	include enough work stations for students enrolled.	0	4	7	7	6	1	**3.48**
20	are safe, functional, and well maintained.	0	2	6	11	5	1	**3.64**
21	are available on an equal basis for all students.	0	5	6	9	4	1	**3.36**

SOPHOMORE RESPONSES TO QUESTIONS 22,23,24 & 25



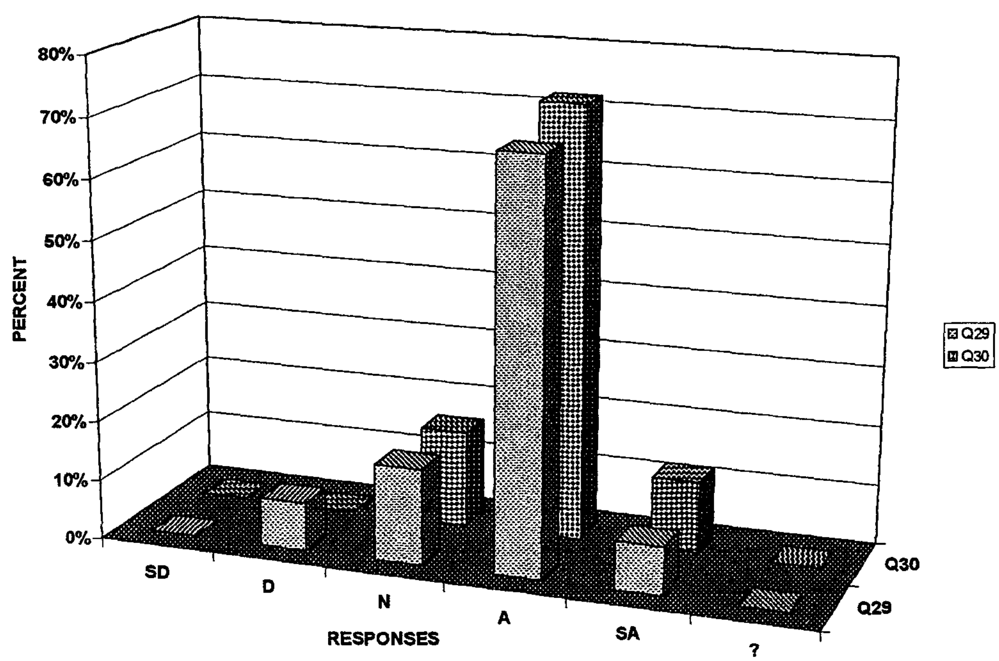
		SD	D	N	A	SA	?	AVE.
	CLASS ROOMS:							
22	provide adequate lighting, ventilation, etc.	0	6	5	8	6	0	**3.56**
23	include enough seats / tables for students enrolled.	0	5	5	9	6	0	**3.64**
24	are safe, functional, and well maintained.	0	1	5	12	7	0	**4.00**
25	are available on an equal basis for all students.	0	1	8	10	6	0	**3.84**

SOPHOMORE RESPONSES TO QUESTIONS 26,27 &28



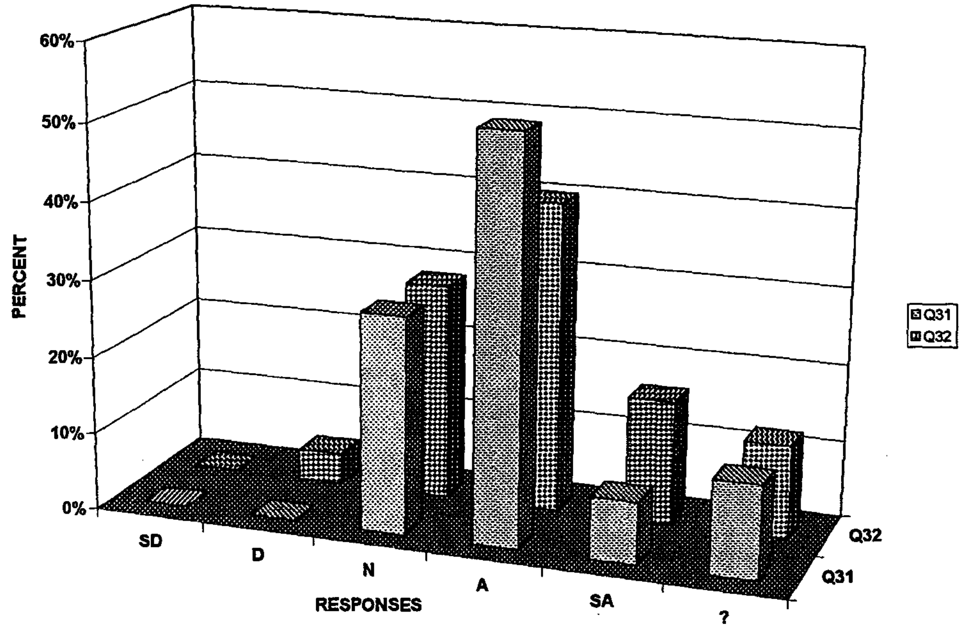
		SD	D	N	A	SA	?	AVE.
	PROGRAM INSTRUCTIONAL EQUIPMENT IS:							
26	current and representative of the industry.	1	0	8	14	2	0	**3.64**
27	in sufficient quantity to avoid long delays in use.	0	3	6	14	2	0	**3.60**
28	safe and good condition.	0	1	6	15	3	0	**3.80**

SOPHOMORE RESPONSES TO QUESTIONS 29 & 30



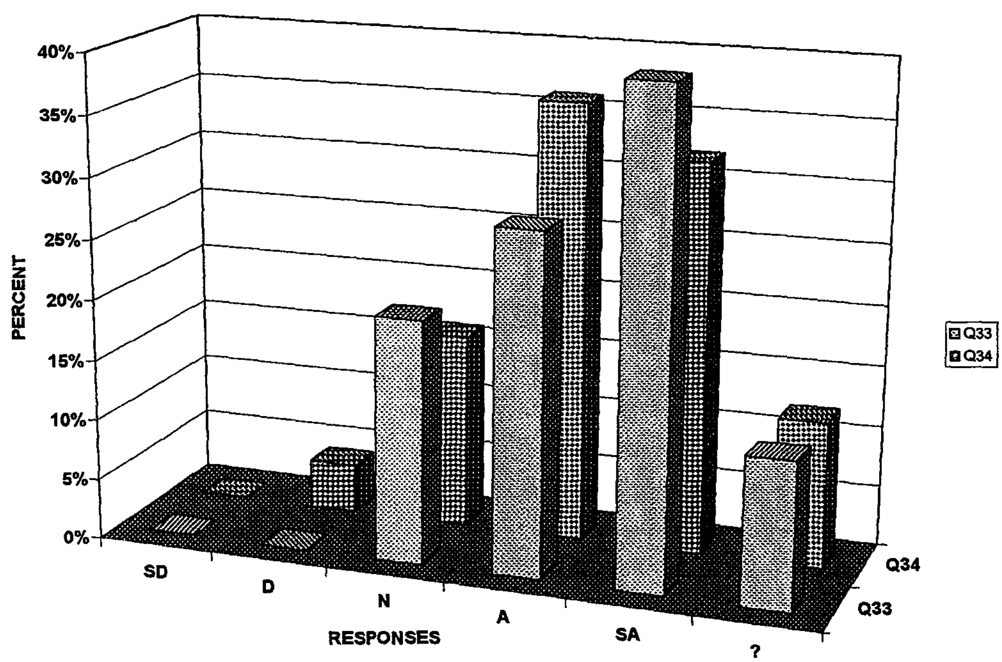
		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL MATERIALS ARE:							
29	current and meaningful to the subject.	0	2	4	17	2	0	**3.76**
30	available and conveniently located for use.	0	0	4	18	3	0	**3.96**

SOPHOMORE RESPONSES TO QUESTIONS 31 & 32



		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL SUPPORT SERVICES (tutoring) ARE:							
31	available to meet your needs and interests.	0	0	7	13	2	3	**3.32**
32	provided by knowledgeable, interested staff..	0	1	7	10	4	3	**3.32**

SOPHOMORE RESPONSES TO QUESTIONS 33 & 34



		SD	D	N	A	SA	?	AVE.
	PLACEMENT SERVICES ARE AVAILABLE TO:							
33	help you find employment opportunities..	0	0	5	7	10	3	**3.72**
34	prepare you to apply for a job.	0	1	4	9	8	3	**3.60**

35The hands-on labs and the teachers knowledge of the subjects help out a lot.
The teachers are well equipped in the information they are sending out to the students. Make sure
you understand in lab and lecture whats going on.
Finding jobs, electronics classes.
Knowledge of the faculty, Job opportunities.
Quality instruction of the professors.
The electrical courses.
Hands on work but there could be more.
Teaching the students formulas about HVACR and giving them quite a bit of hands on experience.
You get a knowledge of how thing work, so when you go out in the field you will know thing should
be done and thing not to do.
The professors, they are great people with a lot of knowledge that are willing to help.
Mr. Stevens.
The HVAC program gives you're a good foundation on the industry, This makes it that much more
easier to learn what your employer expects of you.
The faculty.
The fact that they have professors and staff that know how things in our industry work outside of the
class material.
I like the program because it is practical and our professors have all worked in the field at one time
or another. They are good teachers who really want us to learn.
Equipment, labs, facilities.
Knowing that when you graduate they will help you find a great job.
It is suppose to be #1 in the Country. It has high job placement for students coming out of the program.
Being able to come in the building and look at, or work on, the tool you are working with or fixing

36The computers are usually full and hard to use one. Some equipment is out of date.
Uses a lot of old useless information.
The two year program is focused too much on preparing students for the 4 year and not for working
as a service tech or related two year graduates job.
Classes start way to early in the morning. We have the rest of our lives to wake up for work early,
why should we do it every single day for a college education. Should have a wider variety of class
times to choose from.
Building is outdated.
Refrigeration!! You don't offer nearly as much education as you should.
Some instructors are boring and the classrooms and labs are terrible.
Need more hands on experiences, more professors with hands on experience like Russ Stevens.
Could be more hand on experience.
Some of the equipment is really ancient & needs to update some of it.
Needs more hands on teaching instead of just lecture.
The way that some material goes into to much detail for what the class is supposed to teach.

36The Ancient equipment, the work area's.
The greatest weakness is the amount of time we get in lab. We need more than one time a week
for three hours.
We don't' have a very good facility.
Rooms are messy sometimes, less lecture, less lab, three hours too much.
Not having enough lab time for classes.
The facility, not enough classrooms.
Not enough lab time to get hands on experience with the equipment & tools needed for your job or
outside the school.

37Not sure - have learned things in each course taken in HVAC.
If their had to be course least valuable, it would Intro 101, because your learn almost the same material in 102. I think they should combine the two classes onto 1.
I believe they are all valuable.
All are valuable.
They are all pretty important.
The class that is least valuable to me is ISYS 100.
Cultural enrichment.
HVAC 132 - so much of the class can be put into other courses.
Fuel oil. Because I am living in the Detroit area where fuel oil is not used.
None, the ones that I have had all help with the understanding of the industry.
I haven't taken a course yet that wasn't important. Every couse I have taken is vital.
HVAC117, because it is the hardest class in the program and it is a one hundred level.
Cultural enrichment classes (Humanities). There is no reason why people should waste their time
with that class, it has nothing to do with the HVACR program.
All of the classes are valuable.
The sheet metal class.

38

Yes/4	No/19	Blank/2

39FSU - Electrical Engineering
Northwest Michigan College
MCC - HVACR
Northwest Michigan College

40Overall I like the program. Some of the classroom get full quick and a new building could be great.
I think more information should be provided to students for finding jobs. We need to know what kind of jobs are out there and what we will be doing at those jobs. We should be told the advantages to going into the 2 yr. Compared to the 4 yr.
There needs to be a wider variety of class times. They are almost all a 8:00 in the morning.
The building in which the classes take place is not suitable.
The program needs a new building because the one there using now is worse than the automotive
building. HVACR program needs better classrooms where there are no interruptions from other students.
Improve the refrigeration classes along with system design.
I think that for the 2 year associates degree that need to have more hands on experiences and then
for the 4 year they can get into more of the design and formula stuff. Here they have to much 4 year information in the 2 year associates program.

40Better labs. More hands on.
I think that they should reevaluate the tool list again. I found by working in the field I will never use
some of the things I was made to purchase.
I feel that each student should get a free shirt for the money they put into the program. Tools etc...
Overall I find the HVACR Program to be very interesting and helpful to what I want to achieve in a
career.
The teachers in my program genuinely care that the students do well. It's not like other programs where students are statistics. Our teachers know us by name and help us out.
All of the professors in the HVACR program are good and they are always interesting in what goes
on in class.
More computers for the students to use. More help from the staff in areas that they can not describe well.

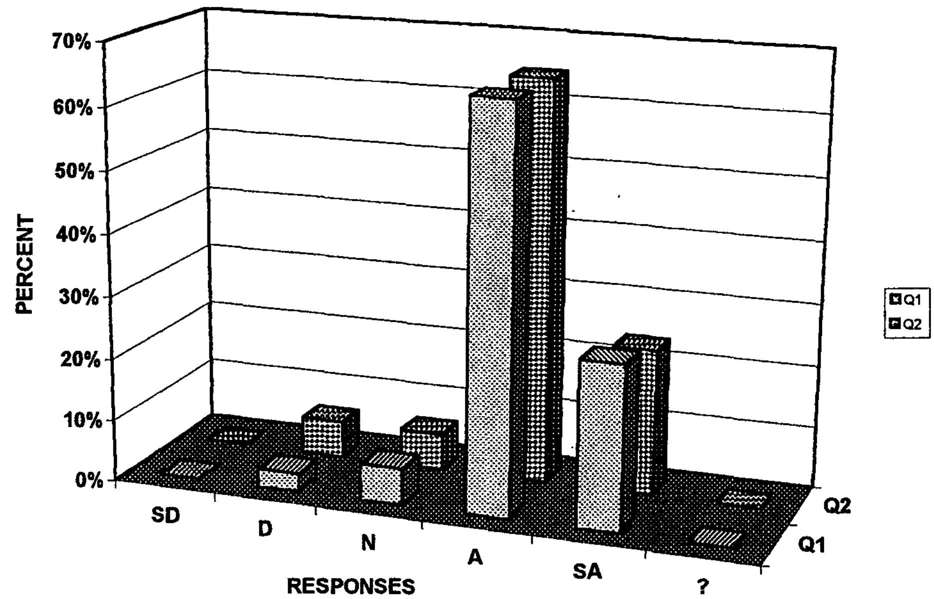
(Section 4 – Student Evaluations – BS Program)

The student list was compiled from course enrollment documents obtained from the registrar's office. A total of 62 students completed the evaluation including 28 seniors and 34 juniors. This represents a 92.5% return rate for the upper division students. The rate of return was considered excellent.

The survey instrument was constructed to look at the following areas: courses offered, course objectives, teaching methods, program faculty, related courses, laboratories, classrooms, equipment and instructional materials, support services and placement. The survey instrument allowed the student to respond to each statement in the following manner: (5) Strongly Agree, (4) Agree, (3) Neutral, (2) Disagree, (1) Strongly Disagree and (?) Don't Know. The last two pages allowed the students the opportunity to comment on program particulars such as strengths, weaknesses and applicable course value.

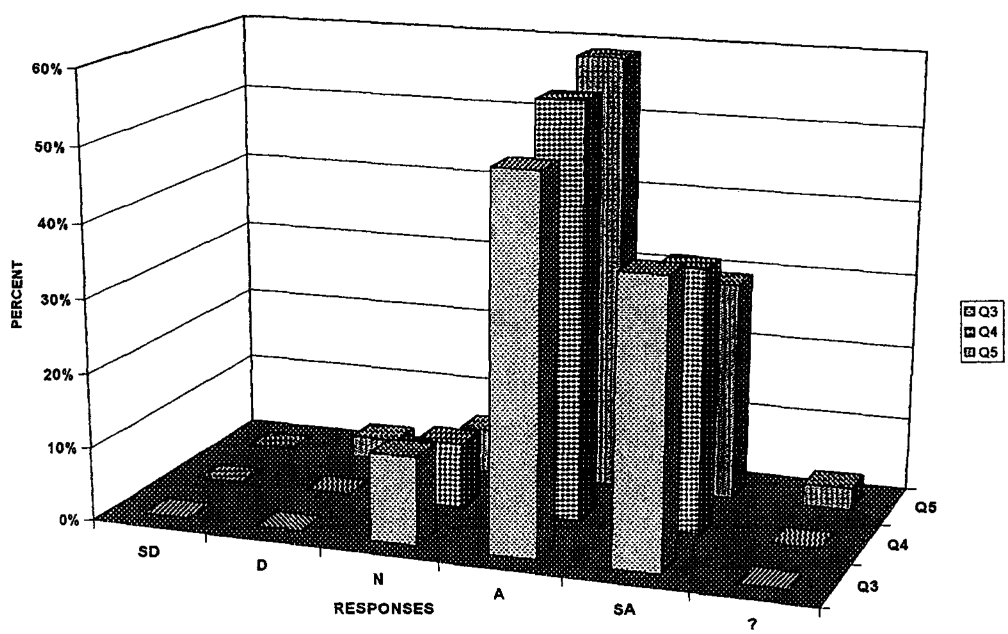
The survey also indicated that 55% of those surveyed in the upper division were transfer students from institutions other than Ferris State University.

JUNIOR RESPONSES TO QUESTIONS 1 & 2



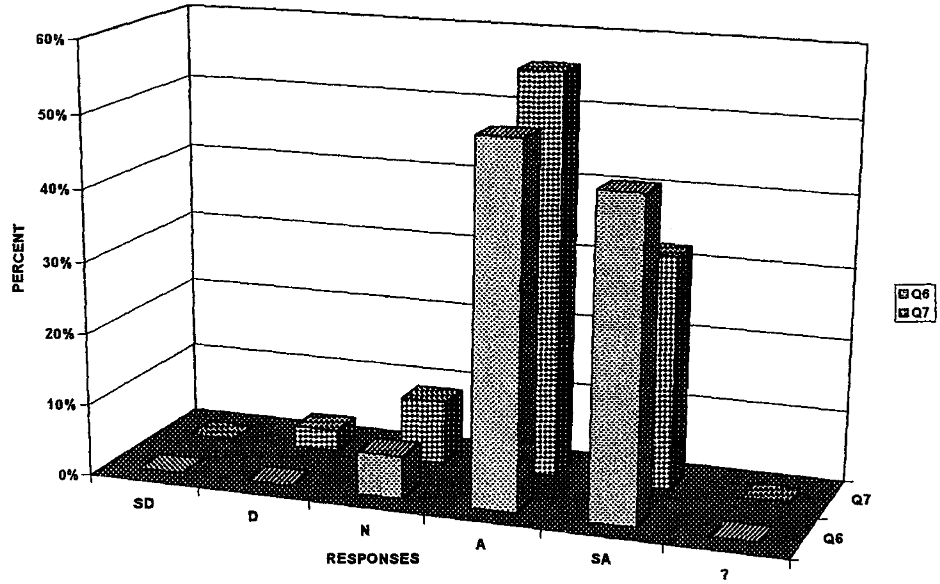
		SD	D	N	A	SA	?	AVE.
	COURSES IN YOUR PROGRAM AREA ARE:							
1	available and conveniently located.	0	1	2	22	9	0	**4.15**
2	based on realistic prerequisites.	0	2	2	22	8	0	**4.06**

JUNIOR RESPONSES TO QUESTIONS 3, 4 & 5



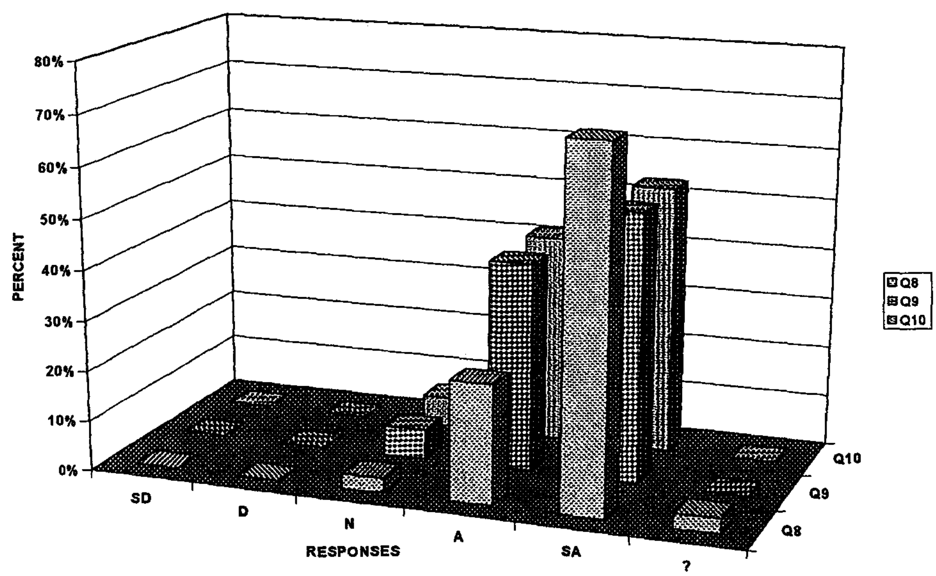
		SD	D	N	A	SA	?	AVE.
	WRITTEN OBJECTIVES FOR COURSES IN YOUR PROGRAM:							
3	are available to students.	0	0	4	17	13	0	**4.26**
4	describe what you will learn in the course.	0	0	3	19	12	0	**4.26**
5	are used by the instructor to keep you aware of your progress.	0	1	2	20	10	1	**4.06**

JUNIOR RESPONSES TO QUESTIONS 6 & 7



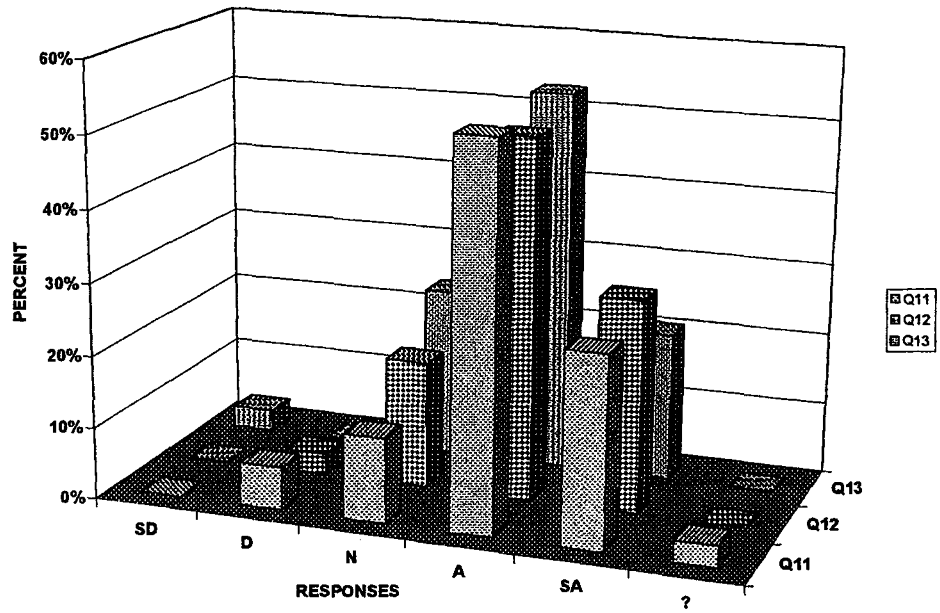
		SD	D	N	A	SA	?	AVE.
	TEACHING METHODS, PROCEDURES & COURSE CONTENT:							
6	meet your projected career needs, interests and objectives.	0	0	2	17	15	0	**4.38**
7	provide supervised practice for skill development.	0	1	3	19	11	0	**4.18**

JUNIOR RESPONSES TO QUESTIONS 8, 9 & 10



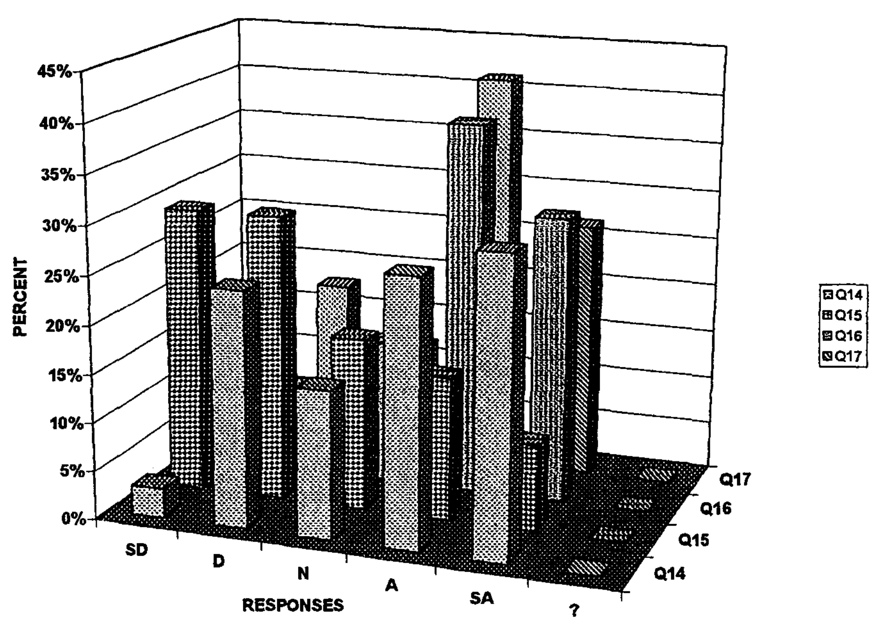
		SD	D	N	A	SA	?	AVE.
	PROGRAM FACULTY:							
8	know the subject matter and occupational requirements.	0	0	1	8	24	1	**4.56**
9	are available to provide help when needed.	0	0	2	14	18	0	**4.47**
10	provide instruction so it is interesting and understandable.	0	0	2	14	18	0	**4.47**

JUNIOR RESPONSES TO QUESTIONS 11,12 & 13



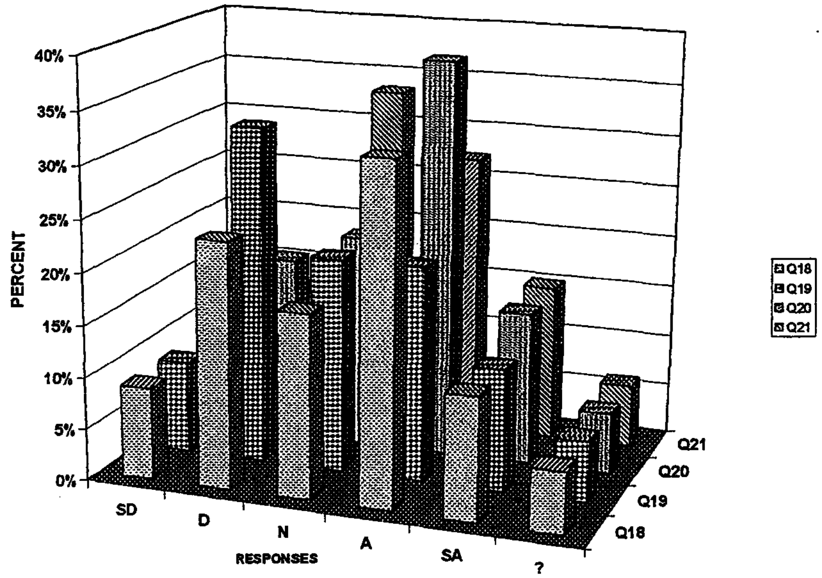
		SD	D	N	A	SA	?	AVE.
	RELATED COURSE FACULTY:							
11	know the subject matter and occupational requirements.	0	2	4	18	9	1	**3.91**
12	are available to provide help when needed.	0	1	6	17	10	0	**4.06**
13	provide instruction so it is interesting and understandable.	1	0	8	18	7	0	**3.88**

JUNIOR RESPONSES TO QUESTIONS 14,15,16 & 17



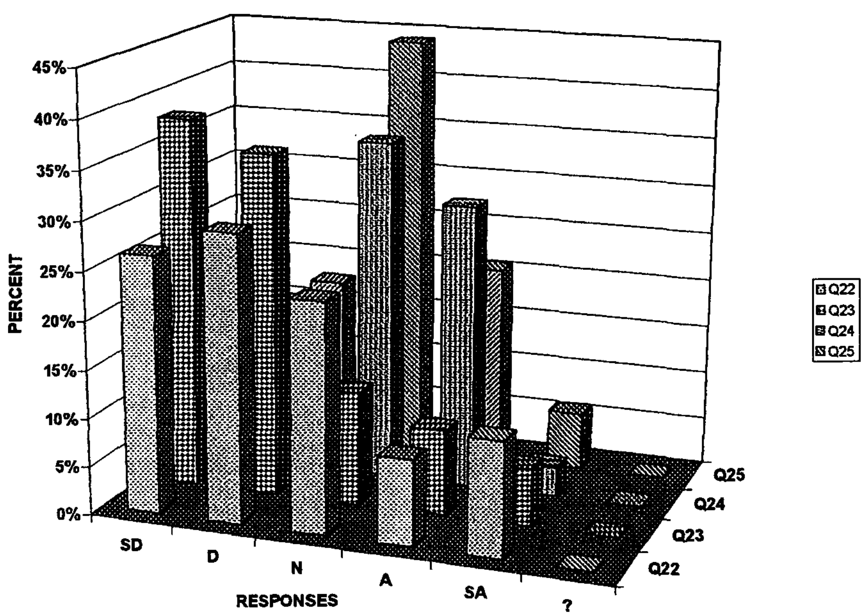
		SD	D	N	A	SA	?	AVE.
	PROGRAM COMPUTER LABORATORIES:							
14	provide adequate lighting, ventilation, etc.	1	8	5	9	10	0	**3.47**
15	include enough work stations for students enrolled.	10	10	6	5	3	0	**2.44**
16	are safe, functional, and well maintained.	3	3	5	13	10	0	**3.71**
17	are available on an equal basis for all students.	1	6	4	14	9	0	**3.71**

JUNIOR RESPONSES TO QUESTIONS 18,19,20 & 21



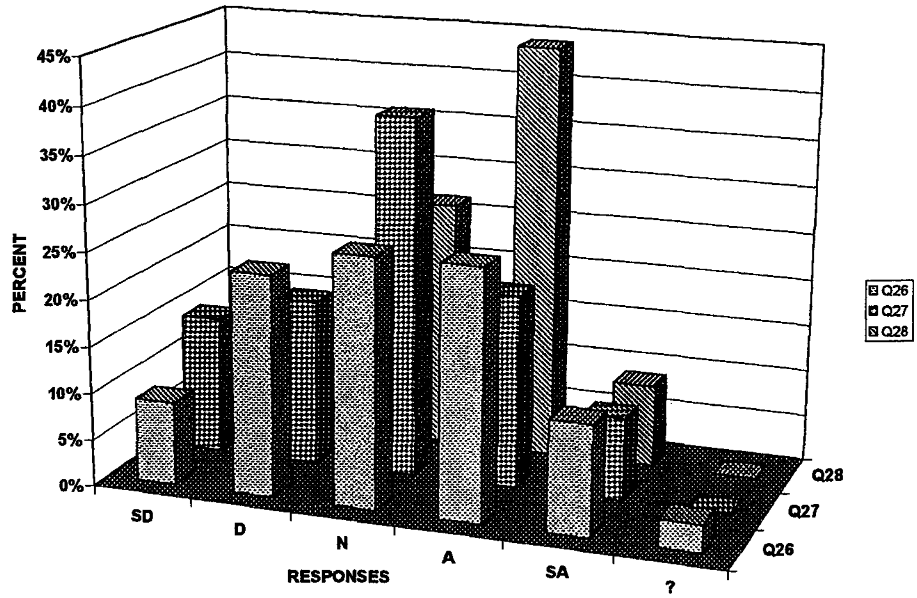
		SD	D	N	A	SA	?	AVE.
	OTHER PROGRAM LABORATORIES:							
18	provide adequate lighting, ventilation, etc.	3	8	6	11	4	2	**2.97**
19	include enough work stations for students enrolled.	3	11	7	7	4	2	**2.76**
20	are safe, functional, and well maintained.	1	6	7	13	5	2	**3.26**
21	are available on an equal basis for all students.	3	3	11	9	5	2	**3.03**

JUNIOR RESPONSES TO QUESTIONS 22,23,24 & 25



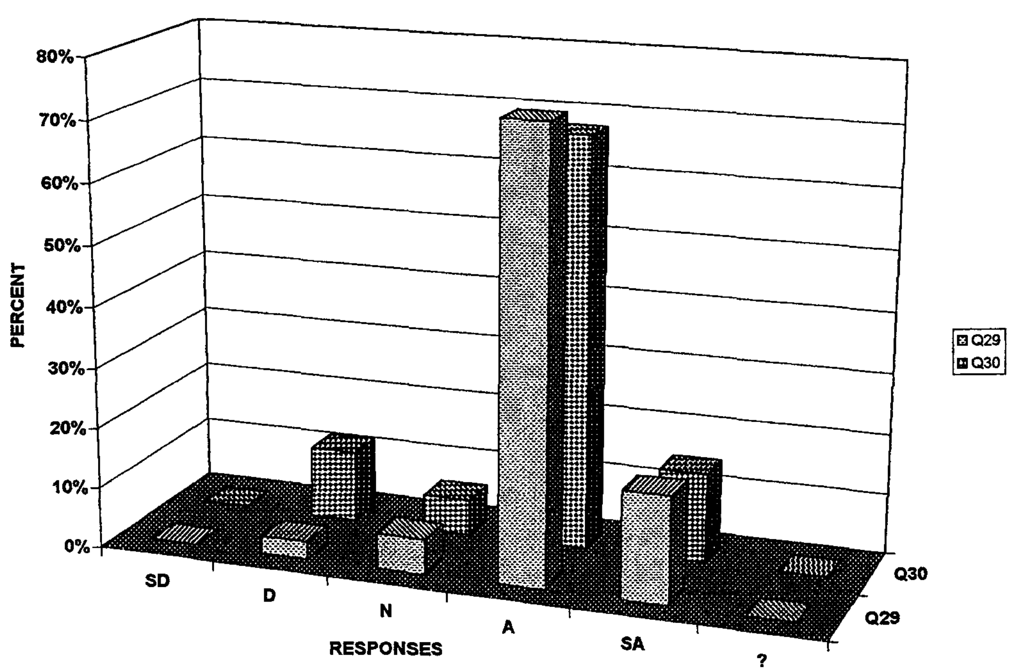
		SD	D	N	A	SA	?	AVE.
	CLASS ROOMS:							
22	provide adequate lighting, ventilation, etc.	9	10	8	3	4	0	**2.50**
23	include enough seats / tables for students enrolled.	13	12	4	3	2	0	**2.09**
24	are safe, functional, and well maintained.	5	6	12	10	1	0	**2.88**
25	are available on an equal basis for all students.	4	6	15	7	2	0	**2.91**

JUNIOR RESPONSES TO QUESTIONS 26,27 &28



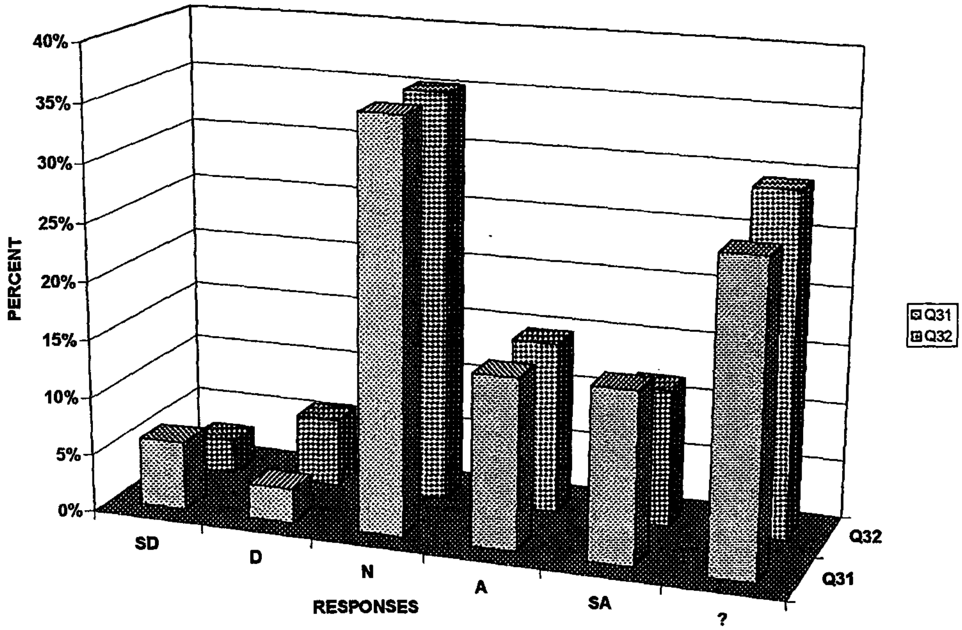
		SD	D	N	A	SA	?	AVE.
	PROGRAM INSTRUCTIONAL EQUIPMENT IS:							
26	current and representative of the industry.	3	8	9	9	4	1	**3.00**
27	in sufficient quantity to avoid long delays in use.	5	6	13	7	3	0	**2.91**
28	safe and good condition.	3	4	9	15	3	0	**3.32**

JUNIOR RESPONSES TO QUESTIONS 29 & 30



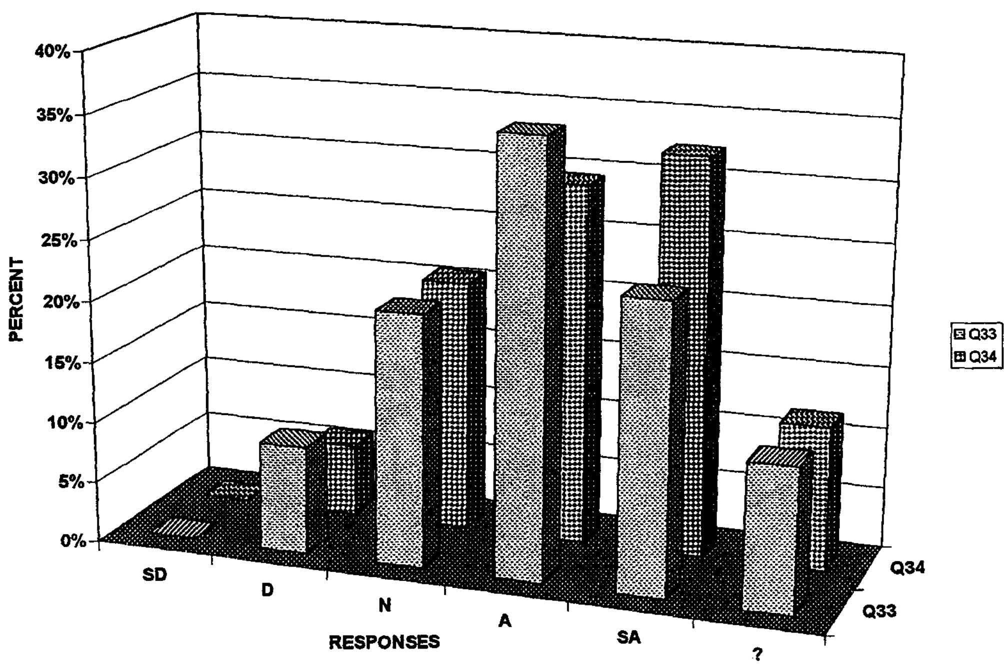
		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL MATERIALS ARE:							
29	current and meaningful to the subject.	0	1	2	25	6	0	**4.06**
30	available and conveniently located for use.	0	4	2	23	5	0	**3.85**

JUNIOR RESPONSES TO QUESTIONS 31 & 32



		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL SUPPORT SERVICES (tutoring) ARE:							
31	available to meet your needs and interests.	2	1	12	5	5	9	**2.50**
32	provided by knowledgeable, interested staff..	1	2	12	5	4	10	**2.38**

JUNIOR RESPONSES TO QUESTIONS 33 & 34



		SD	D	N	A	SA	?	AVE.
	PLACEMENT SERVICES ARE AVAILABLE TO:							
33	help you find employment opportunities..	0	3	7	12	8	4	**3.38**
34	prepare you to apply for a job.	0	2	7	10	11	4	**3.53**

Junior Class Survey Comments:

35. What are the HVACR programs greatest strengths?

The field itself. The money that is held by the programs. The demand for the students.

Most of the Instructors have a great deal of knowledge of the program, school and industry.

Relating to real work place situations.

Sound faculty, Jan is helpful.

The hands on experience. The quality of the instructors. All of them know what they're talking about & relate it to the industry today.

Knowlegeable faculty, only 4 year program in country fo HVACR Engr. Tech., information that is taught is very applicable to actual career situations.

Having our own computer lab, Hands-on learning experience.

The different labs allow good hands-on learning. The computer labs in the building are a great asset.

Professor's knowledge of what is out there.

The hands-on experience.

Good course material and knolegable teachers.

Good instructors.

?

Excellent HVAC instructors. Content.

The greatest strength in the high demand for graduates in the field. The Teachers are knowledgealbe and care about the students progress.

The access or availability to the computer labs. The faculty also.

It is a very well structured and organized program that prepares you for the working environment.

The only class I've had so far in program is 331 and I think it is a good career course.

Information provided for learning.

Most of the chairs are comfortable and the instructors are ok to.

Good instructors, knowledgeable, and they care about the students.

It's a renowned program. The instructors are pretty good.

The faculty and labs.

Providing comfortable environment for people's need. Promoting good food quality for people's need.

The faculty and the reputation of the program.

The information and skills that are taught.

It's well known as a leader in the industry. Faculty know the industry and how to prepare us for it.

Knowledgeable instructors, exposure to different types of systems and design aspects.

Teachers seem to know what is important to our industry.

The method of teaching.

The number of people in the program. Keep the program going and it supplies the program with money.

Instructors

36. What are the HVACR programs greatest weaknesses?

Space for the program. To grow. Computer lab.

The building and the inability to have a good learning setting are its greatest weaknesses.

Facilities are lacking. Not enough scholarships for non-need based students who excel in class.

More space is needed. Some "large" commercial equipment would be nice. A more modern, up-to-date facility.

Lab areas and equipment are too small and outdated. More space is needed in some of the class-rooms as well.

Classes and labs are small. Not enough computers in the lab.

The labs are older and not with the ever changing field.

Keep students up with new equipment.

The facility is sometimes very noisy from machines in it.

Lack of proper class rooms, noise and disturbances.

Not enough equipment, not enough training & educating in refrigeration.

?

Poor computer instructors. Questions are not answered adequately. Computer lab is too small. During classes in the computer lab students roam in and out without any regard for students in class.

The greatest weakness is the lack of privacy in the classrooms. The students find it distracting when people walk in the room & when other classrooms can be heard thru the openings in the walls.

The noise level from equipment operating in certain classrooms.

The building is way to small for the program and they need more instructors so there won't be 30 students crammed into a lab where they have to wait 45 minutes everytime they have a question to ask the professor.

The office next to the classroom is a bit irritating.

The two year program; oil heat, no on uses it!! Why teach it?

Redo HVACR classrooms & related computer work facility.

Facilities are old and overcrowded. Every room is to hot even on extremly cold days, this seems rediculous for an HVAC Program.

The facilities in lab, computer availability could be much better. I was a little disappointed to know Ferris is the only school in the nation with a Bachelors program to find such small and "outdated" type of working lab.

The building needs to be better. Need to keep updating labs with new technology.

The need for more room.

Lack of some necessary equipment.

Some instructors need to be more cooperative with helping students.

The CTC building is pretty crappy for the #1 HVAC school in the nation.

The building is small with a lot of shared space making interuptions to class time frequent.

Our labs are in terrible condition. With lack of supplys to adequtly preform needed work.

Not much 1 on one teaching.

Not enough room for number of people in the class.

Classroom facilities. Loud sink drain in one classroom. Feel like I'm learning in a broom closet. Loud noise often in room adjacent to offices. Poor parking and access.

37. Which course would you consider least valuable in the HVACR Program and Why?

HVAC 207 because the professor tends to favor the majority of students and singles out the minority. He is arrogant and tends to make certain students feel inferior.

ISYS 204

Comm 221 – Small Group Decision Making. This course has taught me nothing of importance to this field of study.

Small Group Decision Making (COMM 221). I have this class right now. To be honest, I haven't learned a thing in there. To me it seems as if the teacher just likes to hear himself talk.

All are valuable.

HVAC 101-102 Could have been better taught. My classes in 101-102 did not have much structure to them.

101 and 102. Although these courses are supposed to be the basis for the program, I feel they did not help at all.

HVAC 207 – had problem getting help.

None. Because all classes that are required will be need in the future.

They are all valuable in helping students gain more knowledge about the HVAC industry.

None, there all valuable.

?

Not necessarily HVAC classes, but Cultural Enrichment classes are not interesting at all. More classes in our major would be for feasible.

The least valuable coarse would probaldy be the Social Awarness coarses.

HVAC 100 because I had Dan McPherson for the professor and he didn't know how to teach.

This is my first year, I cannot say.

Visual Basic – Let the computer experts do the programming!! Don't waste my time!!

Don't know??

Labs are too long in many of the 2 year Programs classes. Much time is wasted.

None. All are valuable here.

There really aren't any. They all seem to be important.

AC Applications.

HVACR 235

235 – Oils aren't used enough to necessitate a 5 credit course.

There is no course as yet that I feel was not helpful or valuable to my continuing education.

HVAC 245 design this course on design is part of the two year program no two year student is going to design a system the system will already be designd for him.

Math 126. It has stuff that I will never see in real life. They make you learn it but will never use it.

Don't know. Probaly Economics.

38. Are you a transfer student?

Yes – 16 No – 18

39. If transfer student from what sxhool and curriculum?

Oakland Community College – HVAC Technology
Grand Rapids CC – HVAC
HVAC-R
Delta College – Mechanical Design
North Seattle Community college – HVAC
IVY Tech Bloomington, IN – HVACR Tech.
New York Technical College
Dunworthy Institute – HVACR Service
Macomb Community College – Climate Control Technology
Humber College- Toronto, Ontario – HVACR
Mid Michigan Community College – HVACR Applied Science
Lansing Community College – HVAC
Shelton State Community College – HVACR
Monroe County Community College

40. Use the remaining space below to add any additional comments that would be helpful in evaluating the HVACR program:

We need more room. Better classrooms. More lab time. More computers.

It seems to be a good program.

The program is getting bigger, yet the building is staying the same size. Why?

This program is very well staffed w/knowledgeable instructors. I feel that the CTC Building is being outgrown by this programs needs. It has quite a bit of shared space. The instructor's offices are located elsewhere making it bit harder to meet w/them for advice and other help.

I feel there should be more than one class of students per year for the bachelors program.

The computer room in CTB should open 7 days a week for those students who have not computers at home to use computer on campus. Altough other computer labs in campus open on weekend, they do not have particular program for HVAC students.

I feel this program has prepared me for future goals.

We really need a new building, the classrooms are loud, not very well planned out, and the lighting isn't very good. The labs also need to be updated more often.

Overall I feel the facilities could be better. If I need help from Mitch LeClaire I have to walk across campus to Johnson Hall. His office as well as the others should all be in the Technology building. This was a little inconvenient to those who needed his help. Better lab facilities and equipment would enhance learning as well. It is nice to have the energy lab we have with the study room inside it, but better working use of the equipment would be nice. Most systems seem in disrepair of some state.

I would like to see more on sizing and picking exhaust and intake louvers.

Small class size. Better lecture & classrooms.

Overall, there will become a point in time where the facility is going to have to be enlarged. Due to the amount of students entering into the program.

For HVAC 331, Mon, Wed, and Fri would be much better than Mon through Thurs classes.

I personally think that the refrigeration program isn't as strong as it should be. There should be more equipment & more instruction in this area.

A larger building with bigger classrooms and labs would help the program considerably.

Most instructors seem to have vast knowledge of the field. The program offers many job opportunities and help in finding internships. The classrooms aren't big enough and some are placed in bad areas. The need for a new building is a great necessity.

The information is well taught. Class size is getting relatively large but the splitting of labs help. The name Ferris HVACR carries well with employers.

Break labs into less students so there is more one on one teaching. More computer work stations.

We need modern laboratories in order to keep up with the rapidly changing industry. The class structure should include more math instead of other courses in order to attain the Engineering status in which most students want.

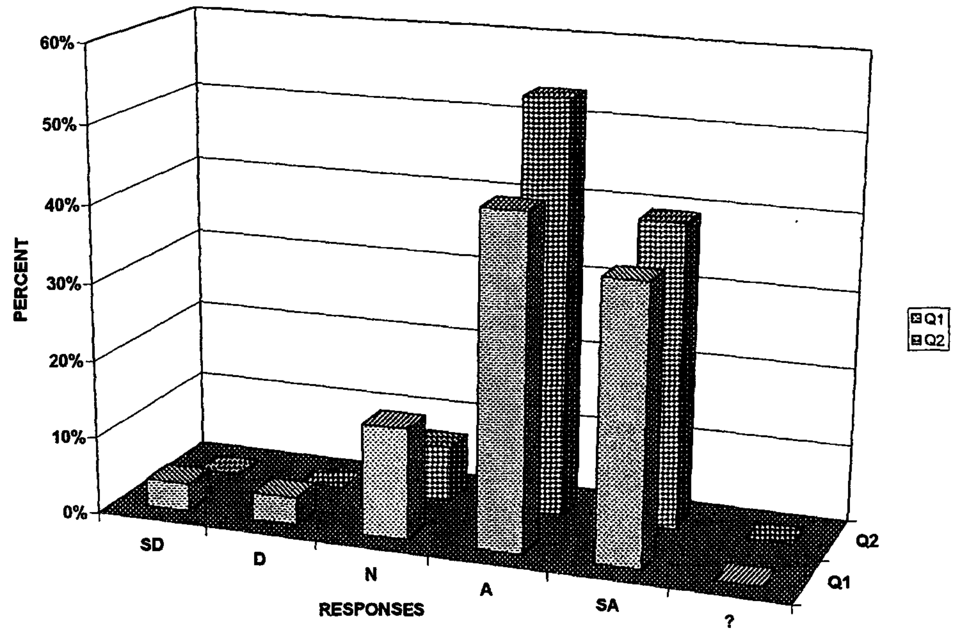
The building needs to be replaced. Scollar ships.

JUNIOR RESPONSES SUMMARY

(Student Evaluations – Juniors)

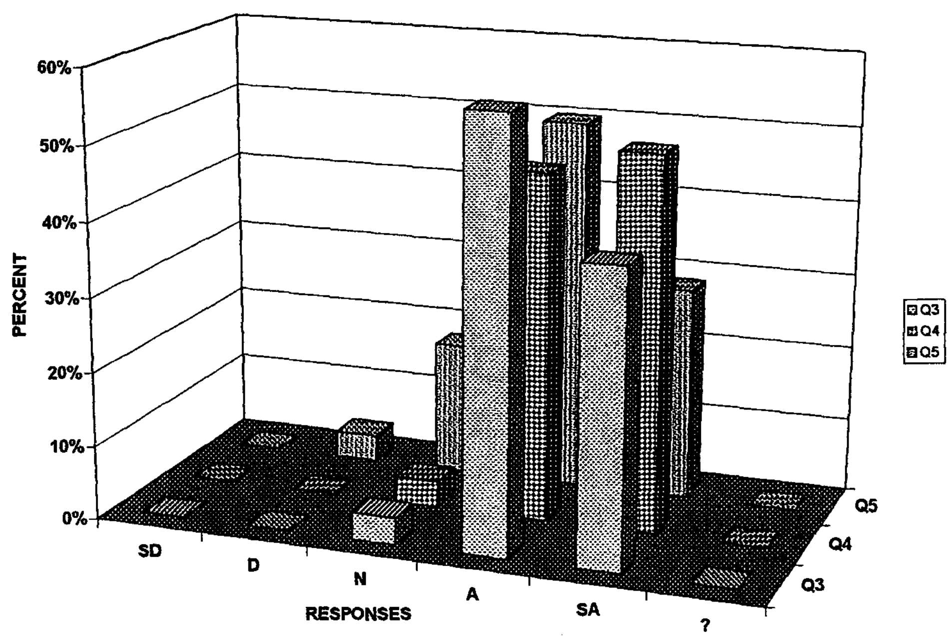
Students in the Junior class of the HVACR Engineering Technology Program are very satisfied with the courses offered within the program, the faculty and the objectives for those courses. They indicate moderate satisfaction with computer lab facilities citing lack of adequate number of workspaces, lighting and ventilation within the space. These students cite dissatisfaction with classroom facilities and instructional equipment. Since many students responded with a question regarding instructional support services (tutoring) it indicates that they may not be aware of the availability of such services or have not taken advantage of those services and cannot judge the adequacy.

SENIOR RESPONSES TO QUESTIONS 1 & 2



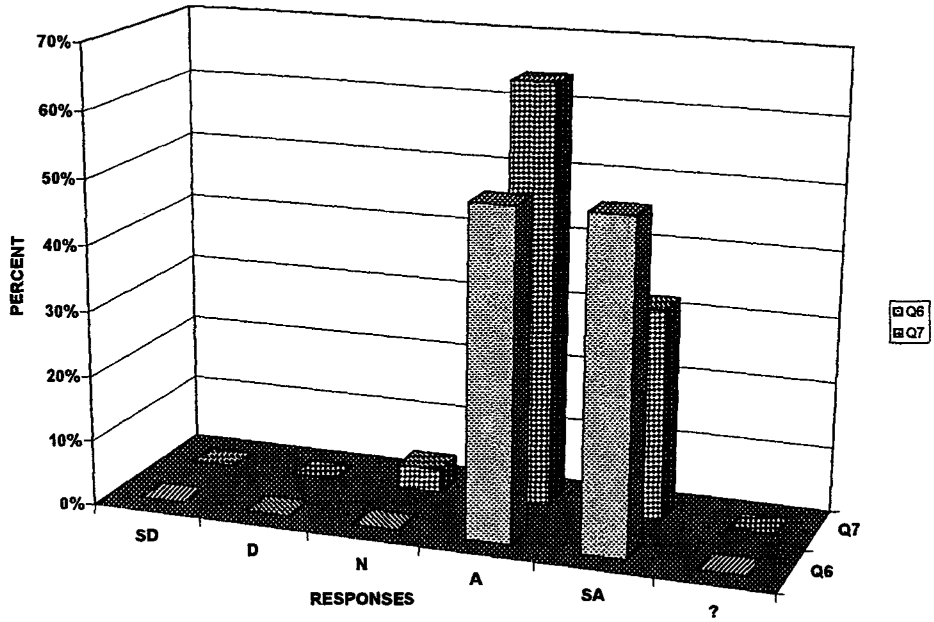
		SD	D	N	A	SA	?	AVE.
	COURSES IN YOUR PROGRAM AREA ARE:							
1	available and conveniently located.	1	1	4	12	10	0	**4.04**
2	based on realistic prerequisites.	0	0	2	15	11	0	**4.32**

SENIOR RESPONSES TO QUESTIONS 3, 4 & 5



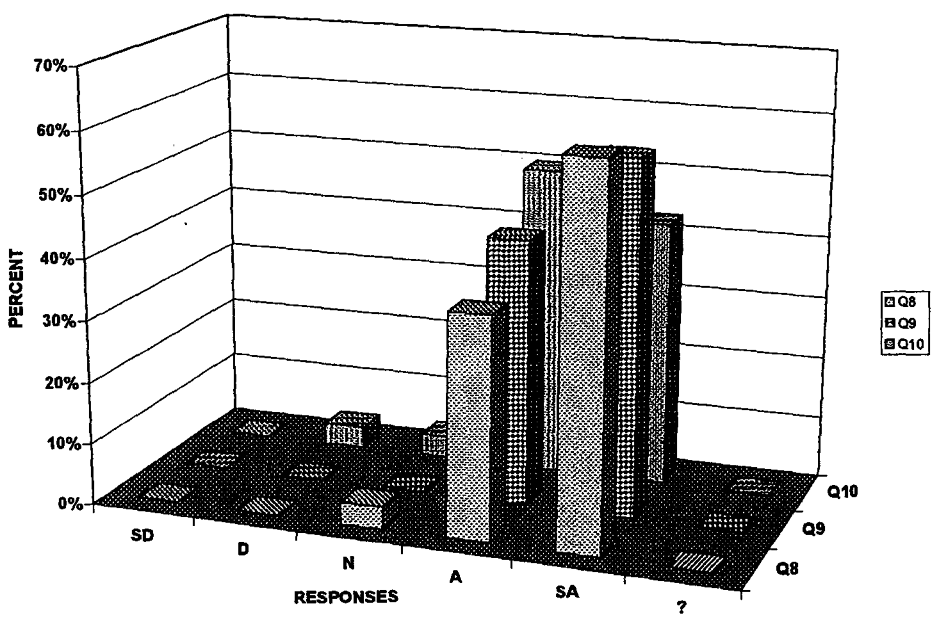
		SD	D	N	A	SA	?	AVE.
	WRITTEN OBJECTIVES FOR COURSES IN YOUR PROGRAM:							
3	are available to students.	0	0	1	16	11	0	**4.36**
4	describe what you will learn in the course.	0	0	1	13	14	0	**4.46**
5	are used by the instructor to keep you aware of your progress.	0	1	5	14	8	0	**4.04**

SENIOR RESPONSES TO QUESTIONS 6 & 7



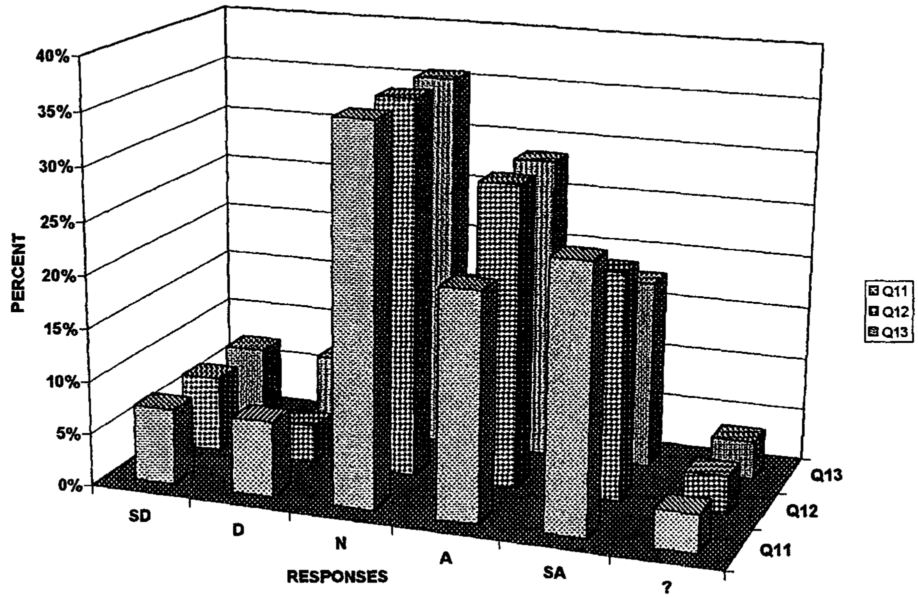
		SD	D	N	A	SA	?	AVE.
	TEACHING METHODS, PROCEDURES & COURSE CONTENT:							
6	meet your projected career needs, interests and objectives.	0	0	0	14	14	0	**4.50**
7	provide supervised practice for skill development.	0	0	1	18	9	0	**4.29**

SENIOR RESPONSES TO QUESTIONS 8, 9 & 10



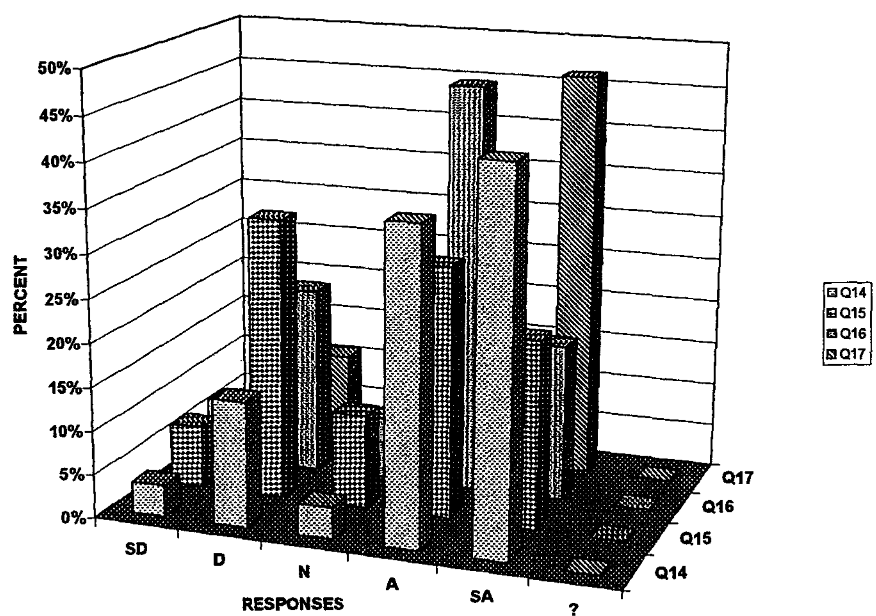
		SD	D	N	A	SA	?	AVE.
	PROGRAM FACULTY:							
8	know the subject matter and occupational requirements.	0	0	1	10	17	0	**4.57**
9	are available to provide help when needed.	0	0	0	12	16	0	**4.57**
10	provide instruction so it is interesting and understandable.	0	1	1	14	12	0	**4.32**

SENIOR RESPONSES TO QUESTIONS 11,12 & 13



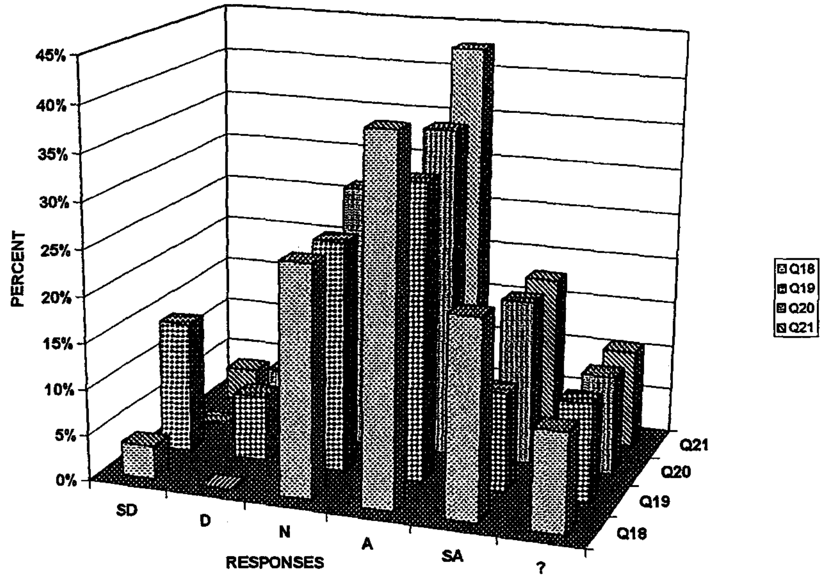
		SD	D	N	A	SA	?	AVE.
	RELATED COURSE FACULTY:							
11	know the subject matter and occupational requirements.	2	2	10	6	7	1	**3.39**
12	are available to provide help when needed.	2	1	10	8	6	1	**3.43**
13	provide instruction so it is interesting and understandable.	2	2	10	8	5	1	**3.32**

SENIOR RESPONSES TO QUESTIONS 14,15,16 & 17



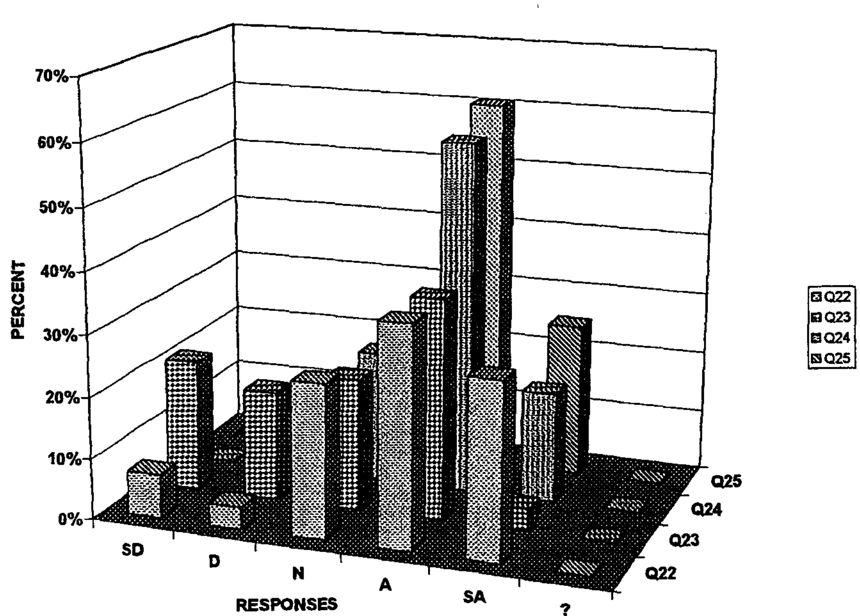
		SD	D	N	A	SA	?	AVE.
	PROGRAM COMPUTER LABORATORIES:							
14	provide adequate lighting, ventilation, etc.	1	4	1	10	12	0	**4.00**
15	include enough work stations for students enrolled.	2	9	3	8	6	0	**3.25**
16	are safe, functional, and well maintained.	2	6	2	13	5	0	**3.46**
17	are available on an equal basis for all students.	0	3	3	9	13	0	**4.14**

SENIOR RESPONSES TO QUESTIONS 18,19,20 & 21



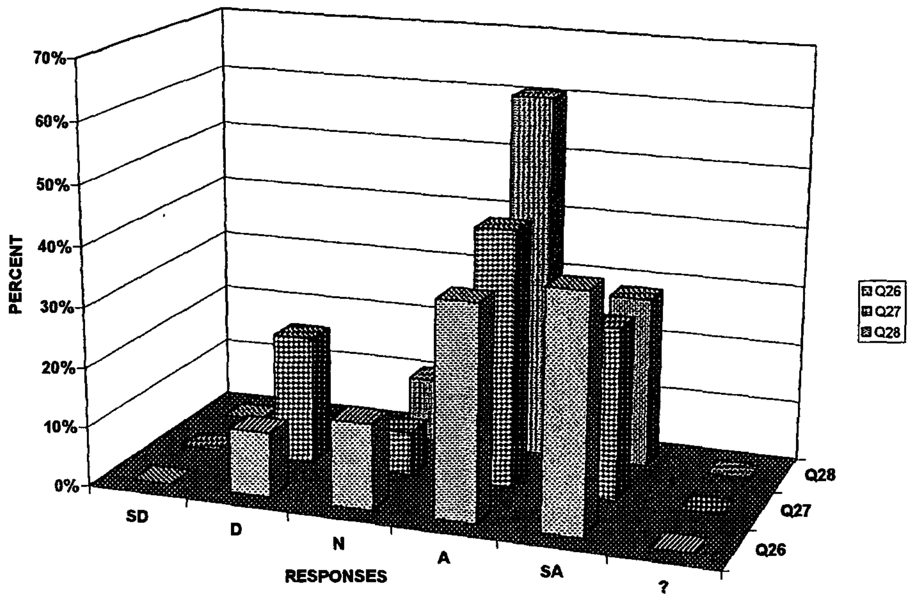
		SD	D	N	A	SA	?	AVE.
	OTHER PROGRAM LABORATORIES:							
18	provide adequate lighting, ventilation, etc.	1	0	7	11	6	3	**3.43**
19	include enough work stations for students enrolled.	4	2	7	9	3	3	**2.86**
20	are safe, functional, and well maintained.	0	2	8	10	5	3	**3.32**
21	are available on an equal basis for all students.	1	0	7	12	5	3	**3.39**

SENIOR RESPONSES TO QUESTIONS 22,23,24 & 25



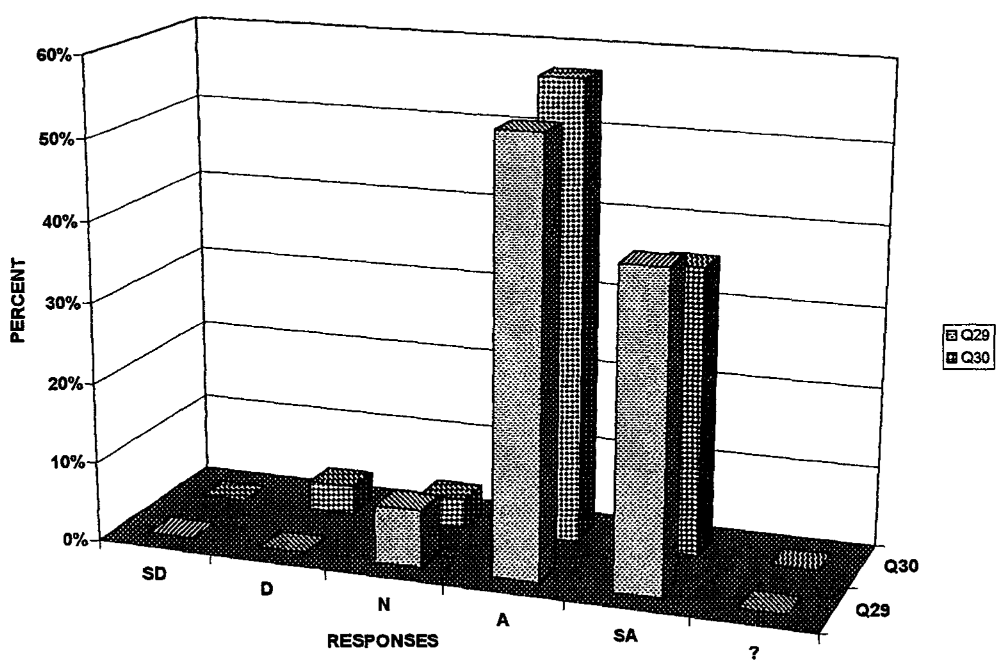
		SD	D	N	A	SA	?	AVE.
	CLASS ROOMS:							
22	provide adequate lighting, ventilation, etc.	2	1	7	10	8	0	**3.75**
23	include enough seats / tables for students enrolled.	6	5	6	10	1	0	**2.82**
24	are safe, functional, and well maintained.	0	1	6	16	5	0	**3.89**
25	are available on an equal basis for all students.	0	1	3	17	7	0	**4.07**

SENIOR RESPONSES TO QUESTIONS 26,27 &28



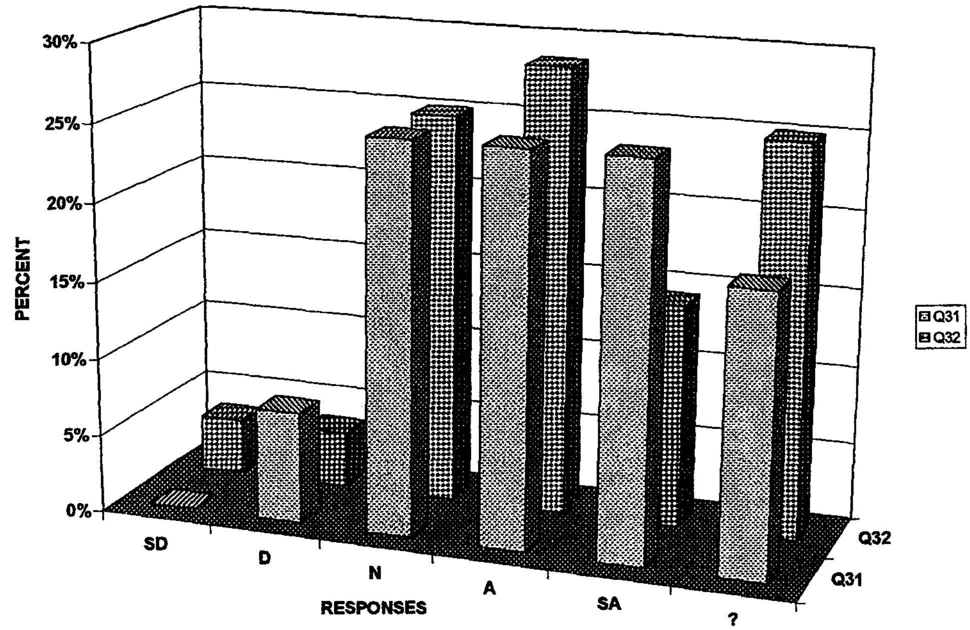
		SD	D	N	A	SA	?	AVE.
	PROGRAM INSTRUCTIONAL EQUIPMENT IS:							
26	current and representative of the industry.	0	3	4	10	11	0	**4.04**
27	in sufficient quantity to avoid long delays in use.	0	6	2	12	8	0	**3.79**
28	safe and good condition.	0	0	3	17	8	0	**4.18**

SENIOR RESPONSES TO QUESTIONS 29 & 30



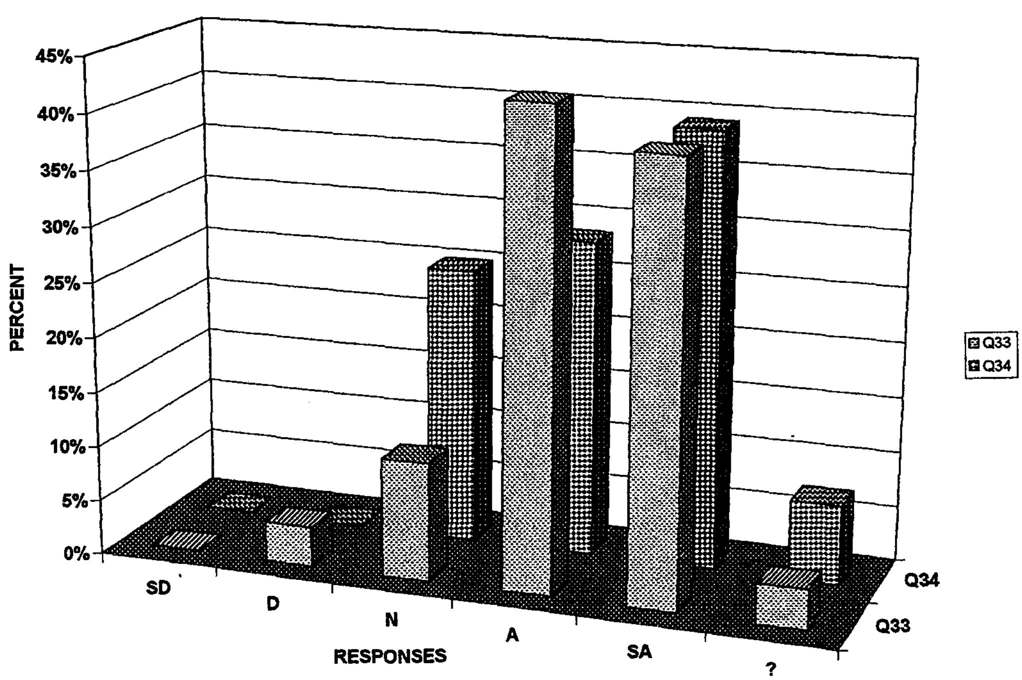
		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL MATERIALS ARE:							
29	current and meaningful to the subject.	0	0	2	15	11	0	**4.32**
30	available and conveniently located for use.	0	1	1	16	10	0	**4.25**

SENIOR RESPONSES TO QUESTIONS 31 & 32



		SD	D	N	A	SA	?	AVE.
	INSTRUCTIONAL SUPPORT SERVICES (tutoring) ARE:							
31	available to meet your needs and interests.	0	2	7	7	7	5	**3.14**
32	provided by knowledgeable, interested staff.	1	1	7	8	4	7	**2.71**

SENIOR RESPONSES TO QUESTIONS 33 & 34



		SD	D	N	A	SA	?	AVE.
	PLACEMENT SERVICES ARE AVAILABLE TO:							
33	help you find employment opportunities..	0	1	3	12	11	1	**4.07**
34	prepare you to apply for a job.	0	0	7	8	11	2	**3.86**

SENIOR RESPONSES TO QUESTIONS 35 – 40

Senior Class Survey Comments:

35. What are the HVACR programs greatest strengths?

One of the HVACR greatest strength is it reputation. With this reputation it helps to get employers to visit the school.

Good faculty and staff. New Johnson Control controllers.

The computer lab is available to all HVAC students and is always available after hours.

Helps learn real world experience.

Curriculum provide real to life scenarios and practices.

You can get out of class help from teachers, and computer lab is open at night.

The teachers in the program are great people and go the extra mile when they really don't have to. The two year program fully prepared me for service work. It is excellent hands on work.

Keeping up with industries and new technology.

Most of the faculty have a good knowledge of their area and continue to persue the most current information in there area.

Hands on opportunities and good teacher-to-student interaction.

The instructors really seem to care about the students educational development. The classes offered give you a good foundation for the real world.

The program is fairly current with the HVAC industry.

Proffessors are great and their courses are well lectured. Helps you ready for the main industry. Also their summer intern is great.

Well known throughout industry.

The HVACR programs greatest strength is the instructors in depth knowledge of all material we have to cover. They spare no expense to ensure everyone understands and grasps the material.

Student/teacher relations. Teacher knowledge of HVACR.

37. Which course would you consider least valuable in the HVACR Program and Why?

None

¾ of the elective classes. Cut down on cultral enrichment and social awarness classes and create more technical trade classes.

Visual basic. This course could be replaced with something more relative to the HVAC Industry.

ISYS 204 Visual basic Programming. Teacher was horrible.

All courses are valuable.

Visual basics. Its just not used after it's taken.

Visual basic – have seen no practical use with the program. HVACR topics were never covered or used in the class.

Visual Basic Programming – The specific programming ideas do not have a practical purpose in our field. Any employee is going to send you to school to learn their language for programming. Your chances of dealing with visual Basic are very slim.

ISYS 204 Basic Programming. Bad teaching.

Visual Basic

Controls – It is 1 slight variation or field in which the path we may take – If I don't want to go into controls I don't feel I should be made to go – Controls is a broad field in itself. There are many manufacturers and variations.

HVAC-462 Mr. Lafferty has wasted too much time on Turbine Engines and Generators. Granted, we may play a part in designing one some day, but I feel that will be far and few between. I feel he should concentrate more on the basics.

Comm/Small group decision making. Prof. Is not good.

COMM 221 – Poor teaching , lecture material is dull and boring. Does not relate to the class material.

COMM 221 – It's a waste of time because we work in groups in our HVAC classes and do just fine.

None

SENIOR RESPONSES TO QUESTIONS 35 – 40 (cont.)

Visual Basic – minimal to no application after taking class.

Any class where the answers are given to you.

Communications – Small group decision making – the teacher told us that he does not like to teach and doesn't like us. We haven't learned much at all.

HVAC 132 it was too basic.

Ductwork – who needs it!

HVAC-132 doesn't cover enough material, needs to go more in depth than it does.

HVAC-132.

38. Are you a transfer student?

Yes = 14 No = 14

39. If you are a transfer student from what school and curriculum?

Grand Rapids Community College
Worcester Technical Institute
Lansing Community College – 2 yr. HVAC
Western Michigan University – Mechanical Engineering
ITT Tech. HVACR
IVY Tech State College – HVAC
New York City College – HVACR
Northwestern Michigan College – AAS
Kellogg Community College – Business Administration
Humber College – HVAC Program
Thaddeus Stevens College of Technology
Mid Michigan Community College

40. Use the remaining space below to add any additional comments that would be helpful in evaluating the HVACR program.

Weekly or biweekly visit by various speakers in the workforce just to have input which might influence one's career path.

I am completely satisfied with my education from Ferris. After interviewing with a variety of companies, I feel I can make an immediate impact in the industry.

Some of the curriculum we are taught are a waste of time . Some of the stuff is out of date and shouldn't have to be known.

It would be nice to have more parking space. If the lab was open 24 hours.

Program is great / needs to be more widely circulated.

Mr. Lafferty is becoming Larry Wagner Jr.

I think it wold be helpful to have advisors to sit down and plan students schedule throughout their time at Ferris. It would be nice to question the students in the 4 year to understand their needs and direct them towards their goals.

The best program. Please take the tuition easy on us transfer students.

Non HVAC related courses should be eliminated from the curriculum unless they are strongly related because they screw up your schedule and create a ton of problems.

Some instructors could make classes easier by being more organized. I think overall the program has an excellent staff that really cares about the material and the students. My only complaint is that the HVAC program is not allowed to add programs to computers that may benefit the students during mid semester.

The HVACR is one of the largest growing fields today. It is important for Ferris to support the program with larger, state of the art facilities to keep up w/ the industry.

The computer lab needs better lighting for the chalkboard. HVAC teachers should be able to download new programs in the computer lab whenever the program is needed and for whatever reason. Computer problems need to be addressed in a more timely manner.

Computer lab is too small and needs more light near front of room.

Parking lot is too crowded. I can never find a place to park. Computer lab needs to be maintained better. There are times when a computer's disk drive has been broken for weeks.

SENIOR RESPONSES SUMMARY

(Student Evaluations – Seniors)

Students in the Senior class of the HVACR Engineering Technology Program are also very satisfied with the courses offered within the program, the faculty and the objectives for those courses. They indicate moderate satisfaction with computer lab facilities citing lack of adequate number of workspaces, lighting and ventilation within the space. These students cite dissatisfaction with classroom facilities but are satisfied with instructional equipment. The senior class also may not have taken advantage of the tutorial services on campus thus indicating questions regarding these opportunities.

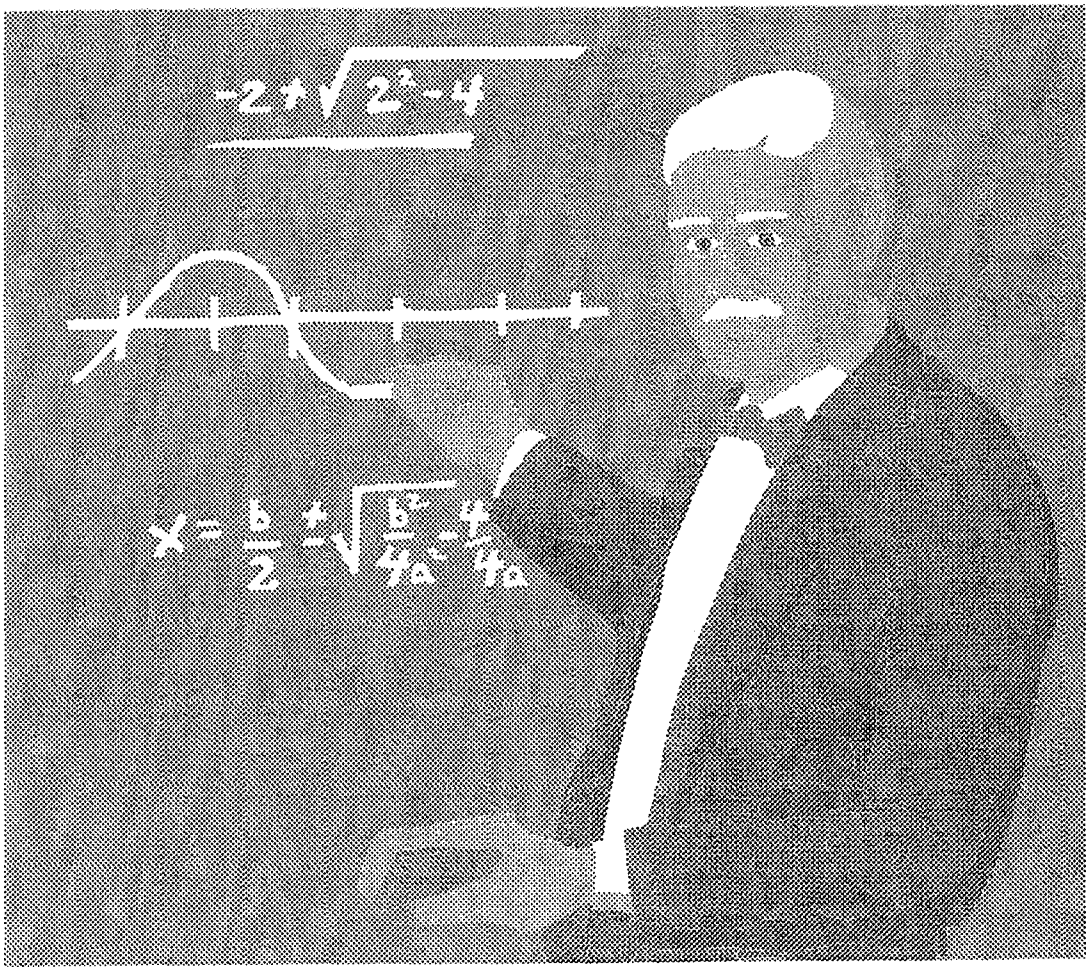
5

FACULTY PERCEPTION SURVEY

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



2000

Goals and Objectives	Excellent (5)	Good (4)	Acceptable (3)	Below Expectation (2)	Poor (1)	Don't Know (0)	Average
Participation in Develoment of HVACR Program Pla	1	7					4.125
HVACR Program Goals	1	5	1			1	3.5
HVACR Course Objectives	2	6					4.25
Competency Based Performance Objectives		4	3	1			3.375
Use of Competency Based Performance		4	3	1			3.375
Use of Information on Labor Market Needs	3	4	1				4
Use of Information on Job Performance Requireme	4	3	1				4.375
Use of Profession/Industry Standards	3	2	3				4
Use of Student follow-up Information		4	3	1			3.375
Adaptation of Instruction		6	2				3.75
Relevance of Supportive Courses		1	6			1	2.75
Coordination with Other Community Agencies and E	2	5	1				4.125
Provision for Work Experience or Cooperative Educ	1	5		1			3.375
Program Availability and Accessibility	1	3	3	1			3.5
Provision for the Disadvantaged		2	4		1	1	2.5
Provision for the Handicapped			4	1	1	2	1.875
Efforts to Achieve Sex Equity	1	2	3	2			3.25
Provision for Program Advisement	2	2	4				3.75
Provision for Career Planning and Guidance	3	2	3				4
Adequacy of Career Planning and Guidance	3	2	3				4
Provision for Employability Information	6	2					4.75
Placement Effectiveness for Students in this Progra	7		1				4.75
Student follow-up System			6			2	2.25
Promotion of the HVARC Programs	1	2	5				3.5
Provision for Leadership and Coordination		2	5	1			3.125
Qualifications of Administrators and/or Supervisors		1	3	3		1	2.375
Instructional Staffing	2	2	4				3.25
Qualifications of Instructional Staff	6		1	1			4.375
Professional Development Opportunities	2	3	3				3.875
Use of Instructional Support Staff		2	4			2	2.5
Use of Clerical Support Staff	4	1	3				4.125
Adequacy and Availability of Instructional Equipmen	1	1	6				3.375
Computer Support Services			2	2	4		1.25
Lecture Room Adequacy			2	4	2		1.75
Lab Area Adequacy			1	4	3		1.375
Office Area Adequacy		1		1	6		1.5

Detailed Comments:

1. Need more space both instructional and faculty office areas.

2. Need support from administration to operate more effectively

3. Labs need to be upgraded, but probably will not happen until some older faculty retire.

4. Performance objectives need to be followed more closely.

5. As coordinator, I think we have a very strong program that is recognized nationally as the premier HVACR program in the country, for both the 2 year and 4 year degrees. Placement of students and job opportunities are not a problem, as there has been 100% employment for years. There is room for improvement, however.

6. Recruiting: We don't have a problem placing graduates, but we do have a problem attracting students. We are in the process of hiring a marketing person specifically for that purpose, which should solve the problem

7. Course Objectives: I was under the impression that this program review would really scrutinize the courses that are offered with emphasis on the objectives of each course. For example, are the objectives relevant to the job needs? Should we drop some objectives and add others? Are some courses (or objectives) redundant? Are there some gaps in the curriculum? Do we over/under emphasize anything? I've seen no detailed analysis of this, and no place in this program review for this to happen.
As far as I know, the courses were set up some time in the past prior to my arrival, and haven't been looked at since. In my opinion, we need to set down with the objectives for all courses in each program, and analyze them relative to the questions that I've raised above. It may be that everything is fine. On the other hand, we may be able to strengthen our program by making some changes.

8. Building is too small to accomplish the current goals & neds of the program.

9. Lecture rooms are small & noisy (converted labs)

10. Cannot teach come concepts in the control area because of the lack of space, and this is where a majority of our graduates are going.

11. Terrible computer support--handicaps teaching--students affected.

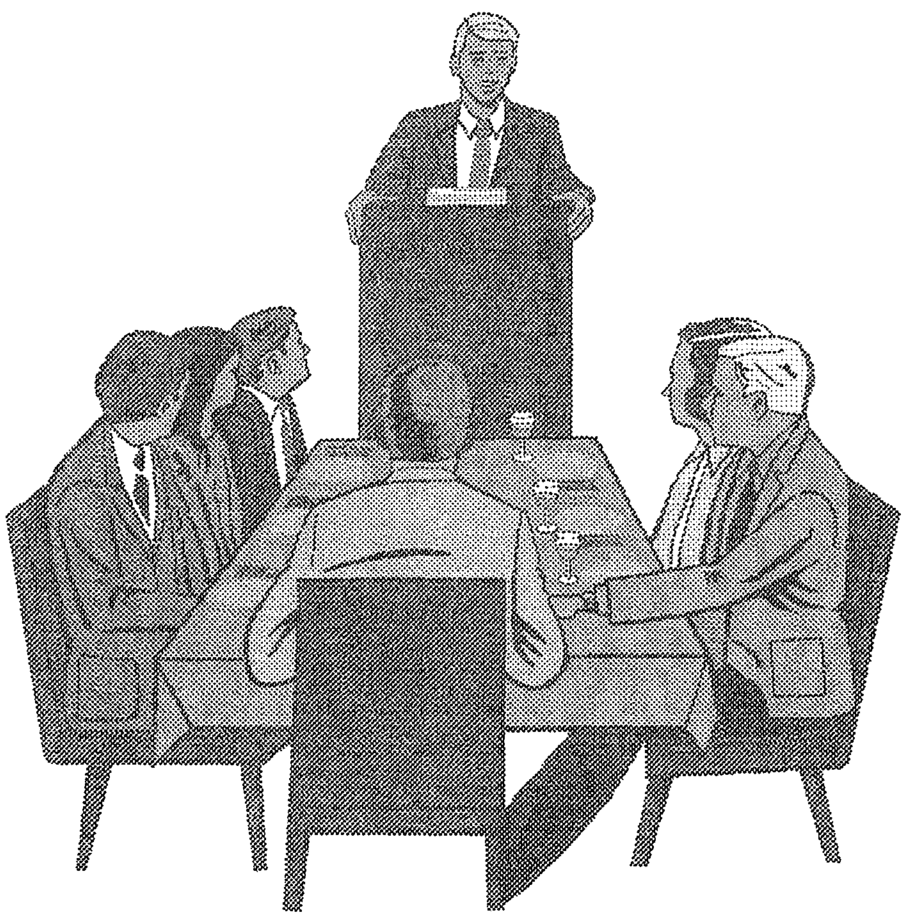
6

ADVISORY COMMITTEE PERCEPTIONS SURVEY RESULTS

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



2000

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SCOPE & OVERVIEW

The HVACR Advisory Committee oversees both the HVACR Technology (AAS) and the HVACR Engineering Technology (BS) programs. All advisory committee members were mailed a twenty one question academic program review survey early in the fall (1999) semester. The committee members were given ample time to mail the self-addressed, postage-paid, single sheet survey back to the appropriate faculty member in the HVACR program. Nine surveys were returned for a return rate of 50%. Survey summaries can be found in the following pages.

A cover letter to the survey explained that all academic programs are reviewed every four years and that the results of this review can range from increasing our programs' resources to placing the program in a probationary status. The cover letter also explained that the advisory committee's honest responses and comments were of utmost importance for the continued success of our nationally renowned programs.

The survey asked the advisory committee members an array of questions covering program lab and computer facilities, university and industrial financial support, graduate numbers and preparation, faculty numbers and expertise, program facility and housing adequacies, internet implementation of the BS program, effectiveness of the advisory committee and several other questions. The survey questions were answered on a scale from one to five including a not applicable column, as follows:

5 = Strongly Agree

4 = Agree

3 = Neutral

2 = Disagree

1 = Strongly Disagree

NA = Not applicable

Survey averages of 3.5 and above on the survey revealed that both programs do adequately utilize the advisory committee and their comments. Also, the advisory committee members are knowledgeable of the HVACR Programs and its members are diverse enough to meet the needs of the programs. It was also pointed out that the advisory committee does meet often enough. Also receiving very high ratings was the fact that the faculty of the programs do have adequate expertise and keep up with changing technologies. Also, the graduates of the program are competitive with other universities and colleges and are adequately prepared to meet industry needs. Respondents said that their company would hire students from either program. Also, a larger, more up-to-date facility would increase enrollment along with the fact that the BS program should be offered on the internet.

The midrange ratings (survey averages of 2.5 to 3.5) were facts that the program has inadequate computer facilities and does not have adequate financial support from the university or the HVACR industry. Also, the programs have an inadequate number of faculty.

The lower rated questions (survey averages below 2.5) pointed out that the programs do not have adequate lab facilities. Also, the programs do not have large enough facilities to adequately house two curriculums and its students. The programs also do not have an adequate number of graduates to meet industry needs.

HVACR PROGRAMS

PURPOSE HVACR PROGRAM REVIEW

SURVEY AREA: **Advisory Board Perceptions of the HVACR Programs.**

Name ______________________ Title ______________________

	Strongly Agree SA	Agree A	Neutral N	Disagree DA	Strongly Disagree SD	Not Applicable NA
1 The advisory committee is diversified enough to meet the needs of what is taught in the programs. Comments:	5	4	3	2	1	NA
2 The advisory committee meets often enough. Comments:	5	4	3	2	1	NA
3 The program adequately utilizes the advisory committee. Comments:	5	4	3	2	1	NA
4 The advisory committee members are knowledgeable about the program. Comments:	5	4	3	2	1	NA
5 Suggestions from the advisory committee are encouraged and adopted by the Program. Comments:	5	4	3	2	1	NA
6 The program has adequate lab facilities. Comments:	5	4	3	2	1	NA
7 The program has adequate computer facilities. Comments:	5	4	3	2	1	NA
8 The program has adequate financial support from the University. Comments:	5	4	3	2	1	NA
9 The program has adequate financial support from industry. Comments:	5	4	3	2	1	NA
10 The graduates from the program are adequately prepared to go to work. Comments:	5	4	3	2	1	NA
11 The program curriculum meets the needs of the industry. Comments:	5	4	3	2	1	NA
12 The program has an adequate number of graduates. Comments:	5	4	3	2	1	NA
13 The program has an adequate number of faculty. Comments:	5	4	3	2	1	NA
14 The faculty in the program has adequate expertise Comments:	5	4	3	2	1	NA
15 Your company would hire a student from this program Comments:	5	4	3	2	1	NA
16 Faculty in the program keep-up with changing technologies. Comments:	5	4	3	2	1	NA
17 The HVACR program should pursue placing the HVACR courses on the internet. Comments:	5	4	3	2	1	NA

		SA	A	N	DA	SD	NA
18	The program has current and adequate instructional equipment to teach with. Comments:	5	4	3	2	1	NA
19	The program has large enough facilities to house two curriculums and its students. Comments:	5	4	3	2	1	NA
20	The program could increase enrollment if it were housed in a larger, more up-to-date facility. Comments:	5	4	3	2	1	NA
21	The graduates of the program are competitive with graduates of similar programs from other universities or community colleges. Comments:	5	4	3	2	1	NA

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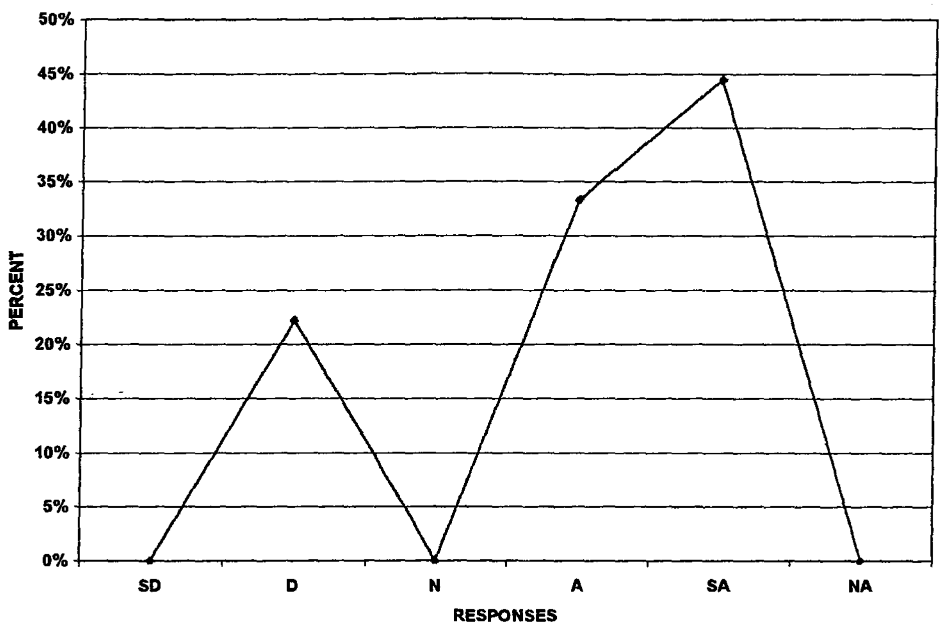
SURVEY RESPONSE TO QUESTION 1

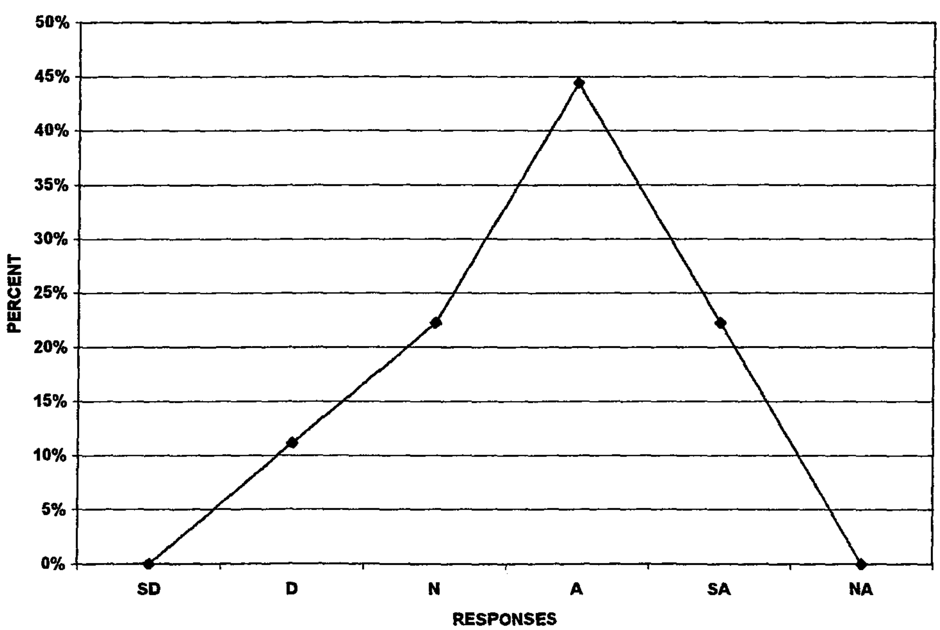


COMMENTS:

- Need more techs.
- Diversity is a major strength of this committee.

	SA	A	N	D	SD	NA	Ave.
The advisory committee is diversified enough to meet the needs	4	3	0	2	0	0	**4.0**

SURVEY RESPONSE TO QUESTION 2

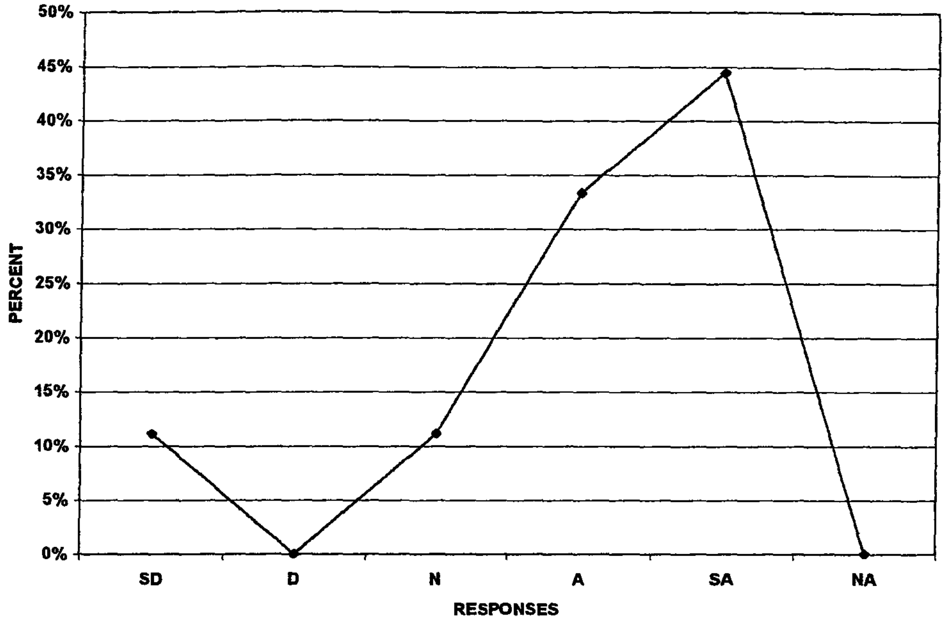


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The advisory committee meets often enough.	2	4	2	1	0	0	**3.8**

SURVEY RESPONSE TO QUESTION 3

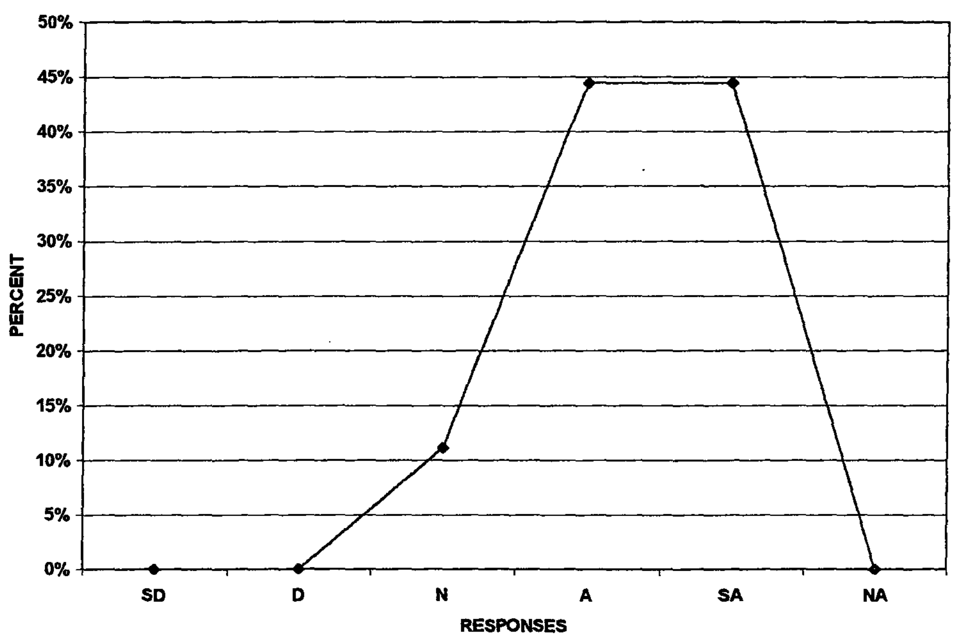


COMMENTS:

- I would like to do more.
- 3 – 4 times per year.

	SA	A	N	D	SD	NA	Ave.
The program adequately utilizes the advisory committee.	4	3	1	0	1	0	4.0

SURVEY RESPONSE TO QUESTION 4

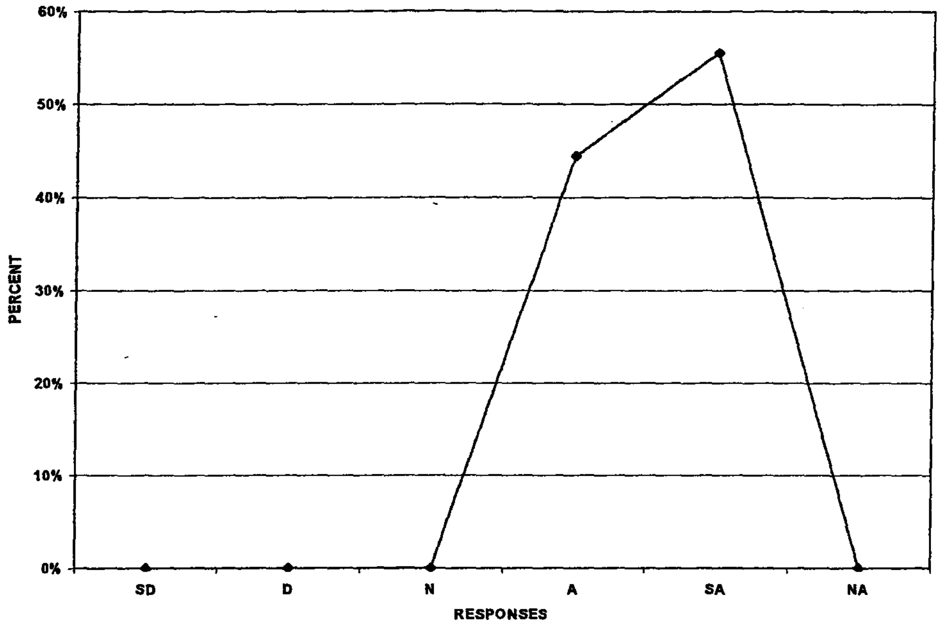


COMMENTS:

- A new member orientation would be helpful.

	SA	A	N	D	SD	NA	Ave.
The advisory committee members are knowledgeable about the program.	4	4	1	0	0	0	4.3

SURVEY RESPONSE TO QUESTION 5

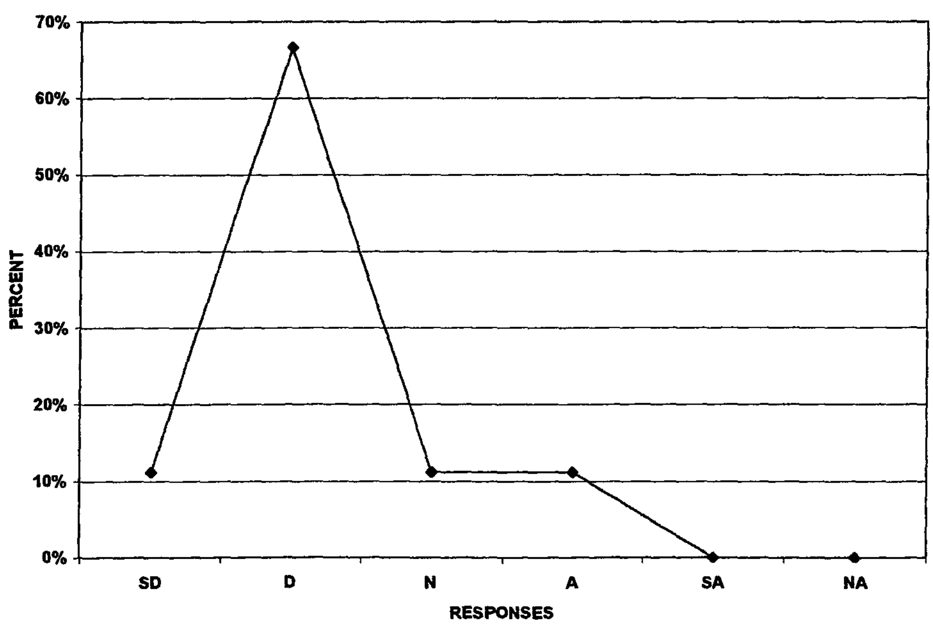


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
Suggestions from the advisory committee are encouraged and adopted by the Program.	5	4	0	0	0	0	4.6

SURVEY RESPONSE TO QUESTION 6

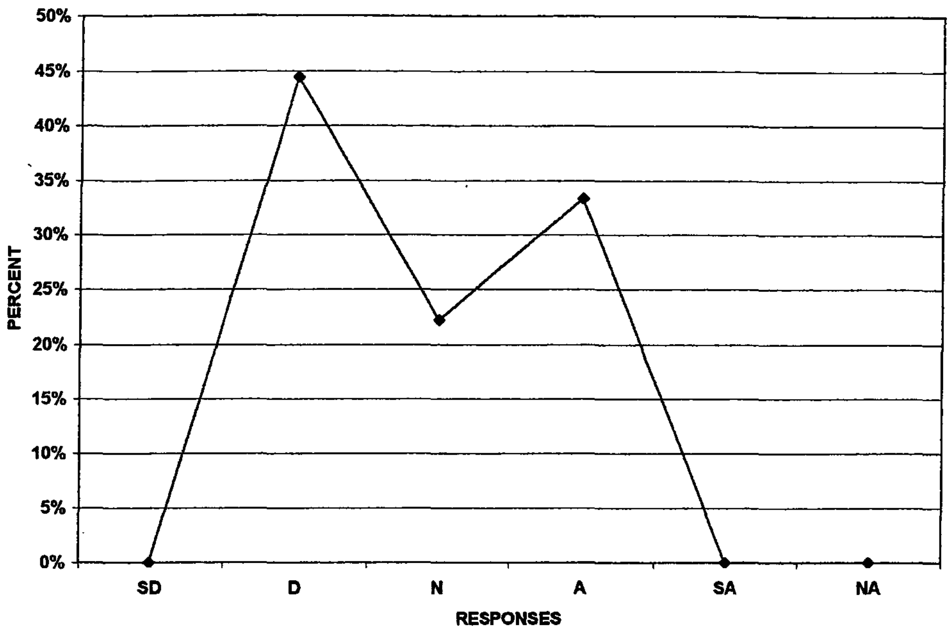


COMMENTS:

- Need more room.

	SA	A	N	D	SD	NA	Ave.
The program has adequate lab facilities.	0	1	1	6	1	0	2.2

SURVEY RESPONSE TO QUESTION 7

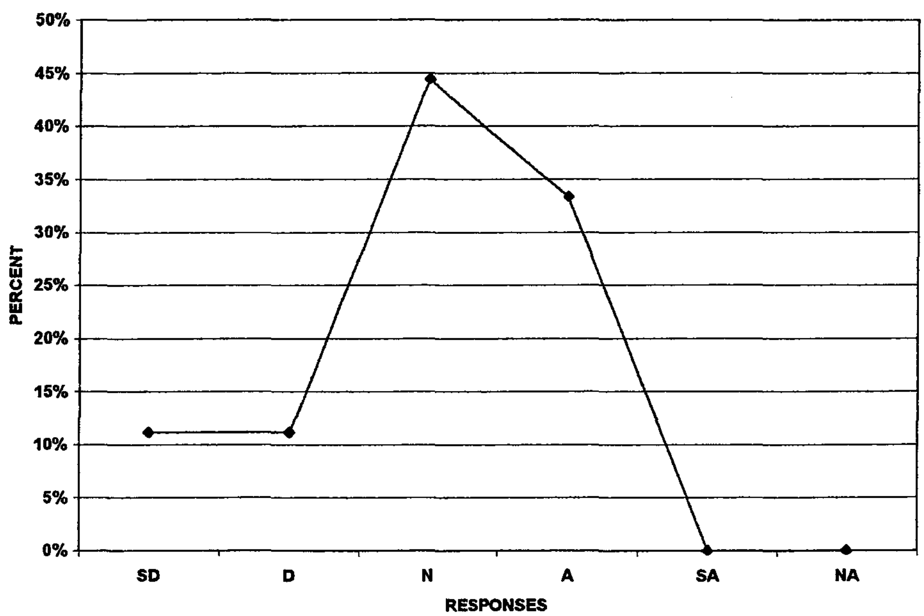


COMMENTS:

- Need more space.

	SA	A	N	D	SD	NA	Ave.
The program has adequate computer facilities.	0	3	2	4	0	0	2.9

SURVEY RESPONSE TO QUESTION 8

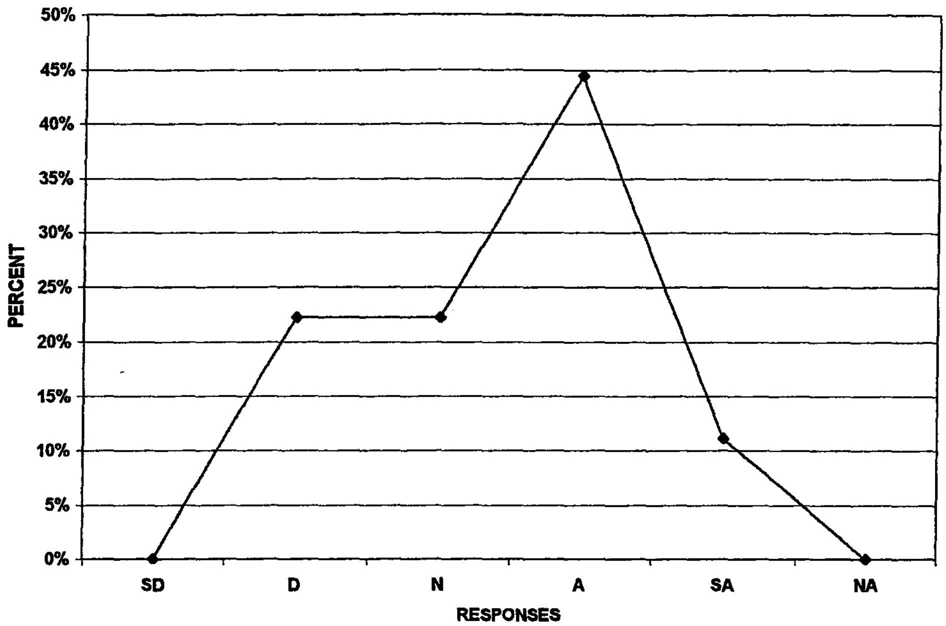


COMMENTS:

- Could always be better.

	SA	A	N	D	SD	NA	Ave.
The program has adequate financial support from the University.	0	3	4	1	1	0	3.0

SURVEY RESPONSE TO QUESTION 9

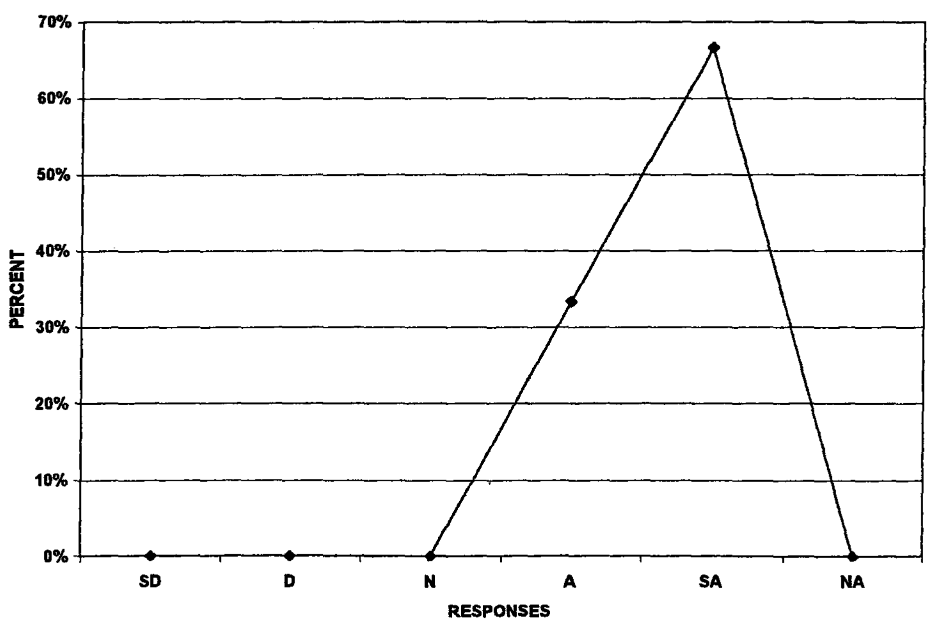


COMMENTS:

- Could always be better.

	SA	A	N	D	SD	NA	Ave.
The program has adequate financial support from industry.	1	4	2	2	0	0	3.4

SURVEY RESPONSE TO QUESTION 10

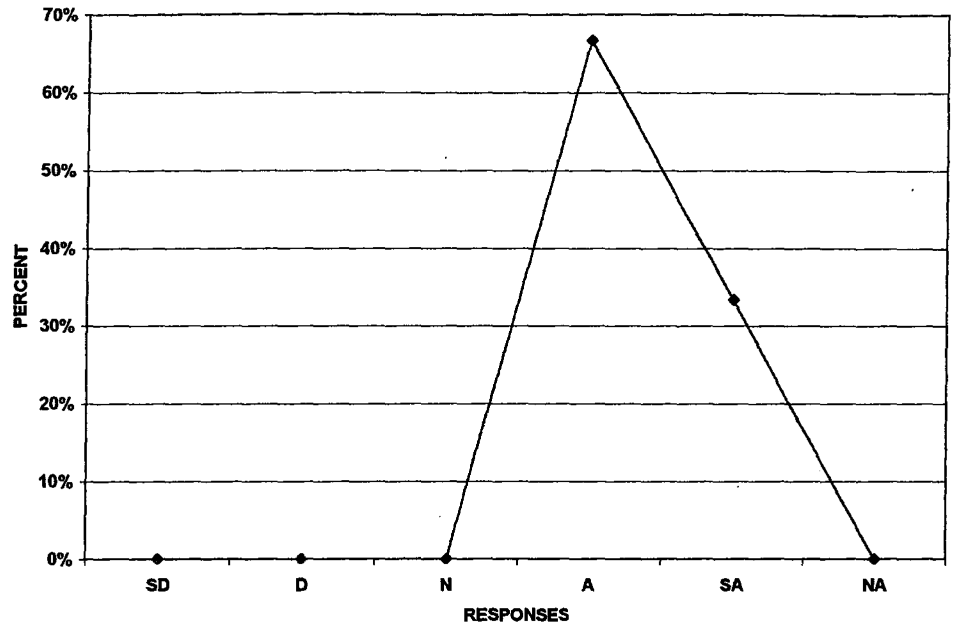


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The graduates from the program are adequately prepared	6	3	0	0	0	0	4.7
to go to work.							

SURVEY RESPONSE TO QUESTION 11

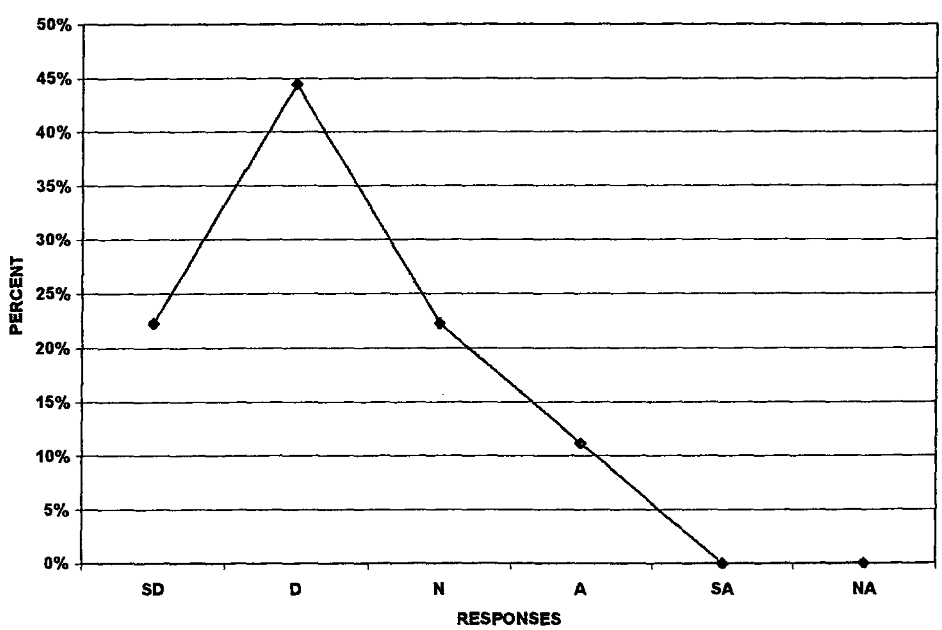


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The program curriculum meets the needs of the industry.	3	6	0	0	0	0	4.3

SURVEY RESPONSE TO QUESTION 12

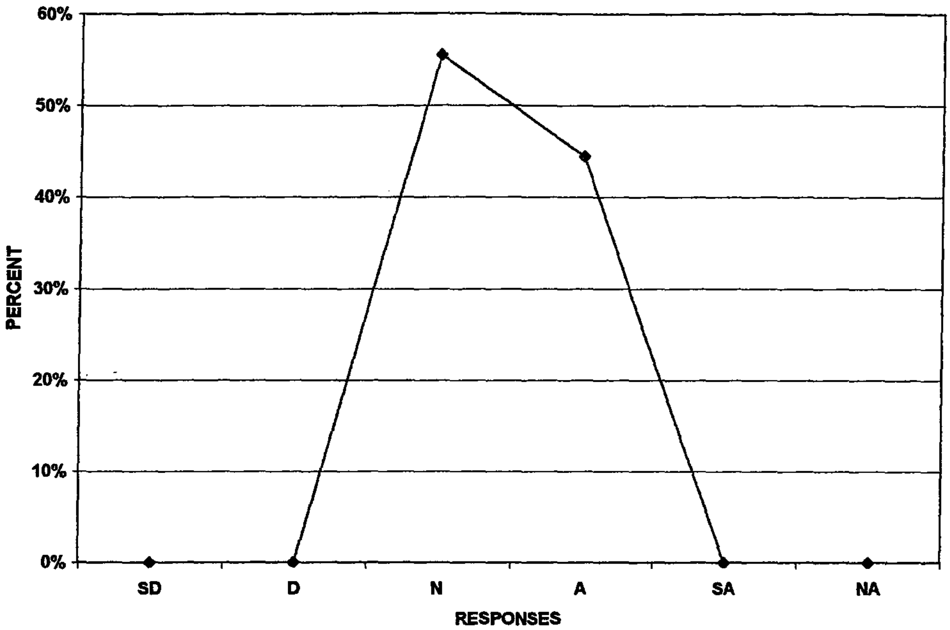


COMMENTS:

- The industry needs more national sources for qualified HVAC Engineers.
- Additional graduates can easily be absorbed.
- Need more and could place more.

	SA	A	N	D	SD	NA	Ave.
The program has an adequate number of graduates.	0	1	2	4	2	0	2.2

SURVEY RESPONSE TO QUESTION 13

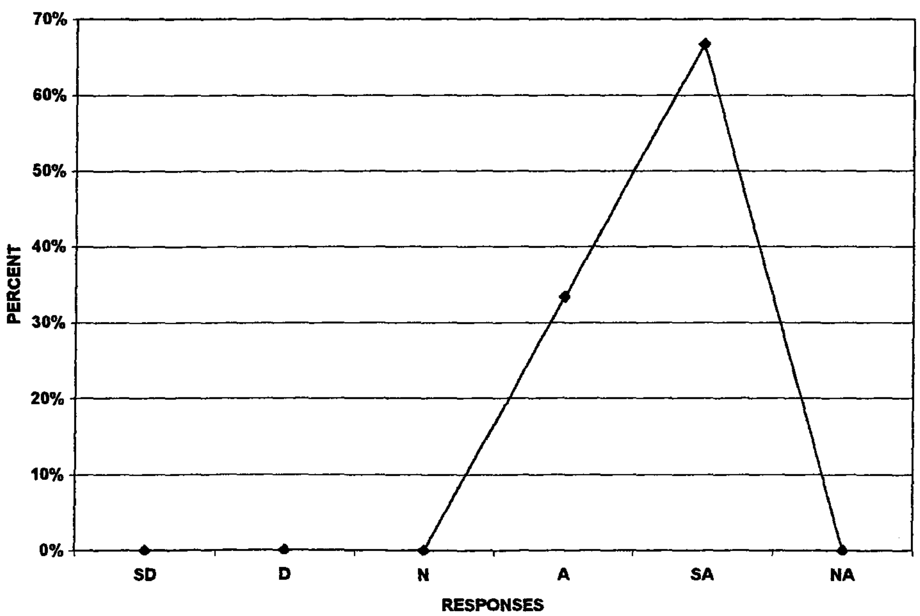


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The program has an adequate number of faculty.	0	4	5	0	0	0	**3.4**

SURVEY RESPONSE TO QUESTION 14

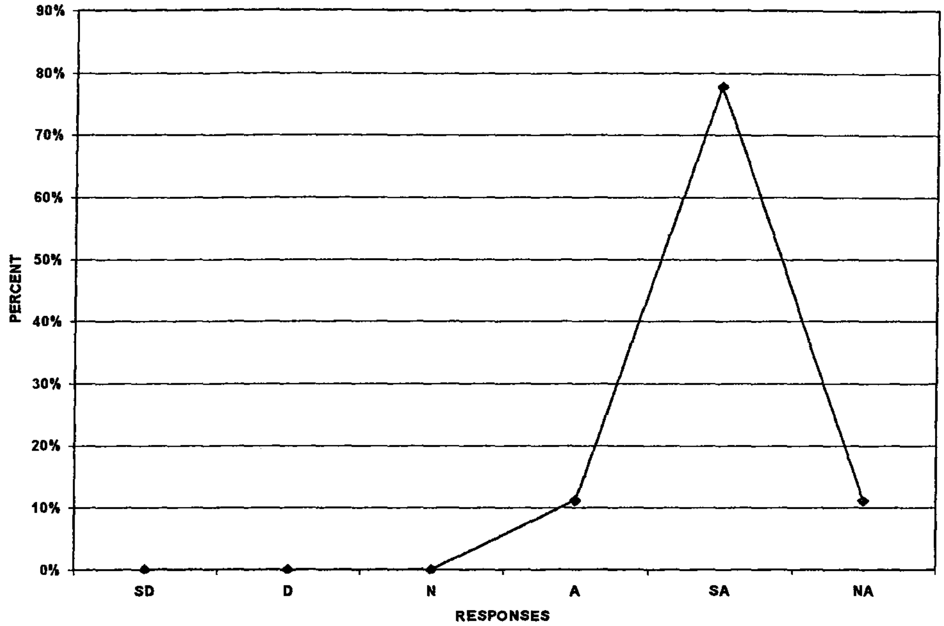


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The faculty in the program has adequate expertise	6	3	0	0	0	0	**4.7**

SURVEY RESPONSE TO QUESTION 15

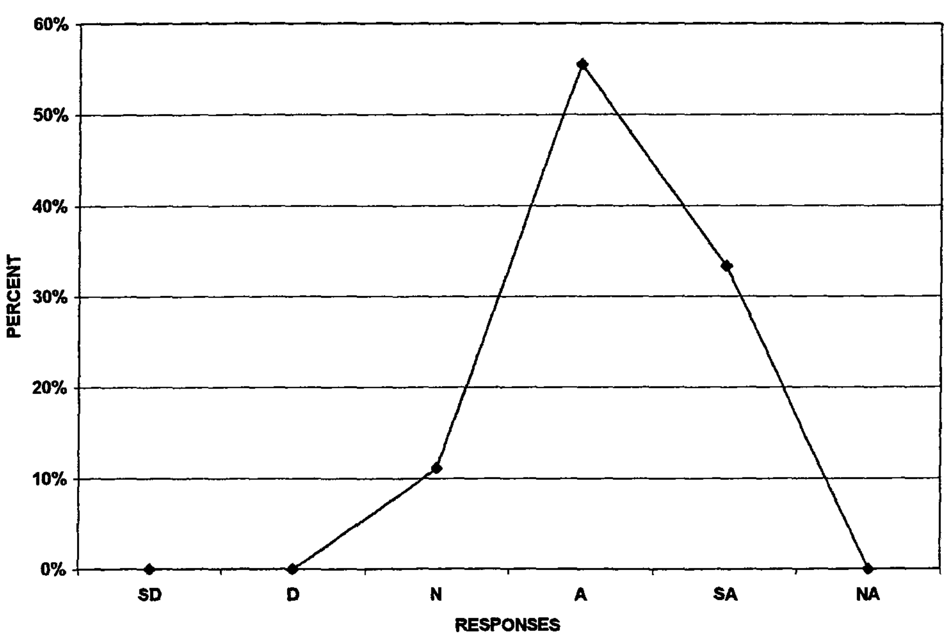


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
Your company would hire a student from this program	7	1	0	0	0	1	4.9

SURVEY RESPONSE TO QUESTION 16

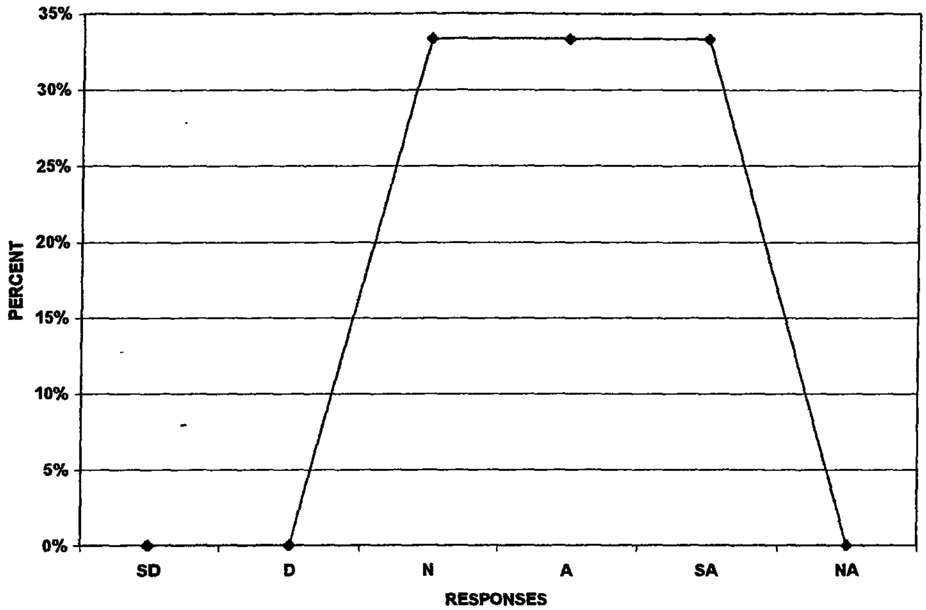


COMMENTS:

- Funding for faculty training should be a budget line item.

	SA	A	N	D	SD	NA	Ave.
Faculty in the program keep-up with changing technologies.	3	5	1	0	0	0	4.2

SURVEY RESPONSE TO QUESTION 17

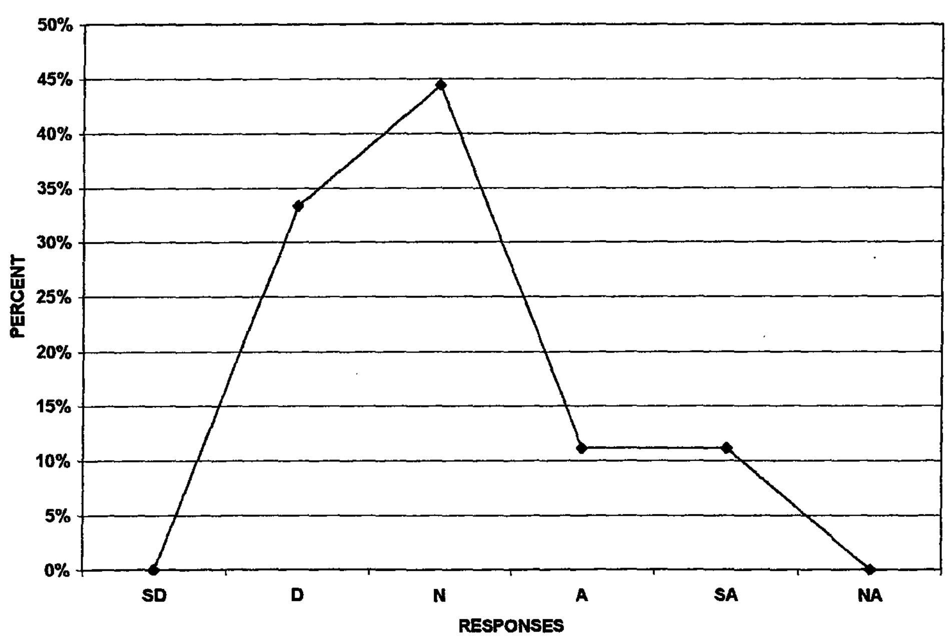


COMMENTS:

- Advanced curriculum should also be developed for continuing education.
- To open ended question – Quality is important.

	SA	A	N	D	SD	NA	Ave.
The HVACR program should pursue placing the HVACR courses	3	3	3	0	0	0	**4.0**
on the internet.							

SURVEY RESPONSE TO QUESTION 18

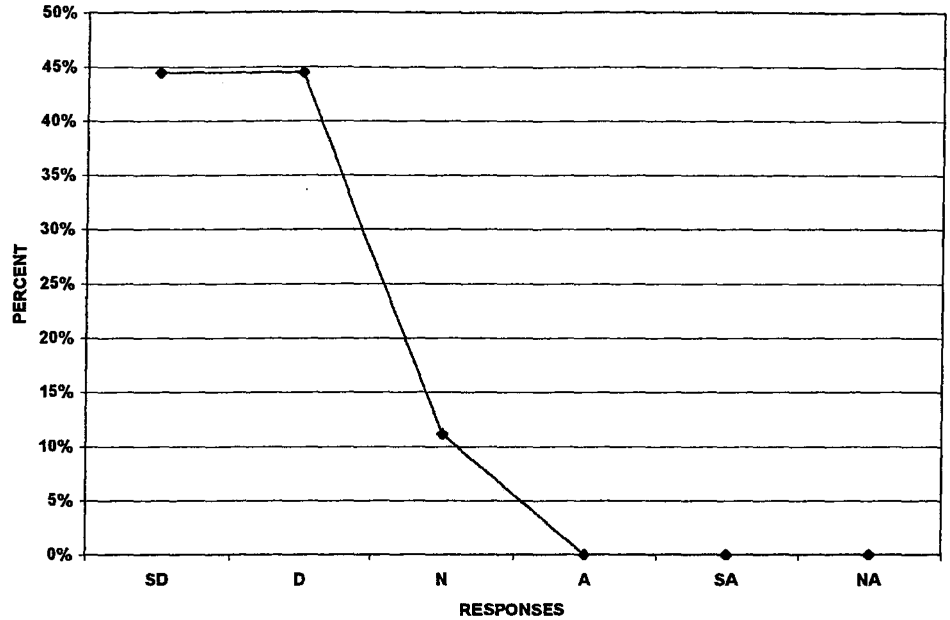


COMMENTS:

- More is better.

	SA	A	N	D	SD	NA	Ave.
The program has current and adequate instructional	1	1	4	3	0	0	**3.0**
equipment to teach with.							

SURVEY RESPONSE TO QUESTION 19

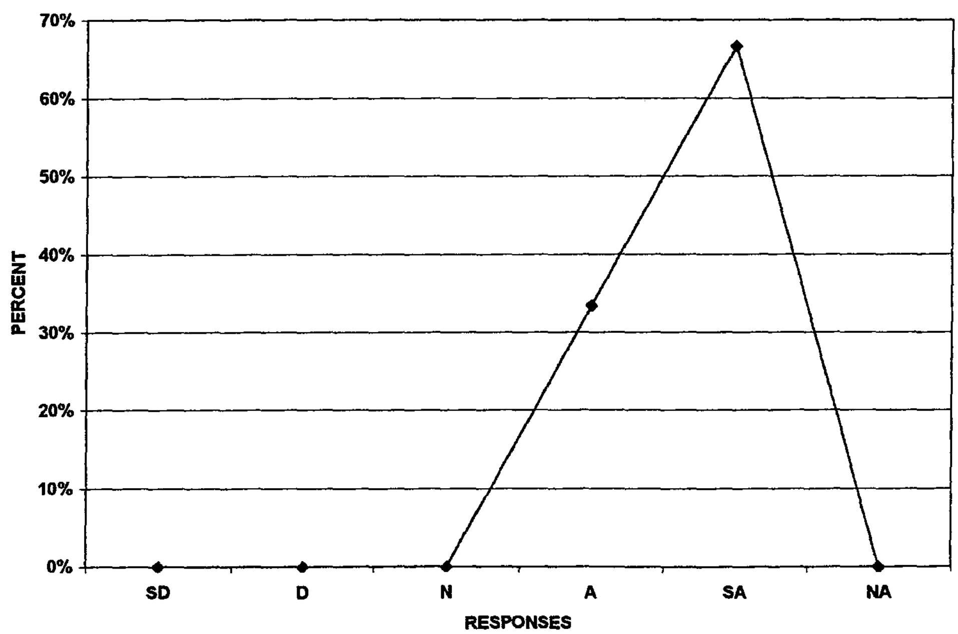


COMMENTS:

- Facilities are a major concern.

	SA	A	N	D	SD	NA	Ave.
The program has large enough facilities to house two	0	0	1	4	4	0	1.7
curriculums and its students.							

SURVEY RESPONSE TO QUESTION 20

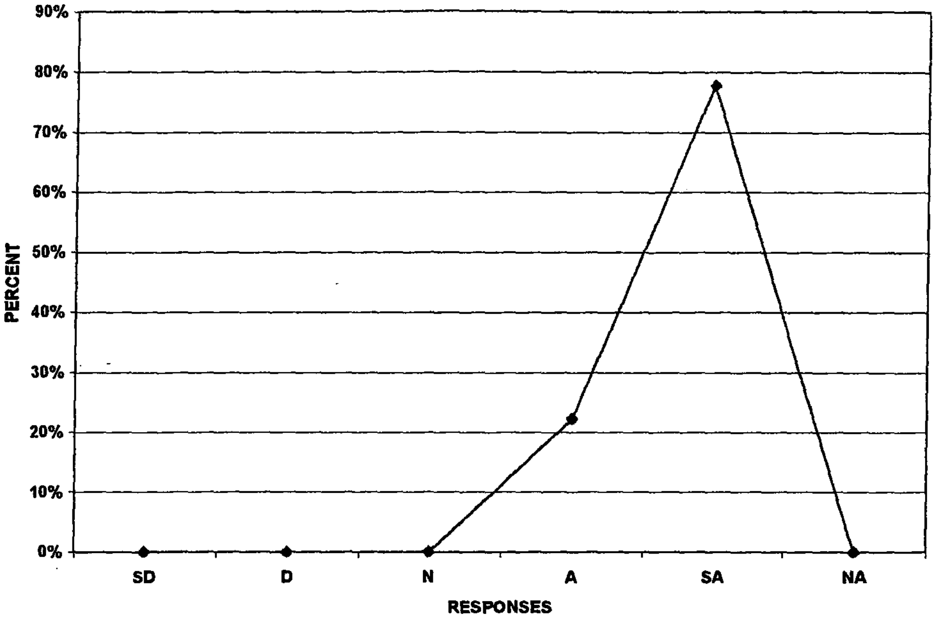


COMMENTS:

- No comments.

	SA	A	N	D	SD	NA	Ave.
The program could increase enrollment if it were housed	6	3	0	0	0	0	4.7
in a larger, more up-to-date facility.							

SURVEY RESPONSE TO QUESTION 21



COMMENTS:

- This is a unique program.

	SA	A	N	D	SD	NA	Ave.
The graduates of the program are competitive with	7	2	0	0	0	0	4.8
graduates of similar programs from other universities							
or community colleges.							

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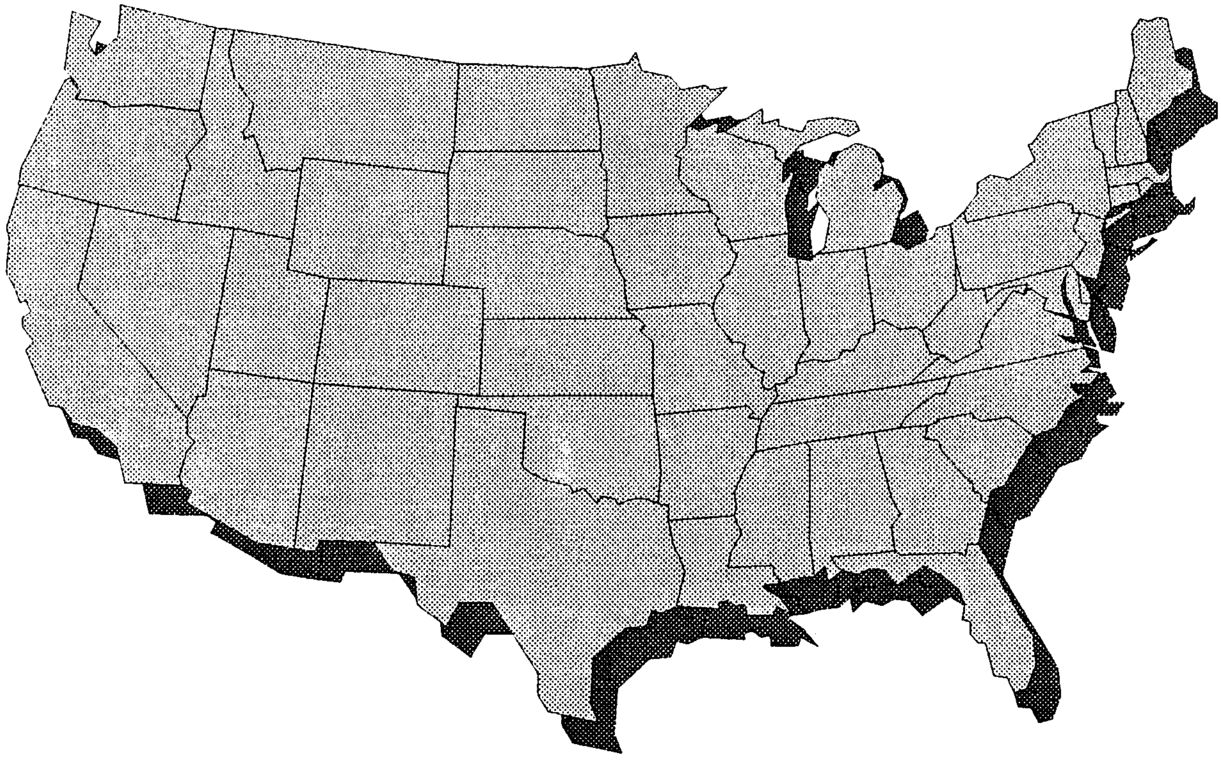
LABOR MARKET ANALYSIS

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



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SECTION 7
Labor Market Analysis

According to the *2000-01 Occupational Outlook Handbook (OOH)*, the employment outlook for Heating, Air Conditioning, and Refrigeration Technicians or Heating, Air Conditioning, and Refrigeration Mechanics and Installers will be "very good, particularly for those with technical school or formal apprenticeship training...". They predict the demand for Heating, Air Conditioning, and Refrigeration Technicians through 2008 to "increase about as fast as the average for all occupations". Summary of the data from the *2000-01 Occupational Outlook Handbook (OOH)* can be seen in this section of the report. There will be some changes, however, in the skills that will be demanded of these technicians. Specifically, there will be increased demand for individuals with proficiency in microelectronics "because they increasing install and service equipment with electronic controls". Interestingly, the 1998-99 OOH mentioned the need for certification in handling refrigerants and even cites Ferris State University's activity in training and certifying technicians for refrigerant handling.

The OOH lists the different areas of work that Heating, Air Conditioning, and Refrigeration Technicians can work and these areas have varying levels of job stability. As has been the case in the past, new installation jobs will remain directly or indirectly linked to the cyclical construction industry thereby exposing the technicians to the possibility of periodic unemployment. The maintenance and repair side of the field has a more stable outlook because it doesn't depend on the new construction industry.

The experience of graduates from the Ferris State University HVACR AAS degree program has shown that students wanting employment in HVACR can find employment. Many openings are left unfilled by our graduates as graduates opt to continue their education. A common path for graduates is to continue into the HVACR Bachelor's degree program. Another options taken by HVACR AAS graduates is to enter the Facilities Management program or into Business or Education. Of the total respondents from our graduate exit interview survey 100% of them are employed in the field or continuing their education. Data from 5 years of these exit surveys starting with 1993-4 can be seen in this section of the report.

SECTION 7
Labor Market Analysis

According to the *2000-01 Occupational Outlook Handbook (OOH)*, the employment outlook for Mechanical Engineers "should have favorable job opportunities". They predict the demand for Mechanical Engineers through 2008 to "increase about as fast as the average for all occupations". Summary of the data from the *2000-01 Occupational Outlook Handbook (OOH)* can be seen in this section of the report. Although Mechanical Engineering is not an ideal fit for the an occupational description of the HVACR BS degree graduates it is the closet fit to the skills and training that can be found in OOH. Under nature of work for a Mechanical Engineer the heating, refrigeration, and air conditioning systems as a Specialty within the field. I also contacted Chris Thom a recruiter for Johnson Controls that consistently hires many of the BS degree graduates (10 students last year). He hires our graduates for application engineering positions and starts them at the same pay rate as mechanical engineering school graduates (low 40's in salary). OOH cites a 1999 National Association of Colleges and Employers survey "bachelor's degree candidates in mechanical engineering received starting offers averaging about $43,300 a year".

Since the category of Mechanical Engineering is so broad and diverse there was no mention of the Heating, Air Conditioning, and Refrigeration Industries tie to the construction Industry. If one refers to the Heating, Air Conditioning, and Refrigeration Technicians section one can glean the tie and dependence on the cyclical construction industry. The OOH lists the different areas of work that Heating, Air Conditioning, and Refrigeration Technicians can work and these areas have varying levels of job stability. As has been the case in the past, new installation jobs will remain directly or indirectly linked to the cyclical construction industry thereby exposing the technicians to the possibility of periodic unemployment. The maintenance and repair side of the field has a more stable outlook because it doesn't depend on the new construction industry.

The experience of graduates from the Ferris State University HVACR BS degree program has shown that students wanting employment in HVACR can find employment. Of the total respondents from our graduate exit interview survey 100% of them are employed in the field. Data from 5 years of these exit surveys starting with 1993-94 can be seen in this section of the report.

Heating, Air-Conditioning, and Refrigeration Mechanics and Installers

Significant Points

Download the PDF (158K)

- Opportunities should be very good for mechanics and installers with technical school or formal apprenticeship training.
- Mechanics and installers need a basic understanding of microelectronics because they increasingly install and service equipment with electronic controls.

Nature of the Work

[About this section] Top

What would those living in Chicago do without heating, those in Miami do without air-conditioning, or blood banks in all parts of the country do without refrigeration? Heating and air-conditioning systems control the temperature, humidity, and the total air quality in residential, commercial, industrial, and other buildings. Refrigeration systems make it possible to store and transport food, medicine, and other perishable items. Heating, air-conditioning, and refrigeration mechanics and installers, also called technicians, install, maintain, and repair such systems.

Heating, air-conditioning, and refrigeration systems consist of many mechanical, electrical, and electronic components such as motors, compressors, pumps, fans, ducts, pipes, thermostats, and switches. In central heating systems, for example, a furnace heats air that is distributed throughout the building via a system of metal or fiberglass ducts. Technicians must be able to maintain, diagnose, and correct problems throughout the entire system. To do this, they adjust system controls to recommended settings and test the performance of the entire system using special tools and test equipment.

Although they are trained to do both, technicians often specialize in either installation or maintenance and repair. Some specialize in one type of equipment—for example, oil burners, solar panels, or commercial refrigerators. Technicians may work for large or small contracting companies or directly for a manufacturer or wholesaler. Those working for smaller operations tend to do both installation and servicing, and work with heating, cooling, and refrigeration equipment.

Furnace installers, also called *heating equipment technicians*, follow blueprints or other specifications to install oil, gas, electric, solid-fuel, and

multiple-fuel heating systems. After putting the equipment in pl
install fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring and controls and check the unit for proper operation. To ensure the proper functioning of the system, furnace installers often use combustion test equipment such as carbon dioxide and oxygen testers.

After a furnace has been installed, technicians often perform routine maintenance and repair work to keep the system operating efficiently. During the fall and winter, for example, when the system is used most, they service and adjust burners and blowers. If the system is not operating properly, they check the thermostat, burner nozzles, controls, or other parts to diagnose and then correct the problem. During the summer, when the heating system is not being used, technicians do maintenance work, such as replacing filters and vacuum-cleaning vents, ducts, and other parts of the system that may accumulate dust and impurities during the operating season.

Air-conditioning and *refrigeration technicians* install and service central air-conditioning systems and a variety of refrigeration equipment. Technicians follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, piping, and other components. They connect this equipment to the duct work, refrigerant lines, and electrical power source. After making the connections, they charge the system with refrigerant, check it for proper operation, and program control systems.

When air-conditioning and refrigeration equipment breaks down, technicians diagnose the problem and make repairs. To do this, they test parts such as compressors, relays, and thermostats. During the winter, air-conditioning technicians inspect the systems and do required maintenance, such as overhauling compressors.

When heating, air-conditioning, and refrigeration technicians service equipment, they must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in air-conditioning and refrigeration systems. The release of CFCs and HCFCs contributes to the depletion of the stratospheric ozone layer, which protects plant and animal life from ultraviolet radiation. Technicians conserve the refrigerant by making sure that there are no leaks in the system; they recover it by venting the refrigerant into proper cylinders; and they recycle it for reuse with special filter-dryers.

Heating, air-conditioning, and refrigeration technicians are adept at using a variety of tools, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, measurement gauges, and acetylene torches, to work with refrigerant lines and air ducts. They use voltmeters, thermometers, pressure gauges, manometers, and other testing devices to check air flow, refrigerant pressure, electrical circuits, burners, and other components.

New technology, in the form of cellular "Web" phones that allow technicians to tap into the Internet, may soon affect the way technicians diagnose problems. Computer hardware and software have been developed that allows heating, venting, and refrigeration units to automatically contact the maintenance establishment when problems arise. The maintenance establishment can then notify the technician in the field via cellular phone. The technician then accesses the Internet to "talk" with the unit needing maintenance. While this technology is cutting edge and not yet widespread, its potential for cost-savings may spur its acceptance.

Other craft workers sometimes install or repair cooling and heating systems. For example, on a large air-conditioning installation job, especially where workers are covered by union contracts, duct work might be done by sheet-metal workers and duct installers; electrical work by electricians; and installation of piping, condensers, and other components by plumbers, pipefitters, and steamfitters. Home appliance repairers usually service room air-conditioners and household refrigerators. (Additional information about each of these occupations appears elsewhere in the *Handbook*.)

Working Conditions [About this section] ▲ Top

Heating, air-conditioning, and refrigeration mechanics and installers work in homes, stores of all kinds, hospitals, office buildings, and factories—anywhere there is climate-control equipment. They may be assigned to specific job sites at the beginning of each day, or if they are making service calls, they may be dispatched to jobs by radio, telephone, or pagers. Increasingly, employers are using cell phones to coordinate technicians' schedules.

Technicians may work outside in cold or hot weather or in buildings that are uncomfortable because the air-conditioning or heating equipment is broken. In addition, technicians often work in awkward or cramped positions and sometimes are required to work in high places. Hazards include electrical shock, burns, muscle strains, and other injuries from handling heavy equipment. Appropriate safety equipment is necessary when handling refrigerants because contact can cause skin damage, frostbite, or blindness. Inhalation of refrigerants when working in confined spaces is also a possible hazard, and may cause asphyxiation.

Technicians usually work a 40-hour week, but during peak seasons they often work overtime or irregular hours. Maintenance workers, including those who provide maintenance services under contract, often work evening or weekend shifts, and are on call. Most employers try to provide a full workweek the year round by scheduling both installation and maintenance work, and many manufacturers and contractors now provide or even require service contracts. In most shops that service both heating and air-conditioning equipment, employment is very stable throughout the year.

Employment [About this section] ▲ Top

Heating, air-conditioning, and refrigeration mechanics and installers held about 286,000 jobs in 1998; more than half of these worked for cooling and heating contractors. The remainder were employed in a variety of industries throughout the country, reflecting a widespread dependence on climate-control systems. Some worked for fuel oil dealers, refrigeration and air-conditioning service and repair shops, schools, and department stores that sell heating and air-conditioning systems. Local governments, the Federal Government, hospitals, office buildings, and other organizations that operate large air-conditioning, refrigeration, or heating systems employed others. Approximately 1 of every 7 technicians was self-employed.

Training, Other Qualifications, and Advancement

[About this section] ▲ Top

Because of the increasing sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those with technical school or apprenticeship training. A sizable number of technicians, however, still learn the trade informally on the job.

Many secondary and postsecondary technical and trade schools, junior and community colleges, and the Armed Forces offer 6-month to 2-year programs in heating, air-conditioning, and refrigeration. Students study theory, design, and equipment construction, as well as electronics. They also learn the basics of installation, maintenance, and repair.

Apprenticeship programs are frequently run by joint committees representing local chapters of the Air-Conditioning Contractors of America, the Mechanical Contractors Association of America, the National Association of Plumbing-Heating-Cooling Contractors, and locals of the Sheet Metal Workers' International Association or the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada. Other apprenticeship programs are sponsored by local chapters of the Associated Builders and Contractors and the National Association of Home Builders. Formal apprenticeship programs normally last 3 or 4 years and combine on-the-job training with classroom instruction. Classes include subjects such as the use and care of tools, safety practices, blueprint reading, and air-conditioning theory. Applicants for these programs must have a high school diploma or equivalent.

Those who acquire their skills on the job usually begin by assisting experienced technicians. They may begin performing simple tasks such as carrying materials, insulating refrigerant lines, or cleaning furnaces. In time, they move on to more difficult tasks, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuits.

Courses in shop math, mechanical drawing, applied physics and chemistry, electronics, blueprint reading, and computer applications provide a good background for those interested in entering this occupation. Some knowledge of plumbing or electrical work is also helpful. A basic understanding of microelectronics is becoming more important because of the increasing use of this technology in solid-state equipment controls. Because technicians frequently deal directly with the public, they should be courteous and tactful, especially when dealing with an aggravated customer. They also should be in good physical condition because they sometimes have to lift and move heavy equipment.

All technicians who purchase or work with refrigerants must be certified in their proper handling. To become certified to purchase and handle refrigerants, technicians must pass a written examination specific to the type of work in which they specialize. The three possible areas of certification are: Type I—servicing small appliances, Type II—high pressure refrigerants, and Type III—low pressure refrigerants. Exams are administered by organizations approved by the Environmental Protection Agency, such as trade schools, unions, contractor associations, or building groups.

The Refrigeration Service Engineers Society offers basic self-study courses for individuals with limited experience. In addition to understanding how systems work, technicians must be knowledgeable about refrigerant products, and legislation and regulation that govern their use. The industry recently announced the adoption of one standard for certification of experienced technicians: the Air Conditioning Excellence program, which is offered through North American Technician Excellence, Inc. (NATE).

Advancement usually takes the form of higher wages. Some technicians, however, may advance to positions as supervisor or service manager. Others may move into areas such as sales and marketing. Those with sufficient money and managerial skill can open their own contracting business.

Job Outlook [About this section] Top

Job prospects for highly skilled heating, air-conditioning, and refrigeration mechanics and installers are expected to be very good, particularly for those with technical school or formal apprenticeship training to install, remodel, and service new and existing systems. In addition to job openings created by employment growth, thousands of openings will result from the need to replace workers who transfer to other occupations or leave the labor force.

Employment of heating, air-conditioning, and refrigeration mechanics and installers is expected to increase about as fast as the average for all occupations through the year 2008. As the population and economy grow, so does the demand for new residential, commercial, and industrial climate-control systems. Technicians who specialize in installation work may experience periods of unemployment when the level of new construction activity declines, but maintenance and repair work usually remains relatively stable. People and businesses depend on their climate control systems and must keep them in good working order, regardless of economic conditions.

Concern for the environment and energy conservation should continue to prompt the development of new energy-saving heating and air-conditioning systems. An emphasis on better energy management should lead to the replacement of older systems and the installation of newer, more efficient systems in existing homes and buildings. Also, demand for maintenance and service work should increase as businesses and home owners strive to keep systems operating at peak efficiency. Regulations prohibiting the discharge of CFC and HCFC refrigerants and banning CFC production by the year 2000 also should continue to result in demand for technicians to replace many existing systems, or modify them to use new environmentally safe refrigerants. In addition, the continuing focus on improving indoor air quality should contribute to the growth of jobs for heating, air-conditioning, and refrigeration technicians. Also, certain businesses contribute to a growing need for refrigeration. For example, nearly 50 percent of products sold in convenience stores require some sort of refrigeration. Supermarkets and convenience stores have a very large inventory of refrigerated equipment. This huge inventory will also create increasing demand for service technicians in installation, maintenance, and repair.

Earnings [About this section] Top

Professional and Technical Occupations

Mechanical Engineers

Nature of the Work | Employment | Job Outlook | Earnings

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Nature of the Work

[About this section] Top

Mechanical engineers research, develop, design, manufacture and test tools, engines, machines, and other mechanical devices. They work on power-producing machines such as electricity-producing generators, internal combustion engines, steam and gas turbines, and jet and rocket engines. They also develop power-using machines such as refrigeration and air-conditioning equipment, robots used in manufacturing, machine tools, materials handling systems, and industrial production equipment. Mechanical engineers also design tools needed by other engineers for their work.

Mechanical engineers work in many industries and their work varies by industry and function. Some specialties include applied mechanics; computer-aided design and manufacturing; energy systems; pressure vessels and piping; and heating, refrigeration, and air-conditioning systems. Mechanical engineering is the broadest engineering discipline, extending across many interdependent specialties. Mechanical engineers may work in production operations, maintenance, or technical sales; many are administrators or managers.

Employment

[About this section] Top

Mechanical engineers held about 220,000 jobs in 1998. Almost 3 out of 5 jobs were in manufacturing—mostly in machinery, transportation equipment, electrical equipment, instruments, and fabricated metal products industries. Engineering and management services, business services, and the Federal Government provided most of the remaining jobs.

Job Outlook

[About this section] Top

Employment of mechanical engineers is projected to grow about as fast as the average for all occupations though 2008. Although overall manufacturing employment is expected to decline, employment of mechanical engineers in manufacturing should increase as the demand for improved machinery and machine tools grows and industrial machinery and processes become increasingly complex. Employment of mechanical engineers in business and engineering services firms is expected to grow faster than average as other industries in the economy increasingly contract out to these firms to solve engineering problems. In addition to job openings from growth, many openings should result from the need to replace workers who transfer to other occupations or leave the labor force.

Earnings

[About this section] ▲ Top

Median annual earnings of mechanical engineers were $53,290 in 1998. The middle 50 percent earned between $42,680 and $74,220. The lowest 10 percent earned less than $35,290 and the highest 10 percent earned more than $87,000. Median annual earnings in the industries employing the largest numbers of mechanical engineers in 1997 were:

Federal government	$66,800
Engineering and architectural services	55,800
Electronic components and accessories	52,900
Aircraft and parts	51,800
Motor vehicles and equipment	48,500

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in mechanical engineering received starting offers averaging about $43,300 a year; master's degree candidates, $51,900; and Ph.D. candidates, $64,300.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

O*NET Code: 22135 About the O*NET codes

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COLLEGE OF TECHNOLOGY
GRADUATION SUMMARY

	93-4	94-5	95-6	96-7	97-8	98-9	99-
ABOD	14	6	14	4	14	~~2~~ 3	
AEMT	2	10	6	1			
AUSV	45	46	29	29	50	~~8~~ 9	
HEQT	21	8	19	31	28	7	
EEIT	15	10	6	18	10	2	
AHEM	41	38	29	34	29	4	
ECNS				1	3		
EEET	28	21	22	26	14	2	
HEET	7	5	3	4	9	5	
HEPT					5	1	
Total	173	144	128	148	162	~~31~~ 33	
ARCH	29	14	20	29	23	~~4~~ 3	
BCTM	15	26	16	23	10	~~6~~ 7	
CETM	7	6	6	12	4	1	
HVAR	11	18	27	19	30	10	
SURT	5	8	2	4	3	~~0~~ 1	
CONM	39	24	24	38	27	7	
FMAN	17	9	19	15	11	1	
HVAC	32	19	27	20	27	1	
SURE	21	24	18	18	19	~~10~~ 11	
CNAO			4		9		
FENO					3	~~0~~ 1	
FMGO			1	9	21	~~1~~ 4	
PMJO				3	1	1	
GEIO					6	4	
Total	176	148	164	190	194	~~46~~ 50	
MECH	13	8	16	15	13	~~3~~ 4	
MFGT	17	11	8	9	19	2	
PLTT	51	50	50	45	5	21	
PTEC	31	29	31	21	12	8	
TDTD	28	24	20	17	27	5	
TECL	10	5	6	0	2	1	
WELT	9	13	27	9	20	1	
MFGE	33	30	28	24	16	6	
PDET	19	30	16	24	29	~~2~~ 4	
PLTE	50	45	48	70	60	18	
PMGT	20	26	22	16	14	3	
WELE	17	18	11	17	21		
QUAL			17	9	11	1	
C-T			(22)	(21)	(56)	(7)	
Total	298	289	300	276	249	~~71~~ 73	
TOTAL	647	581	592	614	605	~~148~~ 159	

CERTIFICATES:

CNAO - Construction Administration
FENO - Field Engineering
FMGO - Facilities Mangement
GEIO - Geographic Information

HEPT - Electrical Power Generation
PMJO - Project Management (Now Known as ACMO) Advanced Construction Management
QUAL - Quality Technology

c:summary

Total includes the Certificates ( )

Revised 1-22-98

Number of Degrees: 31 Number responding: 22 *(71%)*

Placement Rate = 100% *(22)*			Full-Time	Part-Time
Continuing Education	2	—	1	1
Employed	22	—	20	2
Seeking Employment	0			
Not Seeking	0			

(Individual numbers may not add up to number responding due to incomplete answers and/or due to individuals responding in more than one category.)

Salary Scale (Full-Time)

$10-12 K	$13-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	> $55 K
			1		1	4	4	8				

Employment Rate = 100%

Employed	22 *(100%)*	In Field	21	*(95%)*
		Completed Internship	21	*(95%)*
		With Current Employer	10	*(48%)*
Seeking	0			
Total in Job Market	22			

Manufacturing Engineering Technology B.S.

Number of Degrees: 16 Number responding: 12 *(75%)*

Placement Rate = 100% *(12)*			Full-Time	Part-Time
Continuing Education	2	—	1	1
Employed	11	—	11	0
Seeking Employment	0			
Not Seeking	0			

(Individual numbers may not add up to number responding due to incomplete answers and/or due to individuals responding in more than one category.)

Salary Scale (Full-Time)

$10-12 K	$13-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	> $55 K
					1	1		3	1	2	1	

Employment Rate = 100%

Employed	11 *(92%)*	In Field	11	*(100%)*
		Completed Internship	8	*(73%)*
		With Current Employer	3	*(38%)*
Seeking	0			
Total in Job Market	11			

HVACR Technology A.A.S.

Number of Degrees: 32 Number responding: 15 *(47%)*

Placement Rate = 100% (15)

		Full-Time	Part-Time
Continuing Education	14	12	2
Employed	2	2	0
Seeking Employment	0		
Not Seeking	0		

(Individual numbers may not add up to number responding due to incomplete answers and/or due to individuals responding in more than one category.)

Salary Scale (Full-Time)

$10-12 K	$13-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	> $55 K
							1					

Employment Rate = 100%

Employed	2 *(13%)*	In Field	1	*(50%)*
		Completed Internship	0	*(0%)*
		With Current Employer	0	*(0%)*
Seeking	0			
Total in Job Market	2			

Industrial Electronics Technology A.A.S.

Number of Degrees: 11 Number responding: 6 *(55%)*

Placement Rate = 100% (6)

		Full-Time	Part-Time
Continuing Education	5	5	0
Employed	1	1	0
Seeking Employment	0		
Not Seeking	0		

(Individual numbers may not add up to number responding due to incomplete answers and/or due to individuals responding in more than one category.)

Salary Scale (Full-Time)

$10-12 K	$13-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	> $55 K
								1				

Employment Rate = 100%

Employed	1 *(17%)*	In Field	1	*(100%)*
		Completed Internship	0	*(0%)*
		With Current Employer	0	*(0%)*
Seeking	0			
Total in Job Market	1			

Beginning Annual Full-Time Salaries for
DOCTORATE, MASTER, AND BACHELOR DEGREE GRADUATES
For the Year 1997-98

College/Curriculum	Number Reporting Salary	Average Salary	Median Salary Range	Range Low	Range High
ALLIED HEALTH SCIENCES					
Bachelors					
Health Care Systems Admin.	11	$ 28,909	$ 24,000 - 27,000	$ 10,000	47,000
Health Information Management	6	24,833	24,000 - 27,000	16,000	31,000
Industrial & Env. Health Mgt.	12	34,500	29,500 - 33,500	24,000	55,000
Medical Technology	10	28,300	29,500 - 33,500	13,000	35,000
Nursing, Professional	16	39,000	40,000 - 43,000	13,000	55,000
ARTS AND SCIENCES					
Bachelors					
Social Work	16	23,250	20,000 - 23,000	13,000	47,000
BUSINESS					
Masters					
Information Systems Management	10	46,050	52,000 - 55,000	10,000	55,000
Bachelors					
Accountancy	12	26,833	25,500 - 29,500	20,000	35,000
Advertising	5	24,700	24,000 - 27,000	20,000	27,000
Business Administration	20	29,500	25,500 - 29,500	13,000	55,000
Computer Information Systems	14	38,071	35,500 - 37,500	28,000	55,000
Hospitality Management	4	25,500	17,500 - 33,500	13,000	39,000
Marketing	7	28,929	28,000 - 31,000	24,000	35,000
Marketing/Professional Golf Mgt.	11	23,318	24,000 - 27,000	13,000	31,000
Marketing/Professional Tennis Mgt.	6	34,833	36,000 - 39,000	16,000	43,000
Visual Communication	5	25,500	24,000 - 27,000	20,000	31,000
EDUCATION					
Masters					
Career and Technical Education	12	41,167	33,500 - 45,500	24,000	55,000
Bachelors					
Business Education	4	30,500	28,000 - 31,000	28,000	35,000
Criminal Justice	21	28,167	28,000 - 31,000	16,000	39,000
Technical Education	5	29,500	28,000 - 31,000	24,000	35,000
OPTOMETRY					
Doctorate					
O.D.	17	49,500	55,000 - 60,000	20,000	55,000
PHARMACY					
PharmD	4	35,500	.28,000 - 31,000	28, 000	55,000
Bachelors					
Pharmacy	42	53,214	55,000 - 60,000	20,000	55,000
TECHNOLOGY					
Bachelors					
Automotive & Heavy Equip. Mgt.	27	34,833	32,000 - 35,000	24,000	47,000
Construction Management	15	34,033	32,000 - 35,000	28,000	43,000
Electrical/Electronics Engr Tech.	7	36,357	36,000 - 39,000	28,000	51,000
Facilities Management	6	30,833	28,000 - 31,000	24,000	39,000
HVACR Engineering Technology	18	37,056	36,000 - 39,000	20,000	43,000
Manufacturing Engineering Tech	9	42,833	40,000 - 43,000	28,000	55,000
Plastics Engineering Technology	22	41,682	40,000 - 43,000	32,000	55,000
Printing Management	7	28,357	28,000 - 31,000	24,000	31,000
Product Design Engineering Tech	9	40,167	40,000 - 43,000	28,000	51,000
Surveying Engineering	14	34,071	32,000 - 35,000	28,000	47,000
Welding Engineering Technology	17	44,559	44,000 - 47,000	40,000	55,000

Salary ranges not calculated for programs with less than four salaries reported.

Program	Employer Name	Occupation	BCITY	BSTATE
HVACR Engineering Technology	Consumers Power Company	Facilities Technical Admin.	Grand Rapids	MI
HVACR Engineering Technology	Downriver Refrigeration Sup	Sales	Westland	MI
HVACR Engineering Technology	Eagle Energy	Project Manager	Maryland Heigh	MO
HVACR Engineering Technology	Ferris State University	Student		
HVACR Engineering Technology	H.A. Campbell Supply	Heating Dept. Manager	Grand Rapids	MI
HVACR Engineering Technology	Harper Mechanical	Project Manager	Sanford	FL
HVACR Engineering Technology	ICE CAP	AC Engineer	Long Island Cit	NY
HVACR Engineering Technology	IVI	HVACE Engineer	Greenville	WI
HVACR Engineering Technology	Johnson & Seamen Enginee	Mechanical Engineer	Auburn	MA
HVACR Engineering Technology	Johnson Controls	Systems Application Engin	Auburn Hills	MI
HVACR Engineering Technology	Johnson Controls	Systems Application Engin	Grand Rapids	MI
HVACR Engineering Technology	Johnson Controls	Assistant Project Technicia	Littleton	CO
HVACR Engineering Technology	Landis & Staefa	System Specialist	Hayward	CA
HVACR Engineering Technology	Landis & Staefa	Design Engineer	Livonia	MI
HVACR Engineering Technology	Michigan Environmental Con	Applications Engineer	Novi	MI
HVACR Engineering Technology	Noresco	Energy Engineer	Farmingham	MA
HVACR Engineering Technology	O'Hara Corporation	Construction Engineer	Fraser	MI
HVACR Engineering Technology	Plumbers & Pipefiters Union	Apprentice	South Bend	IN
HVACR Engineering Technology	Potomac Energy Group	Mechnical Design Engineer	Alexandria	VA
HVACR Engineering Technology	Process Engineer & Equipm	HVACR Sales Engineer	Comstock Park	MI
HVACR Engineering Technology	Progressive AE	Construction Dept.	Grand Rapids	MI
HVACR Engineering Technology	Technical Energy Solutions	Project Engineer	Byron Center	MI

College/Curriculum	Reporting Salary	Average Salary	Median Salary Range	Range Low	Range High
ALLIED HEALTH					
Bachelors					
Health Care Systems Admin.	12	$28,833	$25,500 - 29,500	$16,000	$51,000
Health Information Management	8	27,000	20,000 - 23,000	20,000	60,000
Indus. & Envir Health Mgt.	8	25,500	24,000 - 27,000	16,000	31,000
Nursing, Professional	18	43,944	40,000 - 43,000	28,000	60,000
ARTS & SCIENCES					
Bachelors					
Applied Biology	4	31,500	24,000 - 27,000	16,000	60,000
Applied Math	4	26,500	25,500 - 29,500	16,000	35,000
Biotechnology	4	24,500	24,000 - 27,000	16,000	31,000
Social Work	13	20,885	20,000 - 23,000	12,000	31,000
BUSINESS					
Masters					
Information Systems Mgt.	8	50,000	48,000 - 51,000	40,000	60,000
Bachelors					
Accountancy	13	25,192	24,000 - 27,000	16,000	39,000
Advertising	8	23,000	21,500 - 25,500	16,000	31,000
Business Administration	46	27,098	24,000 - 27,000	10,000	55,000
CIS/Accountancy	4	34,500	32,000 - 35,000	28,000	43,000
Computer Info Systems	13	27,462	28,000 - 31,000	10,000	43,000
Hospitality Management	8	24,000	20,000 - 23,000	12,000	47,000
Human Resource Management	5	27,900	24,000 - 27,000	20,000	39,000
Marketing	4	32,500	25,500 - 29,500	16,000	60,000
Marketing/Pro Golf Mgt	34	20,559	20,000 - 23,000	12,000	39,000
Marketing/Pro Tennis Mgt	5	29,500	20,000 - 23,000	20,000	60,000
Marketing/Sales	7	31,214	24,000 - 27,000	20,000	60,000
Public Relations	5	24,700	20,000 - 23,000	20,000	31,000
Small Business Management	5	29,500	28,000 - 31,000	16,000	39,000
Visual Communication	6	21,500	20,000 - 23,000	16,000	27,000
EDUCATION					
Masters					
Career and Technical Education	8	39,500	40,000 - 43,000	12,000	60,000
Bachelors					
Biology Education	4	26,500	25,500 - 29,500	20,000	31,000
Business Education	4	27,500	25,500 - 29,500	24,000	31,000
Criminal Justice	34	25,544	24,000 - 27,000	10,000	39,000
Recreation Leadership	4	25,500	24,000 - 27,000	20,000	31,000
Television Production	9	21,222	20,000 - 23,000	10,000	35,000
OPTOMETRY					
Doctorate					
O.D.	12	50,500	55,000 - 60,000	20,000	60,000
PHARMACY					
Bachelors					
Pharmacy	44	51,864	52,000 - 55,000	32,000	60,000
TECHNOLOGY					
Bachelors					
Auto & Heavy Equip Mgt.	29	33,086	32,000 - 35,000	24,000	39,000
Construction Management	24	33,667	32,000 - 35,000	24,000	60,000
Elec/Eltr Engr Tech	6	39,500	37,500 - 41,500	24,000	60,000
HVACR Engineering Tech	13	38,115	36,000 - 39,000	28,000	60,000
Manufacturing Engr Tech	11	45,500	44,000 - 47,000	32,000	60,000
Plastics Engr Tech	30	37,367	36,000 - 39,000	12,000	51,000
Printing Management	17	27,382	24,000 - 27,000	20,000	35,000
Product Design Engr Tech	9	33,500	32,000 - 35,000	24,000	51,000
Surveying Engineering	12	30,167	28,000 - 31,000	20,000	39,000
Welding Engineering Tech	15	41,233	40,000 - 43,000	28,000	47,000

Salary ranges not calculated for programs with less than four salaries reported.

College/Curriculum	Number Reporting Salary	Average Salary	Median Salary Range	Range Low	Range High
ALLIED HEALTH					
Dental Hygiene	20	$33,175	$32,000 - 35,000	$10,000	55,000
Health Information Technology	9	19,889	20,000 - 23,000	10,000	27,000
Nursing Technology	9	30,833	28,000 - 31,000	24,000	35,000
Radiography (X-Ray)	14	23,893	24,000 - 27,000	10,000	35,000
Respiratory Care	4	24,500	24,000 - 27,000	16,000	31,000
ARTS & SCIENCES					
Industrial Chemistry Technology	6	26,167	24,000 - 27,000	20,000	35,000
BUSINESS					
	N/A	N/A	N/A	N/A	
EDUCATION					
Child Development	4	13,625	10,000 - 12,000	10,000	23,000
OPTOMETRY					
	N/A	N/A	N/A	N/A	
TECHNOLOGY					
Architectural Technology	8	19,688	17,500 - 21,500	10,000	31,000
Automotive Service	6	23,083	24,000 - 27,000	10,000	31,000
Building Construction Technology	5	35,900	32,000 - 35,000	16,000	60,000
Heavy Equipment Technology	10	29,900	25,500 - 29,500	20,000	55,000
HVACR Technology	5	30,300	32,000 - 35,000	20,000	35,000
Plastics Technology	7	37,500	40,000 - 43,000	24,000	47,000
Printing Technology	5	18,300	16,000 - 19,000	12,000	27,000

Salary ranges not calculated for programs with less than four salaries reported.

Number of Degrees: 5 Number responding: 4 *(80%)*

Placement Rate = 100% (4)		Full-Time	Part-Time
Continuing Education	0	0	0
Employed	4	4	0
Seeking Employment	0		
Not Seeking	0		

Salary Scale (Full-Time)

$10-12 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
				1	2							

Employment Rate = 100%

Employed	4 *(100%)*	In Field	4 *(100%)*
		Completed Internship	4 *(100%)*
		With Current Employer	0 *(0%)*
Seeking	0		
Total in Job Market	4		

HVACR Engineering Technology B.S.

Number of Degrees: 19 Number responding: 17 *(89%)*

Placement Rate = 100% (17)		Full-Time	Part-Time
Continuing Education	3	1	2
Employed	16	16	0
Seeking Employment	0		
Not Seeking	0		

Salary Scale (Full-Time)

$10-12 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
					1	5	5				1	1

Employment Rate = 100%

Employed	16 *(94%)*	In Field	16 *(100%)*
		Completed Internship	10 *(63%)*
		With Current Employer	3 *(30%)*
Seeking	0		
Total in Job Market	16		

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Program	Employer Name	Occupation	BCITY	BSTATE
HVACR Technology	B & V Mechanical	HVACR Tech & Controls S	Grand Rapids	MI
HVACR Technology	Belonga Heating & Cooling	Service Technician	St. Ignace	MI
HVACR Technology	Johnson Controls	Controls Tech	Tempe	AZ
HVACR Technology	R & M Heating & Cooling	Service Tech	Coloma	MI
HVACR Technology	River City Mechanical		Comstock Park	MI
HVACR Technology	River City Mechanical	Serv. Tech	Comstock Park	MI

Number of Degrees: 34 Number responding: 31 *(91%)*

Placement Rate = 100% (31)			Full-Time	Part-Time
Continuing Education	22	—	21	1
Employed	10	—	10	0
Seeking Employment	0			
Not Seeking	0			

Salary Scale (Full-Time)

$10-12 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
			1	4	3	1					1	

Employment Rate = 100%				
Employed	10 *(32%)*	In Field	9	*(90%)*
		Completed Internship	0	*(0%)*
		With Current Employer	0	*(0%)*
Seeking	0			
Total in Job Market	10			

VACR Technology A.A.S.

Number of Degrees: 20 Number responding: 12 *(60%)*

Placement Rate = 100% (12)			Full-Time	Part-Time
Continuing Education	7	—	6	1
Employed	6	—	6	0
Seeking Employment	0			
Not Seeking	0			

Salary Scale (Full-Time)

$10-12 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
			1		1	3						

Employment Rate = 100%				
Employed	6 *(50%)*	In Field	6	*(100%)*
		Completed Internship	0	*(0%)*
		With Current Employer	0	*(0%)*
Seeking	0			
Total in Job Market	6			

Program	Employer Name	Occupation	BCITY	BSTATE
HVACR Engineering Technology	Burt Tool & Cage	HVACR Maintenance		
HVACR Engineering Technology	Energis Resources	Energy Eng.	Edison	NJ
HVACR Engineering Technology	Ferris State University	HVAC Prog Coord	Big Rapids	MI
HVACR Engineering Technology	Guardian Engironmental Ser		Livonia	MI
HVACR Engineering Technology	Johnson Controls	System Rep	Grand Rapids	MI
HVACR Engineering Technology	Johnson Controls	System Rep	Arlington Hts	IL
HVACR Engineering Technology	Johnson Controls	System Rep	Troy	MI
HVACR Engineering Technology	Landis & Staefa, Inc	Service Specialist	Needham Heig	MA
HVACR Engineering Technology	Landis & Staefa, Inc	Eng. Specialist	Portland	OR
HVACR Engineering Technology	Landis & Staefa, Inc	Design Eng	Livonia	MI
HVACR Engineering Technology	Limbach Co.	Project Eng.	Pontiac	MI
HVACR Engineering Technology	Limbach Co.	Project Mgr	Pontiac	MI
HVACR Engineering Technology	Noresco	Assoc. Energy Eng.	Framingham	MA
HVACR Engineering Technology	Progressive	Eng.	Grand Rapids	MI
HVACR Engineering Technology	United Engineering	HVACR Eng	Chicago	IL
HVACR Engineering Technology	Vanderweil Eng.	Design Eng	Alexandria	VA

College/Curriculum	Number Reporting	Median Salary Range	Range Low	Range High
ALLIED HEALTH				
Health Information Management	6	$28,000 - 35,000	$12,000	$47,000
Indus. & Envir Health Mgt.	8	24,000 - 31,000	20,000	35,000
Nursing, Professional	17	32,000 - 35,000	20,000	51,000
ARTS & SCIENCES				
Applied Biology	5	12,000 - 15,000	12,000	23,000
Social Work	9	20,000 - 23,000	16,000	35,000
BUSINESS				
Accountancy	9	20,000 - 23,000	12,000	27,000
Advertising	4	17,000 - 22,000	12,000	23,000
Business Administration	31	24,000 - 27,000	12,000	60,000
Computer Info Systems	8	32,000 - 35,000	28,000	39,000
Hospitality Management	10	24,000 - 27,000	20,000	39,000
Management	4	20,000 - 23,000	16,000	27,000
Marketing/Pro Golf Mgt	18	20,000 - 23,000	12,000	47,000
Marketing/Sales	5	24,000 - 27,000	12,000	35,000
Office Automations	4	16,000 - 27,000	16,000	35,000
Public Relations	4	20,000 - 23,000	9,000	39,000
Visual Communications	6	20,000 - 23,000	20,000	47,000
EDUCATION				
Career and Technical Education	9	20,000 - 27,000	12,000	55,000
Criminal Justice	39	24,000 - 27,000	12,000	35,000
Recreation Leadership	6	16,000 - 23,000	12,000	39,000
Technical Education	5	28,000 - 31,000	20,000	31,000
OPTOMETRY				
O.D.	10	55,000 - 60,000	24,000	60,000
PHARMACY				
Pharmacy	28	52,000 - 55,000	32,000	60,000
TECHNOLOGY				
Auto & Heavy Equip Mgt.	9	28,000 - 35,000	16,000	43,000
Construction Management	8	28,000 - 31,000	12,000	35,000
Elec/Eltr Engr Tech	8	32,000 - 35,000	24,000	43,000
Facilities Management	6	28,000 - 35,000	20,000	47,000
HVACR Engineering Tech	7	32,000 - 35,000	28,000	39,000
Manufacturing Engr Tech	16	32,000 - 35,000	28,000	60,000
Plastics Engr Tech	10	32,000 - 39,000	24,000	43,000
Printing Management	17	24,000 - 27,000	16,000	35,000
Product Design Engr Tech	9	28,000 - 31,000	20,000	47,000
Surveying	6	28,000 - 35,000	12,000	35,000
Welding Engineering Tech	9	36,000 - 39,000	32,000	43,000

HVACR Engineering Technology

Employers	City and State	Positions
American Auto Matrix	Export PA	Applications Engineer
Granger Construction	Lansing MI	Mechanical Designer
Honeywell	Kentwood MI	Control Systems Specialist
Johnson Control	Chicago IL	Systems Application Manager
Landus APASA	Livonia MI	
Mayco Heating & Air Cond	Long Valley NJ	
Quality Air	Midland MI	Service Technician
Quality Air of Midland	Midland MI	

Number receiving degrees	23	
Number responding to survey	8	*34.8%*

		Full-Time	Part-Time	PT/FT Unknown
Continuing their education	0	0	0	0
Total employed	8			
Employed in field		8	0	0
Employed, but not in field		0	0	0
Seeking in field	0			-
Still seeking employment	0			
Not seeking employment	0			

Had an FSU internship 8 Did their internship with the employer 1

Employment rate *100%*

Full Time Salaries

# of grads indicating full-time employment: 8 **Did Not Answer: 1** **# Reporting: 7**

$9-11 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
					2	4	1					

Heavy Equipment Technology A.A.S.

Number receiving degrees 17

Number responding to survey 12 *70.6%*

		Full-Time	Part-Time	PT/FT Unknown
Continuing their education	8	7	1	0
Total employed	5			
Employed in field		4	0	0
Employed, but not in field		1	0	0
Seeking in field	0			
Still seeking employment	0			
Not seeking employment	0			

Had an FSU internship 1 Did their internship with the employer 1

Employment rate *100%*

Full Time Salaries

# of grads indicating full-time employment: 5 **Did Not Answer: 0** **# Reporting: 5**

$9-11 K	$12-15 K	$16-19 K	$20-23 K	$24-27 K	$28-31 K	$32-35 K	$36-39 K	$40-43 K	$44-47 K	$48-51 K	$52-55 K	$55-60 K
	1		3			1						

TABLE VIII
Placement Profile for Graduates
in the College of TECHNOLOGY
1994-95

CURRICULUM	Employed		Continuing Education				Not Seeking Employment	Seeking Employment	Unknown	T
			Ferris State		Other Instit.					
	Major Field	Not Related	Under-grad.	Grad.	Under-grad.	Grad.				
B.S. DEGREES										
Auto & Heavy Equip Mgt	23	1	0	0	0	0	0	0	13	
Construction Management	19	0	0	0	0	0	0	1	6	
Elec/Eltr Engr Tech	22	0	0	0	0	0	0	0	4	
Facilities Management	10	0	0	0	0	1	0	1	2	
Heavy Equip Serv Eng Tech	2	0	0	0	0	0	0	0	4	
HVACR Engineering Tech	15	0	0	0	0	0	0	0	1	
Manufacturing Engr Tech	25	2	0	0	0	0	0	1	3	
Plastics Engr Tech	34	1	0	0	0	1	0	0	16	
Printing Management	19	5	0	0	0	1	0	0	1	
Product Design Engr Tech	21	0	0	0	0	0	0	1	7	
Surveying	18	0	0	0	0	0	0	0	9	
lding Engineering Tech	18	0	0	0	0	0	0	0	1	
TOTALS:	226	9	0	0	0	3	0	4	67	

TABLE VIII CONTINUED
Placement Profile for Graduates
in the College of TECHNOLOGY
1994-95

CURRICULUM	Employed		Continuing Education				Not Seeking Employment	Seeking Employment	Unknown
			Ferris State		Other Instit.				
	Major Field	Not Related	Under-grad.	Grad.	Under-grad.	Grad.			
ASSOCIATE DEGREES									
Architectural Tech	2	1	6	0	1	0	0	0	2
Automotive Body	1	0	3	0	0	0	0	0	4
Automotive Eng Machine Tech	1	1	3	0	1	0	0	0	3
Automotive Service	13	2	13	0	0	0	0	1	12
Building Const Tech	5	0	14	0	0	0	0	1	4
Civil Engineering Tech	1	1	3	0	0	0	0	0	1
Heavy Equipment Service	5	0	1	0	0	0	0	0	4
HVACR Technology	5	0	11	0	0	0	0	0	3
Industrial Eltr Tech	0	0	7	0	0	0	0	0	4
Manufacturing Tooling Tech	6	1	4	0	0	0	0	0	1
Mechanical Engr Tech	0	0	5	0	0	0	0	0	2
Plastics Technology	5	2	50	0	0	0	0	1	2
Printing	6	1	19	0	0	0	0	1	3
Surveying Technology	0	1	4	0	0	0	0	0	3
Tech Dftg & Tool Design	3	0	14	0	0	0	0	1	5
Technical Illustration	2	0	2	0	1	0	0	0	0
Welding Technology	2	1	12	0	0	0	0	0	1
TOTALS:	57	11	171	0	3	0	0	5	54

College/Curriculum	Number Reporting	Average Salary	Range High - Low
ALLIED HEALTH			
Health Information Management	5	$ 25,802	$ 37,000 - 14,560
Indus. & Envir Health Mgt.	15	24,842	30,000 - 16,640
Medical Technology	13	26,133	31,260 - 19,760
ARTS & SCIENCES			
Social Work	13	19,599	25,000 - 11,440
BUSINESS			
Accounting	17	26,377	35,000 - 17,680
Advertising	6	20,173	25,000 - 14,040
Business Administration	34	24,984	50,000 - 11,960
Computer Info Systems	20	29,995	36,000 - 20,800
Finance	5	27,180	34,500 - 14,400
Hospitality Management	11	23,085	33,000 - 14,040
Human Resource Management	5	22,720	29,000 - 15,600
Management	7	23,057	25,500 - 20,000
Marketing	5	18,056	24,000 - 14,400
Marketing/Pro Golf Mgt	25	18,129	36,000 - 12,000
Marketing/Retail	4	23,100	25,000 - 21,000
Marketing/Sales	10	25,676	40,000 - 18,000
Small Business Management	5	25,100	41,600 - 15,600
Visual Communications	7	18,769	30,000 - 15,000
EDUCATION			
Criminal Justice	38	22,912	32,500 - 10,560
OPTOMETRY	N/A	N/A	N/A
PHARMACY			
Pharmacy			
Registered	53	49,600	56,680 - 25,000
Intern	10	32,246	42,000 - 20,800
TECHNOLOGY			
Auto & Heavy Equip Mgt.	16	31,958	40,000 - 20,800
Construction Management	16	28,633	38,000 - 23,400
Elec/Eltr Engr Tech	9	29,319	42,250 - 15,000
HVACR Engineering Tech	11	32,345	35,000 - 27,000
Manufacturing Engr Tech	13	34,031	42,000 - 26,000
Plastics Engr Tech	26	34,988	45,000 - 21,320
Printing Management	17	23,746	30,000 - 19,448
Product Design Engr Tech	19	31,270	53,000 - 17,680
Surveying	15	26,971	32,000 - 20,800
Welding Engineering Tech	15	37,068	47,840 - 25,560

NOTE: The above table includes only those curriculums where salary information was received from five or more students employed in positions related to their major.

TABLE VIII
Placement Profile for Graduates in the College of TECHNOLOGY 1993-94

CURRICULUM	Employed		Continuing Education				Not Seeking Employ.	Seeking Employ.	Unknown	TOTAL
			Ferris State		Other Instit.					
	Major Field	Not Related	Under-grad.	Grad.	Under-grad.	Grad.				
B.S. DEGREES										
Auto & Heavy Equip Mgt	36	2	0	0	1	0	0	2	15	56
Construction Management	28	1	0	0	0	0	0	2	8	39
Elec/Eltr Engr Tech	16	0	1	0	1	0	0	0	7	25
Facilities Management	5	3	0	0	0	0	0	2	3	13
Heavy Equip Serv Eng Tech	2	0	0	0	0	0	0	0	2	4
HVACR Engineering Tech	13	0	0	0	0	0	0	1	0	14
Manufacturing Engr Tech	33	0	0	0	0	0	0	0	1	34
Plastics Engr Tech	52	0	0	0	0	0	0	0	9	61
Printing Management	10	2	0	0	0	0	0	0	6	[illegible]
Product Design Engr Tech	14	1	0	0	0	0	0	0	2	[illegible]
Surveying Engineering	13	0	0	0	0	1	0	0	4	[illegible]
Welding Engineering Tech	18	1	0	0	0	0	0	0	0	[illegible]
TOTALS:	240	10	1	0	2	1	0	7	57	318

TABLE VIII CONTINUED
Placement Profile for Graduates
in the College of TECHNOLOGY
1993-94

CURRICULUM	Employed: Major Field	Employed: Not Related	Continuing Education: Ferris State Under-grad.	Continuing Education: Ferris State Grad.	Continuing Education: Other Instit. Under-grad.	Continuing Education: Other Instit. Grad.	Not Seeking Employ.	Seeking Employ.	Unknown	TO
ASSOCIATE DEGREES										
Architectural Tech	4	2	13	0	6	0	0	0	2	
Automotive Body	4	0	3	0	1	0	0	2	4	
Automotive Eng Machine Tech	2	0	0	0	0	0	0	0	0	
Automotive Service	25	2	19	0	0	0	0	1	6	
Building Const Tech	6	1	10	0	0	0	0	0	1	
Civil Engineering Tech	2	0	5	0	0	0	0	0	0	
Heavy Equipment Service	15	0	3	0	0	0	0	0	4	
HVACR Technology	20	0	12	0	0	0	0	1	1	
Industrial Eltr Tech	1	2	15	0	0	0	0	0	0	
Manufacturing Tooling Tech	7	0	6	0	0	0	0	0	6	
Mechanical Engr Tech	2	0	8	0	1	0	0	0	1	
Plastics Technology	3	1	41	0	0	0	0	0	4	
Printing	7	0	25	0	1	0	0	0	3	
Surveying Technology	3	0	2	0	1	0	0	0	0	
Tech Dftg & Tool Design	7	1	16	0	2	0	0	0	2	
Technical Illustration	1	1	6	0	0	0	0	0	3	
Welding Technology	2	0	6	0	0	0	0	0	2	
TOTALS:	111	10	190	0	12	0	0	4	39	

College/Curriculum	Number Reporting	Average Salary	80% Range High - Low
ALLIED HEALTH			
Health Information Mgt	9	$ 22,762	$35,000 - 17,000
Health Systems Mgt	5	23,080	24,960 - 20,000
Indus & Envir Health Mgt	13	23,254	28,000 - 16,640
Medical Technology	9	28,502	30,992 - 24,960
ARTS & SCIENCES			
Social Work	11	20,967	24,000 - 18,000
BUSINESS			
Accounting	28	24,099	31,500 - 16,640
Advertising	6	22,313	22,880 - 17,000
Business Administration	35	21,968	27,500 - 16,500
Computer Info Systems	30	28,190	33,050 - 24,000
Finance	11	25,871	28,000 - 21,000
Hospitality Management	9	20,527	25,000 - 14,560
Management	9	20,333	27,050 - 12,480
Marketing	9	19,956	25,000 - 15,000
Marketing/Pro Golf Mgt	21	17,183	22,000 - 13,200
Marketing/Pro Tennis Mgt	8	27,255	37,440 - 18,000
Marketing/Retail	5	17,588	21,320 - 12,500
Marketing/Sales	9	24,090	31,500 - 18,200
Office Auto Systems	6	18,417	22,000 - 14,060
EDUCATION			
Criminal Justice	32	21,716	27,000 - 14,560
TV Production	5	17,972	22,000 - 14,560
OPTOMETRY	N/A		
PHARMACY			
Registered	47	49,150	56,160 - 45,000
Intern Status	14	31,359	41,600 - 20,800
TECHNOLOGY			
Auto & Heavy Equip Mgt	19	25,761	29,000 - 22,776
Construction Management	19	28,009	31,800 - 23,000
Elec/Eltr Engr Tech	9	25,593	28,000 - 22,880
HVACR Engineering Tech	10	31,684	35,000 - 28,500
Manufacturing Engr Tech	15	30,203	35,300 - 19,760
Plastics Engr Tech	37	32,375	37,000 - 28,992
Product Design Engr Tech	9	27,069	36,400 - 16,640
Surveying Engineering	10	26,044	30,000 - 21,000
Welding Engineering Tech	17	34,135	36,000 - 33,000

NOTE: The above table includes only those curriculums where salary information was received from five or more students employed in positions related to their major. Figures do not include any incentive income over and above base salary. (It should be noted that many grads receive additional compensations, such as bonuses and overtime pay.)

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TABLE X
Beginning Annual Salaries for
ASSOCIATE DEGREE Graduates
For the Year 1993-94

COLLEGE/Curriculum	Number Reporting	Average Salary	80% Range High - Low
ALLIED HEALTH			
Dental Hygiene	9	$ 33,367	$ 37,440 - 29,016
Health Information Tech	5	18,100	20,000 - 13,000
Nursing Tech	5	30,870	31,680 - 29,760
Radiography (X-Ray)	10	22,569	22,880 - 21,840
Respiratory Care	6	24,295	27,000 - 21,996
ARTS & SCIENCES			
Industrial Chemistry Tech	6	22,800	23,600 - 22,000
BUSINESS	N/A		
EDUCATION	N/A		
OPTOMETRY	N/A		
EDUCATION	N/A		
TECHNOLOGY			
Automotive Service	12	$ 19,682	24,168 - 14,500
Heavy Equipment Service	5	21,506	24,908 - 18,720
Printing	6	17,707	22,000 - 15,600
HVACR Technology	9	22,065	31,200 - 17,680

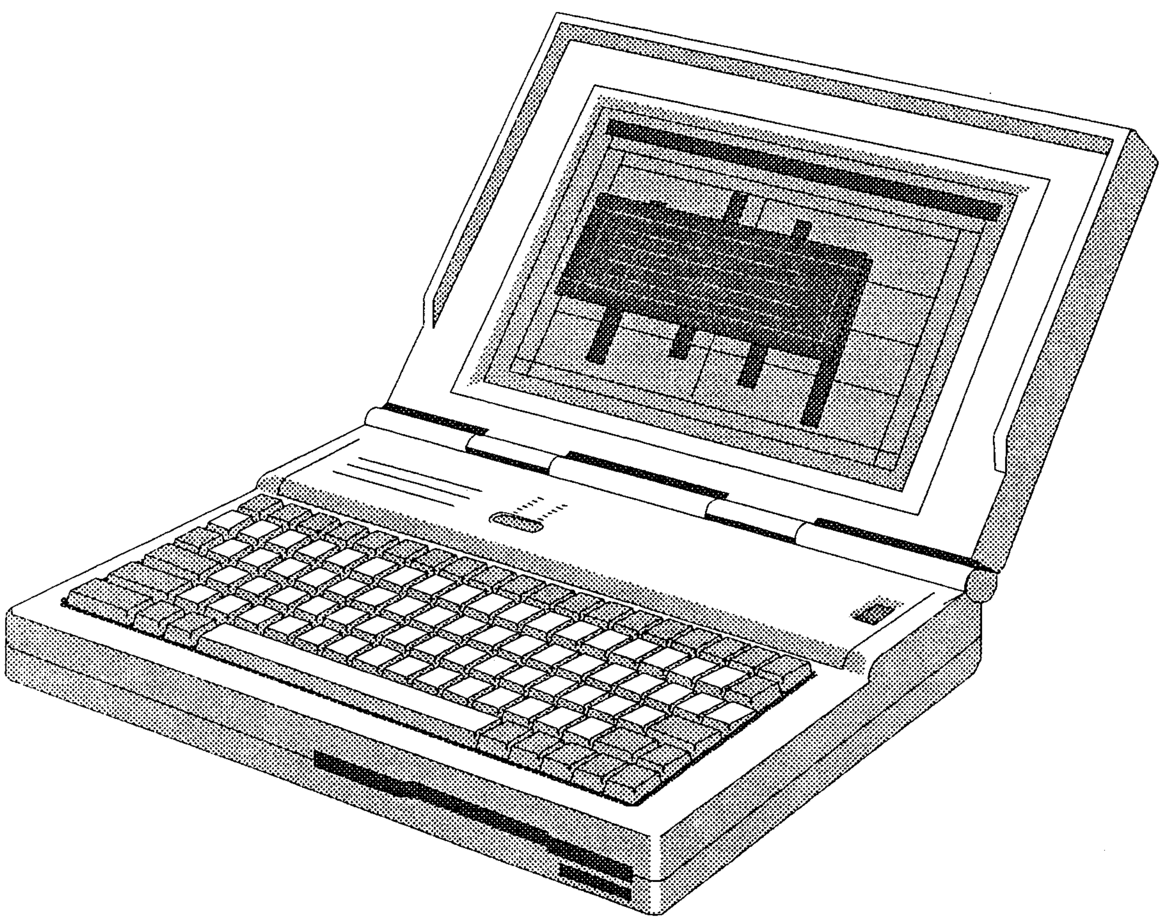
NOTE: The above table includes only those curriculums where salary information was received from five or more students employed in positions related to their major. Figures do not include any incentive income over and above base salary. (It should be noted that many grads receive additional compensations, such as bonuses and overtime pay.)

FACILITIES & EQUIPMENT EVALUATION

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



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SCOPE & OVERVIEW

The HVACR Program primarily utilizes classrooms and laboratories in the Construction Technology Center (CTC). Sometimes lecture rooms are used in the Automotive building, SWAN and the Science building to accommodate larger than normal classes. The Basic Electrical class for the AAS program is taught by the Transportation-Electronics Department in the SWAN building.

Present existing space and usage is listed below.

ROOM NO.	USAGE
CTC 103	OFFICE and TOOLS & PARTS STORAGE
CTC 105	COMMERCIAL REFRIGERATION & SUMMER AIR CONDITIONING LAB
CTC 108	BASIC REFRIGERATION FUNDAMENTALS LAB & SUMMER AIR CONDITIONING LAB
CTC 110	SECRETARY OFFICE
CTC 110A	PROGRAM COORDINATOR'S OFFICE
CTC 111B	ENERGY SYSTEMS LAB
CTC 111A	COMPUTER LAB - LECTURE
CTC 113	LECTURE ROOM
CTC 114	ELECTRICITY CONTROLS LAB & LECTURE AREA, COPY MACHINE & STORAGE AREA
CTC 114A	FACULTY OFFICE
CTC 114C	FACULTY OFFICE & COPY MACHINE
CTC 118	OIL & GAS HEATING LAB
CTC 118A	PART OF GAS HEATING LAB & STORAGE
CTC 211A	SHEET METAL LAB
CTC 211B	ENERGY SYSTEMS STORAGE
CTC 217B	STORAGE

Laboratory classrooms and number of units or stations for student laboratory projects are listed below.

LABORATORY	UNITS / STATIONS
COMMERCIAL REFRIGERATION	19
SUMMER AIR CONDITIONING	19
BASIC REFRIGERATION	20
COMPUTER LAB	20
ELECTRICITY CONTROLS	10
GAS HEATING	24
OIL HEATING	16
ENERGY SYSTEMS	7
SHEET METAL	12
FACILITY CONTROL AREA	10

SCOPE & OVERVIEW (cont.)

Laboratory Class Rooms utilized for the AAS program consist of five (5) major lab areas, these are the Basic Refrigeration Fundamentals and Troubleshooting lab, Electrical Fundamentals and Troubleshooting lab, Commercial Refrigeration and Air Conditioning Troubleshooting lab, the Oil and Gas Heating Troubleshooting lab, and the Computer Lab, which is used for the Design class to perform Heat Load Calculations.

Laboratory Class Rooms utilized for the BS program consist of one (1) major lab area and the computer lab. The major lab area is used for Design, Air Testing and Balancing Problem Solving, Hydronic Piping and Control Systems classes. Also, within the major lab area, a separate area was installed to hold the new facility control & network stations donated by Johnson Controls. This is the facility control lab area. The computer lab is used for computer assisted Design and Calculations.

The major lab used for the BS has a 35 Horsepower, gas fired boiler, a 10 ton chilled water air conditioning system with a Variable Air Volume on the air handler, a Dual Duct system, Infrared Tube heating system and a Controls system to operate all the equipment.

Existing facilities are questionable as to being adequate for the present program, this program has changed and expanded tremendously over the last 25 years to try and keep abreast of the every changing technology in the industry. We are basically working with the same or less facilities than we had when only a AAS program was being taught, now we have added a BS program and added a considerable number of students. Also, the program is involved with other projects that took room away from the already limited space available. Some examples are:

1. Faculty offices are very small and house two faculty in most cases, also some faculty offices are on the other side of campus. In this curriculum, faculty offices should be in the same building where the courses are taught. A majority of student questions re quire the faculty and student to go to a piece of equipment to answer. This is not possible from offices across campus.

2. There are only 3 lecture areas to teach a lecture structured class, 2 of these lecture areas are within laboratory spaces that create several negative factors when lecturing. Also the lecture areas are too small to properly seat all of the students. Students currently have to sit at lab benches at the perimeter of the lecture area. This is not a good learning environment. Our program teaches HVAC, yet our building is an one of the poorest examples of HVAC application to a educational building. In the two lecture areas that are in laboratories, the applied HVAC was meant for a warehouse application (Unit heaters). This system has to be shut off in order for the students to hear the lecture. At this point the human comfort factor is lost.

3. The amount of tools, test equipment and spare parts necessary have out grown the existing storage spaces. Just about any vacant spot of any kind in the building right now becomes a storage space, this makes it very difficult for the person responsible to adequately keep track of things and maintain the necessary inventory.

4. The existing laboratories have so many units in them that they are extremely close together and it is almost close to impossible for a student to get in between his or her unit and the one next to it, also some of the units are installed so close to the wall that the back of the unit is not accessible.

5. The number of classes and assignments that require the use of a computer has grown tremendously, this requires more computers, the main problem is we don't have space enough to keep adding more.

The expectations of the program in the very short future is to double the enrollment of the AAS program and triple the enrollment of the BS program, will not happen without increasing the facilities.

The existing equipment in our laboratories could be considered adequate. Most of the equipment is acquired by the faculty and the program coordinator through donations.

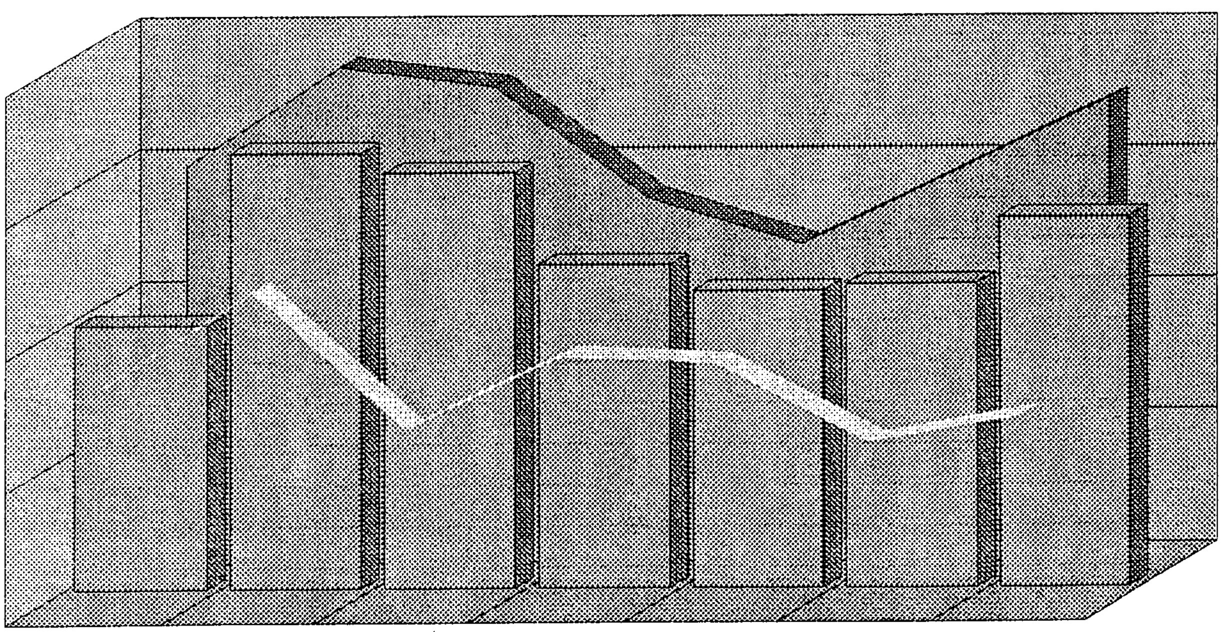
Technological advances have increased the variety of HVACR equipment that students must be taught on. The future requirement for equipment will still be mainly through donations and the program is confident that these donations can be achieved. The problem is the space to put this equipment. Increased facility area will be required to fit this new equipment.

CURRICULUM EVALUATION

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



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SCOPE & OVERVIEW

A.A.S. Degree

The HVACR Associate Degree program was created in 1946 as a refrigeration repair course, with very strong emphasis on theoretical basics and application principles. Later, technology changes and enrollment pressures lead to program expansion and curriculum enhancements. Following sound educational principles, the program grew in size and recognition, such that graduating students have always been heavily recruited and very well-placed relative to their training. Associate Degree alumni are found in all areas of the industry from technician to middle management, giving graduating sophomores a firm base of entry into the industry.

Currently, students are given refrigeration basics in HVACR 101, 102. Heating basics are given in HVACR 132. Electrical basics are currently taught in EEET 115 and HVACR 117. Those skills are then exercised in the application courses, HVACR 206, 208, 234 and 235. A design course, HVACR 245 completes the core associate degree program. Students are required to enroll in MATH 115 for an Associate Degree. Students that are planning to continue on to the Baccalaureate program substitute MATH 116. General Education requirements are met by the balance of the Associate level check sheet. Students are also given the opportunity to enroll in HVACR 100, a curriculum overview course and/or HVACR 225, Sheet Metal.

By addressing the constant changes of the technology, industry and environmental concerns relative to HVACR, the Associate Degree program has gained considerable stature and recognition within the HVACR industry. To date, faculty in the Associate Degree program have written and published numerous textbooks and articles. The books have covered a broad array of subject material relative to the HVACR industry. Two nationally recognized testing programs, Refrigerant Handling and Geothermal Heat Pump Technician Training were authored and have resulted in considerable national, international attention and financial prosperity for the HVACR program. A multi-media CD-ROM, teaching electrical troubleshooting was authored by a four member faculty team. It has been well received by the industry and is viewed as a professional academic product with very pragmatic applications.

Currently, an industry funded, scientific study of a cutting-edge technology in the Geothermal Heat Pump arena is being conducted. It involves quantifying in-ground, machine and system variables with this new ultra-high efficiency heating-cooling system. This testing is opening up new and exciting academic and industry avenues of recognition for Ferris State University.

The Associate Degree program remains a healthy productive addition to the Ferris State University, College of Technology.

B.S. Degree

The HVACR Engineering Technology program has been in existence since 1984. In the beginning, the program was named Energy Management. The name was subsequently changed to Heating, Ventilation, Air Conditioning Engineering Technology. The curriculum was designed to educate individuals for positions between the technician and the engineer. Math skills developed from the requirement of MATH 126 were assumed to be appropriate for the graduate filling those positions. This curriculum was designed to follow the university's 2+2 format. Ultimately, a large percentage (30%) of the AAS graduates enter the baccalaureate program.

Technical course content has closely followed the original course descriptions, with necessary changes being made to accommodate semester conversion and industry technical detail changes. A very strong commitment to the basics of system design and creature comfort in buildings has always dictated that we teach "the big picture" of building HVACR systems.

The curriculum has reflected the strong necessity to service the HVAC system's electronic control portion of the industry. Presently, HVAC 312 and 415 directly highlight the control logic and design areas. The courses, HVAC 451 and 499 are developed around the need of the HVAC system to closely follow the building requirements of energy control. These courses also highlight government and utility variables in "real world" circumstances that impact creature comfort in buildings and concentration upon system performance. HVAC 499 is a capstone course which emphasizes the design process to select and configure HVAC systems. HVAC 451 and 499 are considered writing intensive courses by General Education requirements. HVAC 331 and 462 are equipment selection courses that center on fluid and thermal dynamics applicable to the HVAC industry. HVAC 342 concentrates on the load requirements of a building using both manual and computer aided calculations.

Visual Basic programming, ISYS 204, is provided due to the relevance to the HVAC industry as many of the industry's programs are written in Visual Basic. An academic minor is offered in Computer Information Systems, with three separate course tracks available. In addition to ISYS 202 and 204, HVAC 415 is required as entry into either of the three tracks.

HVACR TECHNOLOGY
ASSOCIATE IN APPLIED SCIENCE DEGREE
FALL SEMESTER
Curriculum Guide Sheet

NAME OF STUDENT ______________________ STUDENT I.D. ____________

Total semester hours required for graduation: 67/ 68

NOTE: Meeting the requirements for graduation indicated on this sheet is the responsibility of the student. Compliance with this agreement will assure the student completion of the program in the time frame indicated. Your advisor is available to assist you.

FIRST YEAR - FALL SEMESTER			CREDITS	COMMENTS/GRADE	
HVAC	101	Introduction to Refrigeration & A/C Systems	4		
EEET	115	HVACR Electronics	3		
MATH	116	Intermediate Algebra and Trigonometry OR	4		
MATH	115	Intermediate Algebra (USE IN AAS ONLY)	3		
ENGL	150	English 1	3		
ISYS	105	Microcomputer Applications	3		
FIRST YEAR - WINTER SEMESTER					
HVAC	102	Thermodynamics of Refrigeration (HVAC 101)	4		
HVAC	117	A.C. Electrical Applications (EEET 115)	5		
HVAC	132	Fundamentals of Heating and Mechanical Systems	3		
____	___	Scientific Understanding Elective **	3/4		
SECOND YEAR - FALL SEMESTER					
HVAC	207	Commercial Refrigeration Systems (HVAC 102/117)	5		
HVAC	245	Design of HVAC Systems (MATH 115 or 116)	5		
HVAC	235	Hydronic Residential Oil Heating (HVAC 117 & 132)	5		
ENGL	211	Industrial and Career Writing	3		
SECOND YEAR - WINTER SEMESTER					
HVAC	208	Air Conditioning Applications (HVAC 117)	5		
HVAC	234	Residential Gas Heating (HVAC 117)	3		
____	___	Social Awareness (Race/Eth/Gen)*	3		
____	___	Cultural Enrichment*	3		
COMM	121	Fundamentals of Public Speaking	3		

OPTIONAL COURSES & DIRECT ELECTIVES

HVAC	100	Survey of HVACR	1
HVAC	225	Ductwork	1
HVAC	290	Special Topics	
HVAC	297	Special Studies	

NOTE: MATH 115 - Intermediate Algebra may be used in the Associate Degree only. Those students laddering into the Bachelor Degree program *must* take MATH 116.

*If planning to pursue the baccalaureate degree in HVACR Engineering Technology, from among the Cultural Enrichment and Social Awareness coursework, at least one global consciousness course should be taken.
** Course must inlude a laboratory section.

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CURRICULUM REQUIREMENTS
HVACR TECHNOLOGY
ASSOCIATE IN APPLIED SCIENCE DEGREE
FALL SEMESTER

TECHNICAL			CREDIT HOURS
HVAC	101	Intro. to Refrig. & A/C Systems	4
HVAC	102	Thermodynamics of Refrigeration	4
HVAC	117	A.C. Electrical Applications	5
HVAC	132	Fund. of Heating & Mech. Systems	3
HVAC	207	Commercial Refrigeration Systems	5
HVAC	208	Air Conditioning Applications	5
HVAC	234	Residential Gas Heating	3
HVAC	235	Hydronic Residential Oil Heating	5
HVAC	245	Design of HVAC Systems	5
Technical Related			
EEET	115	HVACR Electronics	3
ISYS	105	Microcomputer Applications	3

GENERAL EDUCATION			CREDIT HOURS
Communication Competence			
ENGL	150	English 1	3
ENGL	211	Industrial and Career Writing	3
COMM	121	Fundamentals of Public Speaking	3
Scientific Understanding			
Elective			3/4
Quantitative Skills			
MATH	116	Intermediate Algebra/Trigonometry	4
MATH	115	Intermediate Algebra (AAS Only)	3
Cultural Enrichment			
Elective			3
Social Awareness			
Elective			3

A.A.S. Degree Minimum General Education Requirements in Semester Hours:

Cultural Enrichment Credits - 3
Commuunications Credits - 6
Social Awareness Credits - 3
Understanding Scientific Credits - 3/4

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
ELECTRICAL/ELECTRONICS DEPARTMETN

COURSE OUTLINE

Course: EEET 115
Date: Fall 1994
Department Approval:

COURSE TITLE: Electronic Technology for HVACR

CREDITS: 3 Credit (2+3)

INSTRUCTOR: G. Kebler, Professor, J-H 209, x2366

TEXTBOOK: Basic Electronics, 7th Edition, Bernard Grob; McGraw/Hill

DESCRIPTION: A course for HVACR majors that introduces students to DC Basics of voltage, current, resistance, and power. Capacitors, RC timing circuits, AC basics, and magnetism are detailed. The use of inductors and capacitors in AC circuits is also introduced.

GENERAL OBJECTIVE:

1. Know theory of Atom
2. Know basics of powers of 10 and basic math
3. Know definition of current, voltage, resistance, power, and energy
4. Know how to apply Ohm's Law and Kirchoff's Law to series and parallel circuits
5. Know basics of magnetism
6. Know definition of frequency and period
7. Know definition of RMS, peak, and average
8. Know basics of capacitors and inductors
9. Know how RC timing circuits operate
10. Know how to apply Ohm's and Kirchoff's Law to AC circuits
11. Know how inductors and capacitors affect AC circuits

PERFORMANCE OBJECTIVES:

1. Be able to design and construct DC series circuits given the proper devices
2. Be able to design and construct DC parallel circuits given the proper devices
3. Be able to measure voltages and currents according to Ohm's Law and Kirchoff's Law using a digital and analog multimeters
4. Design and build voltage divider circuits
5. Be able to calculate, design, and manipulate the characteristics of RC timing circuits
6. Be able to calculate the power for AC, RL, and RC circuits
7. Design, build, and measure the characteristics of RL and RC AC circuits
8. Be able to use a scope to measure period, frequency and voltage of an AC ware

ATTENDANCE: Students are expected to be present at every lecture or lab. Make-up exams will be given only for documented excused absences. Missed homework and quizzes will not be accepted late.

GRADING: In accordance with established F.S.U. policy. See handout for further details.

ASSIGNMENTS: Each assignment is to be prepared prior to class. Assignments will be collected as notified by instructor.

READING AND HOMEWORK ASSIGNMENTS:

(This is a tentative schedule)

PERIOD TOPICS	TEXT PAGES	HOMEWORK
1. Course goals, attendance, grading, safety rules, the atom	1-17	
2. Charge, voltage and resistance	18-36	6, 7, 8
3. Current and resistance	41-54	1-11
4. Ohm's Law	60-68	odd 1-17
5. Power	69-74	
6. Series circuits, current	82-90	odd 1-9
7. Power in series circuits	91-96	odd 11-17
8. Kirchoff's Law, review for test	198-200	handout
9. TEST #1, Chapter 1 thur 4		
10. Parallel circuits	102-113	all 1-7
11. Parallel circuits and review TEST	114-119	8, 10-15
12. Series-parallel circuits	124-131	all 1-7
13. Analyzing circuits and bridge	132-135	all 8-12
14. Grounding	136-141	all 13-16
15. Voltage dividers	148-155	1, 3, 10
16. Bridge circuits and meter loading	156-160	Handout
17. TEST #2 Chapters 5 thru 9	172-179	
18. Capacitance	472-482	1-4
19. Series and parallel	483-492	7, 10, 12
20. RC timing circuits	533-544	2-5
21. Charging curves	545-555	odd 7-15
22. Magnetism	306-320	TBA
23. TEST #3		
24. Electromagnetic induction	340-354	1-6
25. AC basics	358-378	1,2, 4, 5, 6, 8, 9
26. AC basics continued	379-391	10-18
27. AC inductance	400-426	1, 5, 6, 9 and Handout
28. AC capacitance	472-485-	TBA and Handouts
29. RL and RC circuits	431-435, 500-510	TBA and Handouts

FINAL EXAM DURING EXAM WEEK

LABORATORY: A report is required with each lab assignment. All reports will be due one week after the lab is performed unless notified by the instructor. Late labs may be penalized. Lab report format will be the instructor's.

PERIOD **TOPICS**

1. Lab procedures, care of equipment, format, digital and analog meters, color code
2. Voltage, current, resistance, Ohm's Law
3. Series circuits and Kirchoff's Law
4. Parallel circuits
5. Parallel circuits and Kirchoff's laws
6. Series/parallel circuits
7. Voltage divider circuits
8. Capacitors
9. RC timing circuits
10. Magnetic principals
11. AC basics and scope
12. AC measurements
13. AC RC circuits
14. AC RL circuits
15. Power factor

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 100
Date: December 1991
Dept **Approval**

COURSE TITLE: Survey of HVACR

COURSE DESCRIPTION: An orientation and survey of the $150 billion dollar industry of HVACR (heating, ventilating, air conditioning & refrigeration). Topics included with this class will include energy, heating & air conditioning equipment, thermal heat properties, heat gains and losses, food preservation, the refrigeration cycle and general requirements for human comfort in buildings.

Semester Hours: 1

Contact Hours: Lecture: 1 hour/week

Textbook Required: Handouts

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

			TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction and Orientation		1	0
II.	History of Refrigeration		1	0
III.	Energy Sources and Units		1	0
IV.	Heat Gain and Loss		1	0
V.	Food Preservation		1	0
VI.	The Refrigeration Cycle		1	0
VII.	Heating Sources Cycle and Equipment		1	0
VIII.	A/C and Heating Unitary Equipment		1	0
IX.	A/C and Heating Central Station Equipment		1	0
X.	Ventilation Air for Buildings		1	0
XI.	Human Comfort		1	0
XII.	HVAC Control		1	0
XIII.	Cogeneration Systems		1	0
XIV.	Thermal Storage and Heat Recovery		1	0
XV.	Conclusion and Evaluation		1	0
	Total	15	15	0

Course Objectives:

1. Given instruction and historical overview of food preservation and human comfort examples. The student will demonstrate a knowledge of pre-mechanical processes and modern practices relative to human comfort, food preservation and general quality of life.

2. Given handouts and instruction of energy sources and units the student will demonstrate a knowledge of energy and perform basic calculations relative to energy conversions and values.

3. Given building examples and building materials, instruction on unitary and central station equipment, the student will demonstrate a knowledge of heat transmission, sizing and selection of equipment for buildings.

4. Given handouts and instruction on fundamental components of a mechanical refrigeration system, laws of physics and thermodynamics, the student will demonstrate a knowledge of the refrigeration cycle.

5. Given handouts and instruction on heating sources, comfort and proper control the student will demonstrate a working knowledge of control loops, equipment operation and total comfort.

6. Given instruction and handouts on cogeneration systems thermal storage and heat recovery, the student will explain the process, benefits and application of each.

ATTENDANCE POLICY: You are expected to be in attendance. See your instructor if an emergency arises for an excused absence.

94-100=A	90-93=A-	87-89=B+	84-86=B	81-83=B-	78-80=C+
75-77=C	73-74=C-	71-72=D+	69-70=D	67-68=D-	66 and BELOW =F

Final Grade Based on: Three each written, technical reports from trade magazines that are HVACR related. Typed, one page minimum, two pages maximum, last paragraph is to be your view or "synopsis" of the article. Did you agree or disagree and why.

Technical Report's Due Date: September 29, 1993
November 3, 1993
December 8, 1993

There will be no final exam in this class.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 101
Date: August 1991
Dept: **Approval**

COURSE TITLE: Introduction to Refrigeration and Air Conditioning Systems.

COURSE DESCRIPTION: An Introductory course covering the physical and chemical laws governing the principles of refrigeration. The basic refrigeration cycle and components will be covered. Applications (3 hours/week) will include alternate refrigerants, transferring and system reprocessing, flaring, soldering and brazing techniques of copper tubing.

Semester Hours: 4

Contact Hours: Lecture 3 hour/week
Laboratory 3 hours/week

Prerequisites: None

Textbook Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson,
Delmar Publishers, Inc. ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND LEARNING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Introduction, Orientation, and Safety	1	1
II.	History and Development of Refrigeration	3	0
III.	Heat and Matter	3	0
IV.	Temperature/Degree	3	1
V.	Pressures	3	1
VI.	Refrigeration System	4	3
VII.	Refrigerants	3	1
VIII.	Use of and Transfer of Refrigerant to Charging Cylinders	1	3
IX.	Reprocessing Procedures, Cap Tube Systems	4	3
X.	Brazing and Silver Soldering	4	6
XI.	System Components and Application	6	9
XII.	Copper Systems	6	9

XIII.	Food Preservation and Spoilage Agents Along with Related Mechanical and Electrical Sequencing		4	8
		Total	45	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction, Orientation, and Safety

A. Course goals, grading and attendance policy
B. Program structure and policy
   1. Curriculum check sheets
   2. Crib
   3. Safety
   4. Safety Glasses

II. History and Development of Refrigeration

A. First developments
B. Economic drive

III. Heat And Matter

A. Molecular motion
B. Heat transfer
C. BTU – quantity
D. Sensible/latent heat
E. Work and energy

IV. Temperature Degree

A. Measurement
B. Absolute
C. Scales
D. Conversion

V. Pressures

A. Atmospheric
B. Absolute
C. Gauge
D. Gauge installation
   1. Schrader valve
   2. Three-way valves

VI. Refrigeration System

A. Components
   1. High and low side
B. Refrigerant cycle
C. Refrigerant state

1. Saturation points
2. Sub cooling
3. Superheating

VII. Refrigerants

A. Molecular structure
B. Types and properties
C. Saturation point
   1. Temp/press relationship
D. Applications

VIII. Use of and Transfer of Refrigerant to Charging Cylinders

A. Refrigerant safety precaution and procedures for safe handling of storage cylinders
B. Pressure differential due to ambient conditions (i.e., saturated vapor pressure)
C. Cylinder charging valve construction and use of liquid and vapor valves
D. Units of weight graduation according to ambient temperatures
E. Venting of charging cylinders while admitting liquid charge
F. Application of charging cylinders as a tool
G. Precautions to prevent damage to the cylinder

IX. Reprocessing Procedures, Cap Tube Systems

A. Use of system tapping devices
   1. Tool Kits
   2. Schraeder valves
   3. Tap valves; packaged
B. Application and use of ammeter
   1. Determination of full load amps
   2. Importance of maintaining a safe ampere draw level through varying conditions of load and charge
   3. Cautions when assuming full load ampere level (motor application)
   4. Use of ammeter accessories
C. Installation and use of gauges
   1. Purging hoses prior to installation of system access fitting, through the manifold set
   2. Gauge construction and calibration
   3. Relationship of pressure to saturated temperature from the instrument dial
D. Establishing recommended factory charge
   1. Reading name plate data
   2. Review factory charging and testing procedures in the laboratory
   3. Processing, using the dial-a-charge
   4. Relationship of saturated vapor point in evaporator
   5. System pressure equalization prior to start up
   6. Precaution of preventing liquid admission to low side when a rotary pump is employed

X. Brazing and Silver Soldering

A. Tools
   1. Hand "Bernzamatic" torch
   2. Air-acetylene (presto-lite)
   3. "Turbo-Torch"
   4. Oxy-acetylene torch

B. Gasses and safety of each
   1. LP
   2. Acetylene
   3. MAPP

C. Alloys-contents and uses of each
   1. Solders - 50/50, 60/40, 95/5
   2. Brazing alloys - "Silfos," silver-solder

XI. System Components and Application

A. Overview of components in a built-up system employing a remote air cooled condensing unit

B. Developing a complete material list of need based upon a sketch

C. Determining a sequence for installation of all components and electrical control

XII. Copper Systems

A. Fitting types (wrought and flare)
   1. Flare
      a. Ells, tees, unions, adapters
      b. Sizes

B. Tools
   1. Soft copper
      a. Cutter, flaring block, bending mandrel

C. Measurement and cutting techniques
   1. Soft tubing
      a. Subtract for take-up
      b. Proper reaming procedure
      c. Bending procedures
   2. Hard copper
      a. Center-to-center measurement

XIII. Food Preservation and Spoilage Agents

A. Deterioration and spoilage
   1. Enzymes
   2. Microorganisms-molds, yeast, and bacteria

B. Control of spoilage
   1. Pickling
   2. Boiling-canning
   3. Drying
   4. Smoking

5. Refrigeration
C. Food groups of preservation and storage
   1. Living
   2. Non-living
D. Storage terms and procedures
   1. Short term
   2. Long term
   3. Frozen storage

E. Electrical and mechanical sequencing
   1. Electrical and mechanical logic
   2. Pictorial diagramming
   3. Across the line diagramming

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given basic refrigeration system, text illustration of compressor, the student will sketch the compressor in sequence with other system components showing piston and cylinder arrangement, suction and discharge routing and refrigerant path.

2. Given text illustration, the student will relate to heat transfer, saturation, subcooling, superheating in a system and where they occur. The student will further relate these principles to refrigerant system components including the evaporator, condenser, compressor, metering device and inter-connecting tubing.

3. Given a refrigeration system, the student will identify each component and explain the function of each component as to the total system. Explain the function of each component as to the total system. Explain and show saturation points, subcooled, and superheated conditions.

4. Given text materials, the student will be able to explain the chemical composition of typical refrigerants, their pressure temperature relationship, specific volume and enthalpy characteristics with application to thermodynamic tables.

5. Given problems, the student will demonstrate conversion skills of Celsius to Fahrenheit and convert each to Rankin and Kelvin.

6. Given the first and second laws of thermodynamics, the student will relate each to heat energy and transfer of heat through mechanical refrigeration.

7. Given instruction/demonstration, forged brass and wrought copper fittings, industry manuals and work sheets, the student will identify by name and size standard refrigeration fittings utilized on domestic refrigeration and air conditioning; and small commercial refrigeration systems.

8. Given instruction/demonstration, handouts, copper refrigeration fittings, tube working tools, acetylene torches, flutes, soldering alloys (and lab practice), the student will demonstrate soldering, brazing and tube working skills.

9. Given a set of oxygen and acetylene tanks, oxygen and acetylene regulators and connecting hoses, torch handle, various sizes of torch tips, instructions on the use and safety precautions on oxyacetylene equipment, the student will be able to ignite the torch and adjust the flame to the proper type of flame and the proper heat to solder, braze, or weld the pipe project so it will be gas or liquid tight.

10. Given instruction and handouts the student will demonstrate an understanding of food retardation relative to refrigeration and other non-cooling methods.

11. Given electrical and mechanical components found in basic refrigeration systems, the student will demonstrate an understanding of "Sequence of Operation."

Grading Policy

Grade	HP	Grade
100-94	4	A
93-90	3.7	A-
89-87	3.3	B+
86-84	3.0	B
83-81	2.7	B-
80-78	2.3	C+
77-75	2.0	C
74-73	1.7	C-
72-71	1.3	D+
70-69	1.0	D
68-67	0.7	D-
66-BELOW	0.0	F

Five tests and Quizzes	66 percent
Lab and Homework	34 percent

Note: It's expected that each student will take full advantage of the program facilities. Absences will only hinder a student's technical development within the program. Because of this daily attendance required. Leaving the lecture or lab area before class has been dismissed will count as an unexcused absence and will effect a person's grade.

Each unexcused absence will take a total of two percentage points (2 percent) off of a person's final percentage score. Any time you are absent, some written documentation must be presented to the instructor the following class period or it will be considered an unexcused absence. All absences will be considered unexcused until the instructor receives some legal documentation explaining the whereabouts of the student on that missed day.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 102
Date:	June 1991
Dept.	**Approval**

COURSE TITLE: Thermodynamic of Refrigeration

COURSE DESCRIPTION: A continuation of the basic refrigeration cycle and application of the Mollier diagram and thermodynamics. Emphasis on instrumentation and testing of system, balance, with proper operating capillary tube and TVX systems, and mechanical system troubleshooting. Problem solving will be covered.

Semester Hours: 4

Contact Hours
Lecture 3 hours/week
Laboratory 3 hours/week

Prerequisite: HVAC 101

Textbook Required: Principles of Refrigeration, 3rd Edition, Dossat

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	Lab. Hrs.
I.	Thermodynamic Laws	2	2
II.	Application of Pressure-Heat Diagram (Mollier) into the use of the thermodynamic tables	8	15
III.	Information from Manufactures Data Plates	1	1
IV.	Theoretical and actual refrigeration capacities with power requirements	8	2
V.	Pressure drop due to frictional line loss in low side of system	2	1
VI.	Vacuum pumps and recovery equipment	2	3
VII.	Leak checking, dehydration and recommended charging and startup procedures for an air cooled open-type machine employing a thermostatic expansion valve and forced air evaporator	3	3
VIII.	Field charging procedure	2	3
IX.	Automated metering devices	5	3
X.	Mechanical System Trouble-Shooting	4	5
XI.	Compressor construction and lubrication	5	6
XII.	Determination, cause and cleanup of burn out	3	1
	Total	45	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. **Thermodynamic Laws**
   A. First law of thermodynamics
   B. Second law of thermodynamics

II. **Application of Pressure-Heat Diagram (Mollier) into the use of the Thermodynamic tables**
   A. Use of test data
   B. Relationship to a plotted chart
   C. Comparison of chart to tables
   D. Use of table data to form analysis
   E. Use of analysis to form conclusions

III. **Information From Manufactures Data Plates**
   A. Dissemination of nameplate data to:
      1. Running specifications
      2. Electrical specification
      3. Mechanical abilities
      4. Warranty information

IV. **Theoretical and Actual Refrigeration Capacities with Power Requirements**
   A. An introduction to the formula necessary to prove changes in capacity due to fluctuating operating conditions
   B. Introduction to the formula necessary to prove changes in required power to satisfy requirements of capacity
   C. In-depth study of the compression process and performance of reciprocating compressions

V. **Pressure Drop Due to Frictional Line Loss in Low Side of System**
   A. Effects on capacity and required power due to pressure drops
   B. Effect on system performance due to changes in compression ratio
   C. High side and subcooling required

VI. **Vacuum Pumps & Recover Equipment**
   A. Variation of designs and efficiencies
   B. Lubricating oil and maintenance of pumps
   C. Importance of hermetic system with no leaks prior to evacuation
      1. Required vacuum under various ambients to attain dehydration
      2. Required hoses due to permeation and hose length
      3. Use of heat sources to aid dehydration
   D. Purpose for "blotting" if used and a holding charge if necessary

VII. **Leak Checking, Dehydration and Recommended Charging and Startup Procedures for an Air Cooled Open Type Machine Employing a Thermostatic Expansion Valve and Forced Air Evaporator**
   A. Review of through leak check method
   B. Review of dehydration

C. Startup checkout list and review of service valve positions
D. Installation of all test equipment and review of calibration for accuracy

VIII. Field Charging Procedure

A. "King" valve location and purpose
B. Use of partable charging cylinders
C. Safety precautions in transport
D. Pump down procedure employing King valve
E. Charging liquid into high side
F. Review of TXV operating range according to evaporator temperature

IX. Automated Metering Devices

A. Thermostatic expansion valve-construction and operation
  1. Liquid, crossed and gas charged elements
  2. Externally and internally equalized
  3. Externally and internally adjustable
  4. Election of valves
B. Automatic expansion valve
  1. Application and operation
  2. Adjustment method
  3. Safety precautions (low limit thermostat and back-pressure setting)
C. High and low side floats
  1. Function and construction of each
  2. Application
D. Over view of TXV's
  1. Liquid charged, gas charged, crossed charged
  2. External/internally equalized types
  3. Superheat adjustment ranges

X. Mechanical System Trouble-Shooting

A. Lab sheets
  1. Performance data
  2. Point-check system sheets
B. Cap tube systems
  1. System analysis of restrictions, improper charge, inefficient comp.
  2. System analysis of improper air flows
C. TXV systems
  1. System analysis of restrictions, improper charge (sight glass), compressor efficiency
  2. System analysis of improper air flows
D. Develop methods of trouble-shooting
  1. Symptoms
  2. Possible causes
  3. Problem correction

XI. Compressor Construction and Lubrication

A. Splash lubrication, scoop
  1. Importance of proper rotation

   2. Oil level requirements
   3. Oil check valve application and purpose

B. Forced-feed, oil pump
   1. Pump location and construction
   2. Galleries and internal oil lines
   3. Determining oil pressure

C. Compressor shaft seals; open compressors
   1. Rotary bellows
   2. Stationary bellows
   3. Packing gland
   4. Diaphragm

D. Determining SSV rating and application of oils
   1. Viscosity, floc-point, cloud point, pour-point
   2. Servicing compressor; checking oil level and adding oil

E. Compressor valves plates
   1. Types of valves employed
   2. Method of servicing and precautions
   3. Determining of a faulty valve plate
   4. Causes of valve failure

F. Disassembling a compressor
   1. Care exercised and method
   2. Reference to manufacturer's illustrations and specs
   3. Care in cleanliness and the use of oil
   4. Use of a troque wrench
   5. Compressor relief valves

G. Compressor capacity relative to demand of the system

H. Compressor drives, v-belts
   1. V-belt construction, sizing, application
   2. Pulley alignment
   3. Belt tensioning specs
   4. Determination of driven speed by ratio
   5. Application to piston displacement

I. Compressor drives, solid couplers
   1 Introduction to dial indicators
   2 Construction features
   3 Installation
   4 Alignment, using dial indicators applied to manufacturers specifications

XII. Determination, Cause and Cleanup of Burnout

A. Use of the Megger to determine winding condition
B. Testing oils for acids
C. System cleanup procedure after burnout
D. Cause and prevention of compressor burnout

SPECIFICATIONS AND PERFORMANCE TESTING

1. Given a unit exposed to varying operating conditions, the student will calculate the compression ratio, suction line pressure drop and determine its effects upon the system, performance, IE, volumetric efficiency—discharge temperatures, etc.

2. Given manufacturer nameplate specs, data sheet and instruction the student will identify model no., name plate, specs—electrical RSIR-CSIR, voltage application, RLA, LRA, refrigerant, and temp. application, and capacity.

3. Given ARI test standards, refrigerant thermodynamic tables, operating data sheet, instruction, the student will determine theoretical compressor capacity in Btu/Min-hr., relationship of system to thermodynamic principles, pressures, temperatures, saturation, subcooling, superheating, and dome temperatures.

4. Given instruction relating to: Thermodynamic tables, domestic refrigeration system, "run" and "off" cycles, electronic temperature tester, lab assignment sheets, the student will test operate system; record pressure and temperature patterns, and record temp. curves with different materials.

5. Given thermocouples and lecture the student will explain the operation, advantages and use of, and record temperature of operating unit.

6. Given test data from an operating system and plotted Mollier diagram, the student will use the thermo-dynamic tables to prove the accuracy of the plot.

7. Given his own operating system, the student will plot Mollier diagrams under varying conditions and determine theoretical actual refrigerating capacities, and required power requirements.

8. Given a text, reference literature and an operating refrigeration unit, the student will test, operate, adjust and analyze a system using a capillary tube.

9. Given units, the student will use operating data to achieve a critically charged domestic cap-tube metered system, employing criteria specified.

10. Given a microcomputer, appropriate software, and test data the student will apply pressure/enthalpy diagrams (graphics) to actual system operating conditions.

11. Given instruction and instrumentation, the student will determine that a system is leak proof.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 117
Date:	June 91
Dept.	**Approval**

COURSE TITLE: AC Electrical Applications

COURSE DESCRIPTION: AC electrical fundamentals, concentrating on the operation, installation and analysis of HVACR components and control circuits. The components include single and polyphase transformer and motors, heating and air conditioning controls, commercial timers, motor starters, contractors, relays and other controlling devices. Lab exercises focus on developing wiring diagrams; wiring and analyzing circuits based on lecture material.

Credit Hours: 5

Semester Hours: Lecture 4 hours / week
Laboratory 3 hours / week

Prerequisites: EEET 115

Textbooks Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson, Delmar Publishers ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Introduction and AC Power	4	6
II.	AC Capacitors	4	3
III.	Single Phase Transformers	4	3
IV.	Three Phase Transformers	3	3
V.	Single Phase Motor Characteristics	6	3
VI.	Hermetic Starting Relays	3	3
VII.	Three Phase Motors	3	0
VIII.	Motor Starters	4	3
IX.	Wiring Diagrams	6	6
X.	Low Voltage Thermostats	4	3

XI.	Defrost Timers	3	3
XII.	Conductor Sizing and Overcurrent Protection	3	3
XIII.	Measuring Devices	4	3
XIV.	Modulating Control Loops	5	3
	Tests	4	
	Total	**60**	**45**

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction and Review of AC

A. Production of the sine wave
B. Calculation of peak, RMS and average voltage
C. Frequency, period
D. Calculation of the instantaneous voltage
E. Solving AC circuit problems

II. AC Capacitor Applications

A. AC run and start capacitors
B. Purpose in a circuit
C. Capacitive reactance, and impedance
D. Relationship between Xc and frequency
E. Phase shift between V and I
F. Power factor

III. Single Phase Transformers

A. Construction
B. Operation
C. Turns ratio and other relationships
D. Troubleshooting

IV. Three Phase Transformers

A. Construction
B. Operation
C. Turns ratio and other relationships
D. Wiring Y and delta
E. Troubleshooting

V. Single Phase Motor Characteristics

A. Operation
B. Cemf/current draw relationship
C. Motor types
D. Power factor
E. Troubleshooting

VI. **Hermetic Starting Relays**

A. Current
B. Potential
C. Solid state
D. Electrical motor circuit schematics

VII. **Three Phase Motors**

A. Operation
B. Cemf/current draw relationship
C. Motor types Y, delta
D. Dual voltage wiring and schematics
E. Wye - delta start
F. Troubleshooting

VIII. **Motor Starters**

A. Construction
B. Operation
C. Sizing of overload heaters
D. Auxiliary contact application
E. Schematics
F. Troubleshooting

IX. **Wiring Diagrams**

A. Types, pictorial, schematic, and ATL
B. Point to point conversion
C. Troubleshooting with voltmeter and diagrams
D. Troubleshooting with solid state

X. **Low Voltage Thermostats**

A. Types, mechanical and solid state
B. Zone dynamics, 2-position and anticipators
C. Operation
D. Wiring applications, schematics
E. I/O troubleshooting

XI. **Defrost Timers**

A. Construction
B. Operation of different types including solid state
C. Schematic wiring into circuit
D. Troubleshooting

XII. **Conductor Sizing and Overcurrent Protection**

A. Current flow and heat production
B. Wire sizing formula
C. National electric code
D. Circuit breakers and fuses

E. Conduit sizing information

XIII. Measuring Devices

A. Thermistors
B. RTD's
C. Humidity sensors
D. Static pressure sensors

XIV. Modulating Control Loops

A. Basic control terminology
B. Temperature loop
C. Economizer applications

ELECTRICITY COURSE OBJECTIVES

1. Given lecture, lab, homework and reading assignments, the student will demonstrate knowledge of Ohms and Kirchoff's Laws by correctly solving for unknown load and circuit characteristics (V, I, R, & P) in lab exercises, homework assignments and tests.

2. Given lecture, homework and reading assignments, the student will be able to accurately explain how AC electricity is generated in a magnetic field through magnetic induction and graph the sine curve.

3. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the characteristics of frequency, peak voltage, RMS voltage, period, peak to peak voltage, effective voltage, single phase, three phase, inductance, capacitance and impedance of an AC circuit and solve for any of the above in lab exercises, homework assignments and test questions.

4. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the characteristics of AC run and start capacitors with respect to: construction, operating and troubleshooting characteristics, phase shifts and series, parallel and combination circuits in lab exercises, homework assignments and test questions.

5. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the characteristics of AC power factor, solve for the power factor angle, apparent power, true power and explain the cause and correction of a poor power factor.

6. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the characteristics of AC inductor with respect to: construction, operating and troubleshooting characteristics, CEMF and resulting phase shifts.

7. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the characteristics of AC transformers with respect to: types, construction, operating and troubleshooting characteristics; and solve for turns ratio, primary and secondary operating voltages, currents, etc. in lab exercises, homework assignments and test questions.

8. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the starting, running and other operating characteristics along with troubleshooting AC induction motors; CSIR, CSCR, SP, PSC, synchronous, shaded pole and universal, open and hermetic.

9. Given reading assignments, lecture, homework and lab exercises, the student will be able to draw the schematic diagram of the AC induction motors; CSIR, CSCR, SP, PSC, synchronous, shaded pole and universal.

10. Given reading assignments, lecture, homework and lab exercises, the student will be able to define the starting, running and other operating characteristics of AC induction motor starting relays; current, potential, solid state and centrifugal switches.

11. Given reading assignments, lecture, homework and lab exercises, the student will be able to draw the schematic diagram of the AC induction motor starting relays and switches.

12. Given reading assignments, handouts, lecture notes and lab exercises, the student will demonstrate his ability to develop pictorial wiring diagrams, component schematics and ladder diagrams of various HVACR equipment using the correct symbols, labels, legends and methodology.

13. Given lecture notes, handouts, reading assignments and lab exercises, the student will demonstrate the ability to wire circuits from a wiring diagram.

14. Given ladder diagram assignments sheets with open and short circuits, the student will demonstrate his ability to correctly troubleshoot the circuit using his knowledge of electricity and a V-O-A meter.

15. Given reading assignments, handouts, lab exercises and lecture notes, the student will demonstrate his ability, determine the wiring configuration of a three-phase power supply. The student will also demonstrate through wiring exercises that he can correctly wire various single and three phase loads to a three-phase network.

16. Given a dual voltage three phase motor, the student will demonstrate a knowledge of wiring configurations by properly wiring handout figures of dual voltage motors and wiring the motor in the lab.

17. Given reading assignments, lecture notes and lab exercises, the student will demonstrate his knowledge of the construction, operation and wiring of both the line and control circuits of a three phase motor starter.

18. Given handouts and lecture notes, the student will prove an understanding of the purpose, operation and application of Wye-Delta starting schemes.

19. Given lecture notes, lab exercises, reading assignments and handouts, the student will demonstrate knowledge of heat/cool thermostat circuits by correctly developing a schematic of the thermostat and subbase and incorporating them into a ladder diagram of a heating/cooling unit.

20. The student will demonstrate the ability to use a ladder diagram to mount, wire and calibrate a thermostat and subbase and hard wire it to various components in the lab.

21. Given a drawing of various heating system components, the student will wire the system correctly and convert the pictorial into a ladder diagram.

22. Given lecture notes, reading assignments, handouts and lab exercises, the student will demonstrate knowledge of the operation, application, system operation and wiring configuration of commercial defrost timers and their related controls.

23. Given lecture notes, NEC handouts, reading assignments and lab assignments, the student will demonstrate the ability to properly size wire and describe the problems associated with improperly sized and misapplied conductors.

24. Given reading assignments, handouts, lab exercises and lecture notes, the student will demonstrate his ability to convert between pictorial wiring diagrams and ladder diagrams using the correct symbol diagrams and schematics representations.

25. Given reading assignments, handouts, lab exercises and lecture notes, the student will demonstrate his ability to use a wiring diagram to construct a circuit and develop a description of operation for the circuit.

26. Given lecture notes and reading assignments, the student will demonstrate a knowledge of the proper procedure for troubleshooting solid state control boards by accurately answering homework and test questions.

MINIMUM REQUIRED STUDENT ACTIVITIES DEFINED:

1. Given lecture, labs 1 and 2, homework and reading assignments, the student will demonstrate knowledge of Ohms and Kirchoff's Law by correctly solving for unknown load and circuit characteristics (V, I, R & P.) (Unit 1)

2. Given lecture, homework and reading assignments, the student will be able to accurately explain how AC electricity is generated through magnetic induction and be able to define the characteristics of the AC voltage source. (Unit 1)

3. Given reading assignments, lecture, homework and lab 3, the student will be able to define the characteristics of AC run and start capacitors with respect to: construction, operation, troubleshooting, phase shifts, series, parallel and combination circuits. (Unit 2)

4. Given reading assignments, lecture, homework and lab 3, the student will be able to define the characteristics of AC power factor, solve for the power factor angle, apparent power, and true power and explain the cause and correction of a poor power factor. (Unit 2)

5. Given reading assignments, lecture, and homework assignments, the student will be able to define the characteristics of AC inductor with respect to: construction, operating and troubleshooting characteristics, CEMF and resulting phase shifts.

6. Given reading assignments, lecture, homework and labs 4 & 5, the student will be able to define the characteristics of AC transformers with respect to: types, construction, operating and trouble-shooting characteristics; and solve for turns ratio, primary and secondary operating voltages, currents, etc. (Units 3 & 4)

7. Given reading assignments, handouts and lecture notes, the student will demonstrate his ability to determine the wiring configuration of a three phase power supply and demonstrate through wiring exercises the proper wiring connections of various single and three phase loads to a three phase network. (Unit 4)

8. Given reading assignments, lecture, homework and lab 6, the student will be able to define the starting, running and other operating characteristics along with troubleshooting AC induction motors; CSIR, CSCR, SP, PSC, synchronous, shaded pole and universal, open and hermetic. (Unit 5)

9. Given reading assignments, lecture, and homework assignments, the student will be able to draw the schematic diagram for AC induction motors; CSIR, CSCR, SP, PSC, synchronous, shaded pole and universal. (Units 5, 6 & 9)

10. Given reading assignments, lecture, homework and lab 7, the student will be able to define the starting, running and other operating characteristics of AC induction motor starting relays; current, potential, solid state and centrifugal switches. (Unit 6)

11. Given a dual voltage three phase motor, the student will demonstrate a knowledge of wiring configurations by properly wiring handout figures of dual voltage motors and wiring the motor in the lab. (Unit 7)

12. Given reading assignments and lecture notes and lab 8, the student will demonstrate his knowledge of the construction, operation and wiring of both the line and control circuits of a three phase motor starter. (Unit 8)

13. Given handouts and lecture notes, the student will prove an understanding of the purpose, operation and application of Wye-Delta starting schemes. (Unit 8)

14. Given reading assignments, handouts, lecture notes and labs 9 & 10, the student will demonstrate his ability to develop pictorial wiring diagrams, component schematics and ladder diagrams of various HVACR equipment using the correct symbols, labels, legends and methodology. (Unit 9)

15. Given lecture notes, handouts, reading assignments and lab exercises, the student will demonstrate the ability to wire circuits from a wiring diagram. (Units 9, 10 & 11)

16. Given ladder diagram assignments sheets with open and short circuits, the student will demonstrate his ability to correctly troubleshoot the circuit using his knowledge of electricity and a V-O-A meter.

17. Given lecture notes, lab 11, reading assignments and handouts, the student will demonstrate knowledge of heat/cool thermostat circuits by correctly developing a schematic of the thermostat and subbase and incorporating them into a ladder diagram of a heating/cooling unit. (Unit 10)

18. The student will demonstrate the ability to use a ladder diagram to mount, wire and calibrate a thermostat and subbase and hard wire it to various components in the lab 11. (Unit 10)

19. Given a drawing of various heating system components, the student will wire the system correctly and convert the pictorial into a ladder diagram. (Unit 10)

20. Given lecture notes, reading assignments, handouts and lab 12, the student will demonstrate knowledge of the operation, application, system operation and wiring configuration of commercial defrost timers and their related controls. (Unit 11)

21. Given lecture notes, NEC handouts, reading assignments and lab 13, the student will demonstrate the ability to properly size wire and describe the problems associated with improperly sized and misapplied conductors. (Unit 12)

22. Given lecture notes, reading assignments and lab 14, the student will demonstrate knowledge of the operating characteristics and circuits using solid state transducers in HVAC applications. (Unit 13)

23. Given lecture notes and reading assignments, the student will demonstrate a knowledge of the proper procedure for troubleshooting solid state control boards by accurately answering homework and test questions. (Unit 13)

24. Given lecture notes, reading assignments and lab 15, the student will demonstrate knowledge of temperature control loop terminology components and operation. (Unit 14)

Syllabus
HVACR 117
A/C Electrical Applications

The course outline shows the units of instruction, objectives, and the minimum required student activities. You are expected to complete all homework and laboratory assignments on time. Homework assignments will be due at the beginning of the first class period after the homework has been assigned unless otherwise instructed by the instructor. Laboratory assignments and projects will normally be due at the beginning of each laboratory period after the project has been assigned unless otherwise instructed by the instructor.

Homework and laboratory assignments that are not turned in at the due date and on time will have points automatically deducted for lateness, so keep up on your work on a daily basis to prevent losing unnecessary points.

Grading And Grading Scale

Written exams will account for 75% of your final grade, and homework, quizzes and laboratory projects will account for the remaining 25% of your final grade.

94-100=A	90-93=A-	87-89=B+	84-86=B	81-83=B-	78-80=C+
75-77=C	73-74=C-	71-72=D+	69-70=D	67-68=D-	66 and Below=F

Absentee Policy

It is a proven fact that people who do not miss classes usually attain better grades than people who do miss classes, therefore, you are required to attend class every scheduled day.

However, emergencies do arise and missing class becomes a necessity so you will be allowed two absences without any penalty as long as you make up any work missed during your absence. Any days missed after two absences you will receive a zero score on any work that was due or any work that you missed.

If you are absent more than five days during the semester you will be removed from the class and receive an F grade. Showing up late for class three times will equal an absent day.

Safety

It is everyone's responsibility to conduct themselves in a safe manner at all times, so I expect everyone to use good safety practices during the course. These safety practices include:

1. Wearing of safety glasses whenever in the lab.
2. No goofing around with each other inside the lab.
3. Make sure the tools you are using are in good shape and use the right tool for the right job.
4. Observe the layout of the lab and know where the "Quick Kill" buttons are to secure the electrical power going to the workbenches.
5. Remember the color code of the gas and air piping inside the lab.
6. Report any broken or dangerous equipment to the instructor.

Final Examination

The last week of the semester has been designated Examination Week and there is a schedule for administering exams in accordance with which days the classes meet. The schedule indicates that the final examination for this class should be administered on ________________________ from ________________________.

The final examination will not be comprehensive.

HVACR PROGRAM
COURSE OUTLINE

Course: HVAC 132
Date: August, 98
Department Approval:

COURSE TITLE: Fundamentals of Heating and Mechanical Systems

COURSE DESCRIPTION: A study of combustion in conventional and high-efficiency units. Mechanical and building blueprints, symbols, drawing and sketching, and views will be covered. Laboratory work on pipefitting, heating components, system identification, and the analysis of fuel consumption rates and cycles.

Credit Hours: 3

Semester Hours: Lecture 2 hours/week
Lab. 2 hours/week

Prerequisites: None

Textbooks Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson, Delmar Publishers, Inc.
ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

		~~TIME WEIGHT~~	
		Lecture /	Lab. Hrs.
1	Introduction and Orientation	1	0
2	Basics of Combustion Chemistry with Gas Fue	8	4
3	Gas Fired Systems and Components	4	8
5	Threaded Pipe Systems and Fittings	5	6
6	Drawing and Sketching	6	6
7	Blueprint Reading	6	6
	Total	30	30

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction And Orientation

- A. Lab Tour And Rules
- B. Safety
- C. No Horseplay, Tobacco, Or Alcohol
- D. Course Goals, And Requirements

II. Gas Combustion Chemistry

- A. What Is Combustion?
- B. Perfect Combustion
- C. Combustion Of Practical Fuels
  1. Proportioning
  2. Mixing
  3. Ignition
  4. Fuel Heating Values
  5. Flame Temperatures
  6. Flame Speeds
- D. Chemistry Of Fuels and Combustion
- E. Combustion Analysis
  1. Combustion Air Requirements
  2. Products Of Combustion
  3. Flue Gas Analyses
     - a) Percent Carbon Dioxide
     - b) Instruments
- F. Combustion Losses (Efficiency)
- G. Chemistry Of Flames
- H. BTU Content

III. Gas Fired Systems

- A. Components Peculiar To Gas Only
  1. Gas Valve Types
     - a) Solenoid
     - b) Mechanical
     - c) Pilot-Operated
     - d) Combination
  2. Pilot And Proving Devices
     - a) Standing Pilot And Relite
     - b) Thermocouple
     - c) Millivolt System
     - d) Gas-Filled Tube And Relay
     - e) Pilot Switch
     - f) Electronic Flame Rectification
  3. Orifice
     - a) Relative Blower Sizes
     - b) Input/Output Relationship
     - c) Sizing – Orifice Drills

- B. Pressure Regulators
    1. Manifold Pressures
    2. Reading Pressure/Manometers
- C. Fuel Consumption
- D. Combustion Test-Gas

IV. Forced-Air Furnace

- A. Heat Exchangers
- B. Burner Types
    1. Atmospheric
    2. Power
- C. Basic Configurations
    1. Upflow
    2. Counterblow
    3. Horizontal
- D. Controls Common To All
    1. Thermostat
    2. Fan Control
    3. Fuel Control
    4. Input Control (Nozzle And Orifice)
- E. Ignition Sources
    1. Standing Pilot
        - a) Aerated and Non-aerated
    2. Ignited Pilot
        - a) Electric Spark
        - b) Glow Coil
        - c) Hot Surface Ignition
    3. Direct Ignition
        - a) Direct Spark Ignition (DSI)
        - b) Hot Surface Ignition
- F. Safety Controls
    1. Flame-Proving Device
        - a) Thermocouples and Thermopiles
        - b) Bimetallic
        - c) Mercury Bulb
        - d) Flame Rectification
    2. Lockout Relay
    3. Blower Door Switch
    4. Limit And Auxiliary
- G. Components Other Than Controls
    1. Blower
    2. Transformer
    3. Heat Exchanger
    4. Manifold
    5. Filter
    6. Plenum (supply & return)
- H. Name Plate Data

    1. Input And Output
    2. Blower Hp
    3. Type Of Gas
- I. Sequence of Operation
    1. Call For Heat
    2. Ignition
    3. Safeties
    4. Satisfied Condition
- J. Furnace Efficiencies
    1. Standard
    2. High
    3. Pulse
    4. Condensing '
- K. Venting

V. Piping

- A. Threaded Pipe Systems And Fittings
    1. Uses
        - a) Gas
        - b) Domestic Water
    2. Fittings
        - a) Types Application
            - (1) Tee, Elbows, Union, Galvanic Fitting, Etc.
        - b) Identification Of Fittings
        - c) Pipe Sizes
    3. Pipe Fitting
        - a) Tools
            - (1) Hand Tools
        - b) Cutting
        - c) Vices
        - d) Threading
            - (1) Dies
            - (2) Oil
            - (3) Use Of Machine
        - e) Assembly Of Threaded Pipe
            - (1) Pipe Dope
            - (2) Proper Use Of Wrenches
    4. General Construction Practices
        - a) Workmanship
            - (1) Level, And Plumb
            - (2) Avoid Traps
        - b) Measurement Techniques
            - (1) End-To-End
            - (2) End-To-Center
            - (3) "Book" Method
    5. Building Codes
        - a) Determining Pipe Sizes
        - b) Pitch for Draining

c) Leak Checking

VI. Drawing And Sketching

A. Uses For Drawing, Sketching Within Industry
B. Drafting Tools That We Use
   1. Triangles –30/60, And 45
   2. Paper
   3. Architects Scale
C. Isometric Views And Drawings
   1. Terms
   2. Uses
   3. Sketch And Drawing Of Objects And Projects
D. Orthographic Projection
   1. Terms
   2. Uses
   3. Sketch And Drawing Of Objects And Projects

VII. Blueprint Reading

A. Production Of Blueprint From Original Drawing/Ozalid Process
B. Terminology Of Print Reading
   1. Symbols
   2. Sizes And Configuration
   3. Title Block Information
   4. Scale And Measurement
C. Reading Prints
   1. Identify Mechanical Components
   2. Determine Pipe And Duct Sizes
   3. Determine Joining Techniques
D. Electrical Schematic for Forced Air Furnace
   1. Sequence of Operation

VIII. Estimating (If we have time, probably not)

A. Parts
B. Labor
C. Fringe Benefits
D. Taxes
E. Overhead
   1. Utility Bills
   2. Rent
   3. Vehicle Payments
   4. License And Professional Fees
   5. Legal Fees
   6. Support Staff (Secretarial, Accounting, Etc)
F. Profit

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given lecture and reference material the student will be able to describe the requirements and the process of combustion.
2. Given lecture and charts the student will be able to calculate orifice size of gas fired heating units.
3. Given lecture and proper data the student will be able to determine firing rate and calculate fuel consumption and cost of operation.
4. Given an existing heating unit and the proper charts the student will be able to take nameplate data from unit and determine if the correct size orifices are installed in the unit.
5. Given lecture and reference materials the student will be able to describe the basic electrical operation of a forced air furnace to include controllers, actuators, and safety controllers.
6. Given lecture and reference material the student will be able to describe the basic mechanical operation of a forced air system to include pressure regulators, types of fuel metering devices and pressure setting and draft.
7. Given various malleable iron pipe fittings, the student will be able to identify them by size and their use and application in a piping system.
8. Given black or galvanized pipe, standard pipe dies, pipe vise and print of an object, the student will be able to cut, thread, and assemble pipe and pipe fittings to sizes and directions indicated on the print given the student.
9. Given a set of mechanical prints with refrigeration piping the student will be able to make a job estimation and labor cost of all fitting and piping needed to complete required job.
10. Given architect's scale, 30°--60°-90° and 45° right triangles, and paper, the student will be able to make a drawing or sketch of an object given to him.
11. Given an isometric view of and object and the drafting tools, the student will be able to draw or sketch the object in orthographic, or plan and elevation views of the object.
12. Given a set of building prints the student will be able to understand how the building is constructed, what symbols are used in the making and drawing of blueprints.
13. Given a set of mechanical prints of a building, the student will be able to locate and identify all the mechanical components of the system.
14. Given mechanical and building prints, covering the piping and ductwork used in air conditioning of residential and commercial buildings. Students will read the building print to determine sizing of pipes and systems, joining techniques, pumps, valves, and applications.

Scoring:

4 Tests	50%
Cumulative Lab Score	30%
Cumulative Final Exam	20%
Total	100%

Required Equipment:
In addition to the standard tool list, you are required to purchase a 30°-60-90 drafting triangle, a 45 drafting triangle and architects scale. All tools and equipment should be available for each class. We may not use them, but have them near by in case we do.

Tobacco/Alcohol

Tobacco and alcohol policy will be as stated by the College of Technology, Deans Office. Absolutely no tobacco products will be used anywhere in the building, including chewing tobacco. Most job sites that you will encounter in your career are smoke free. This is the place to start that practice.

Attendance:
Absenteeism/tardiness are viewed as the student's loss. You are an adult, and can make adult decisions. If you choose to miss class, that is your choice. However, I will not make myself available to you for make up lectures or tutoring on material that you missed. Habitual tardiness will not be tolerated. If you skip a class, that's your problem. If you're tardy, you disrupt the entire class, and that's not fair to the group. If you have a class on the other side of campus prior to this class, let me know, and I will make an exception.
On the other hand, if you want to learn, and show an eagerness for learning, I will do all I can to help you succeed.

Grading scale

A	94	100
A-	91	94
B+	88	91
B	85	88
B-	82	85
C+	79	82
C	76	79
C-	73	76
D+	70	73
D	67	70
D-	64	67
F	61	64

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 207
Date: August 1991
Dept. **Approval**

COURSE TITLE: Commercial Refrigeration Systems

COURSE DESCRIPTION: A study of refrigeration units associated with the supermarkets and restaurants. Topics include electrical & mechanical refrigeration systems found in today's applications. Laboratories will cover testing, adjusting and troubleshooting electrical and mechanical problems.

Credit Hours: 5

Semester Hours: Lecture 3 hours/week
Laboratory 6 hours/week

Prerequisites: HVAC 102 and HVAC 117

Textbooks Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson, Delmar Publishers, Inc.
ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction, Orientation, Safe Practices, and Review of Electrical Components and Motors	2	8
II.	Compressors, Lubrication and Related Safety Controls	4	10
III.	System Cycling and Defrosting Controls	4	10
IV.	Water Cooled Condensers and Related	4	3
V.	Low Ambient Controllers	3	1
VI.	Heat Reclaim Systems	3	1
VII.	Automatic Ice Piece Machine	4	10
VIII.	Automatic Ice Flake Machines	3	10
IX.	Low, Medium, and Utra-Low Temp. Systems, Floating Head Intercoolers, Compound Compression, Liquid Injectors, and Refrigerants	3	0
X.	Multiple Temperature Application Including Suction Line Control Sizing, Servicing and Maintenance	5	7

XI.	Equipment Performance Testing, Troubleshooting, Maintenance and Adjustment of Electrical and Mechanical Problems Relating to Ice Makers, Walk-ins, Aisle Cases, and Reach-Ins.	0	20
XII.	Uneven Parallel Systems and Related Components	5	5
XIII.	Piping Procedures and Equipment Selection	5	5
	Total	45	90

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introductions, Orientation, Safety and Review

A. Course grading, attendance, and safety policy
B. Safety lecture
   1. Fire extinguishers
   2. Oxy/Acy practices
   3. Safety glasses
   4. Breaker location
C. Equipment orientation
   1. Name plate data
   2. Across the line diagrams
D. Electrical review
   1. Potential and current magnetic relays
   2. Three-phase circuits
E. Hermetic motor review
   1. PSC motors
   2. CSCR motors
   3. CSIR motors
   4. Three-phase motors
   5. Air flow, energy usage and study of various commercial cases

II. Compressors, Lubrication and Related Safety Controls

A. Four basic types of compressors and their application
   1. Reciprocating (piston type), open, fully hermetic, and semi-hermetic
   2. Rotary type
   3. Screw type
   4. Centrifugal
B. Compressor safety controls (function, sizing, and servicing)
   1. High pressure cutout
   2. Low pressure cutout
   3. Current and temperature overload controls (external and internal)
   4. Automatic pump-down systems
   5. Crankcase heater
   6. Piping design (p-traps and line pitch)
   7. Crankcase pressure regulators
   8. Oil separators
   9. Suction line accumulators

III. System Cycling and Defrosting Controls

A. Pressure and temperature controls
    1. Low pressure controls (types, range, differentials altitude setting)
    2. Thermostats (sensing bulb, bi-metal and thermistor)
B. Time cocks
    1. Time-time
    2. Time-temperature
    3. Time –pressure
C. Defrosting methods
    1. Electric defrost
    2. Air defrost
    3. Natural defrost
    4. Hot gas defrost

IV. Water Cooled Condensers and Related Components

A. Types of water cooled condensers
    1. Double tube (Co-Axial) cylindrical, spiral, and rectangular shaped
    2. Shell and tube
    3. Shell and coil
B. Efficiencies of water cooled condensers
C. Types and operation of water regulating valves
    1. Electrical water valves
    2. Thermostatic water valves
    3. Pressure operated water valves
D. Water volumes required per ton of refrigeration
E. Parallel vs. series piping arrangement
    1. Associated water pressure drops
    2. Associated water delta tee differences
F. Fouling factors and rates of fouling

V. Low Ambient Controllers

A. Types, functions, service procedures and application of low ambient controllers
    1. Limitizers
    2. Headmaster
    3. Cycling fans
    4. Modulating dampers
    5. Heat blankets

VI. Heat Reclaim Systems

A. Series systems
B. Parallel systems
C. Function and design of reclaim systems
D. System components
    1. Three-way valve
    2. Check valves
    3. Head pressure controllers
    4. Heat reclaim coils

5. Sizing and design of heat reclaim coils

VII. Automatic Ice Piece Machine

A. History
B. Types, function and service of different machines
  1. Cell type
  2. Plate type
  3. Tube type
  4. Rod type
  5. Mold type
C. Water systems
  1. Filtering
  2. Softening
  3. Cleaning
  4. Bleed-off systems
  5. Maintenance and service

VIII. Automatic Ice Flake Machines

A. History
B. Types, function and service of different machines
  1. Tube type
  2. Cylinder of drum type
C. Water systems
D. Maintenance and service

IX. Low, Medium, and Ultra-Low Temp Systems, Floating Head, Intercoolers, Compound Compression, Liquid Injectors, and Refrigerants

A. History
B. Applications
  1. Pharmaceutical storage
  2. Bacteriological storage
  3. Chemical storage
  4. Lens grinding
  5. Superconductor applications
  6. Steel alloy treatment
  7. Plasma and blood storage
  8. Research labs
C. Types of systems (multistage)
  1. Series (compound)
  2. Cascade
D. Problems associated with ultra-low systems
  1. Energy
  2. Discharge temperatures
  3. Frosting
  4. Oil return
  5. Compressor size
  6. Motor overloading

7. Compression ratio

E. Evaporators
   1. Forced air vs. static
   2. Larger size

F. Types of intercoolers
   1. Flash type (open)
   2. Shell and coil (closed)
   3. Dry expansion

G. Interstage
   1. Pressures
   2. Temperatures

H. Ultra-low temperature refrigerants and their properties
   1. Refrigerants used in ultra-low temp.

X. Multiple Temperature Application Including Suction Line Control Sizing, Servicing, and Maintenance

A. Evaporator pressure regulators (pressure and temperature type)
   1. Function (snap action and modulating)
   2. Sizing
   3. Servicing

XI. Equipment Performance Testing Troubleshooting, Maintenance and Adjustment of Electrical and Mechanical Problems Relating to Ice Makers, Walk-ins, Aisle Cases and Reach-ins

A. Air flow characteristics (fan and ducting)
B. Electrical circuits
C. Mechanical circuits

XII. Uneven Parallel Systems and Related Components

XIII. Piping Procedures and Equipment Selection

OBJECTIVE REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given a unit, the students will identify and describe the application, and electrical components found in commercial refrigeration equipment.

2. Given reading assignment, and lecture, the student will describe the application, and operation of Ultra-low temperature series (multi-state) and Cascade system.

3. Given handouts, reading assignments and lectures, the student will describe the operation and application of various types of ice machines, electrical mechanical sequence, determine ice production, cleaning, troubleshooting and servicing procedures.

4. Given handouts, reading assignments, and lectures, the student will describe energy conserving systems that are used in supermarkets and other commercial applications.

5. Given handouts, reading assignments and lectures, the student will determine the air flow of isle cases, the type of fans used on the equipment, the rotation of the fan, draw/blow through, and troubleshoot problem involving air flow of the unit.

6. Given instruction, the student will relate the temperature, humidity, Co2 and air velocity to the longevity of food preservation.

7. Given handouts, reading assignments and lectures, the student will describe the operation and application of low ambient control systems.

8. Given handouts, reading assignments and lectures, the student will describe the operation, water requirements, fouling factors, and service of water-cooled condensers and water regulating valves.

9. Given handouts, reading assignments, lectures, and low and medium temperature units, the student will properly set low initiation and termination intervals, test and troubleshoot commercial defrost systems.

10. Given lecture and text material, the student will demonstrate the operation, application, and pros and cons of different defrost systems.

11. Given handouts, reading assignments and lectures, the student will adjust, test and troubleshoot commercial refrigeration flow control valves, suction pressure regulators, temp/press control, E.P.R. valves, solenoid valves and oil separators that are used on single and multi-type units.

12. Given handouts, reading assignments and lecture, the student will be able to identify the types and characteristics of refrigerant, used in commercial applications.

13. Given commercial food preservation units, with electrical and/or mechanical problems, the student will systematically troubleshoot the unit and repair and/or replace to restore to original operation.

Syllabus
HVAC 207
Commercial Refrigeration Systems
Food Preservation and Commercial Systems

Course Description:
Study of refrigeration systems associated with preservation of food and ice producing equipment commonly found in supermarkets and restaurants. Topics covered are: electrical systems, various compressor designs, heat reclaim units, ambient controls, air/wc condensers, defrost intervals/methods, low temp. systems, and press./temp. control.

Laboratory consist of testing, adjusting, and troubleshooting electrical/mechanical problems related to this course of study.

Textbook(s) Required: Refrigeration and Air Conditioning Technology, by William C. Whitman and William M. Johnson.

Handout material from instructor and occasional reference to: Modern Refrigeration and Air Conditioning, by Althouse-Turnquist.

Required Equipment:
1. Minimum of three protective notebook covers ("ACCO Fastener" type), with basic assignment covers.
2. OHM/VOLT/AMMETER combination. Thermal sensing device.
3. Tool box, with all tools required when issued initial tool requirement list. Individuals are responsible for his/her own tools.
4. If there is most a safe place to lock tools, obtain bicycle type cable, with lock. Secure tool box to a girder or heavy piece of equipment. Personal lockers are often available I either the Commercial Laboratory or Energy Management Laboratory.
5. Protective acetate covers for submission of class-assigned homework.

UNITS OF INSTRUCTIONA AND LEARNING GOALS-Estimated Contact Hours

		Lecture	Lab.
I.	Introduction, orientation, safe practice, and review of electrical components	2	8
II.	Compressors, lubrication, safety devices	4	10
III.	System cycling and defrosting controls	4	10
IV.	Water-cooled condensers, service and maintenance	4	3
V.	Low ambient controllers	3	1
VI.	Heat reclaim systems	3	1
VII.	Automatic ice piece machine	4	10
VIII.	Automatic ice flake machines	3	10
IX.	Low medium, and ultra-low temperature systems-floating head, intercoolers, compound compression, liquid injectors, applicable refrigerants	3	0
X.	Multi-temperature application-suction line control sizing, service/ maintenance	5	7
XI.	Equipment performance testing, troubleshooting, adjustment and maintenance of electrical/mechanical problems relating to ice makers, walk-ins, aisle cases, reach-ins	0	20
XII.	Uneven parallel systems- related components	5	5
XIII.	Piping procedures and equipment selection	5	5
	TOTALL ESTIMATED CONTACT (hours)	45	90

Grading:

1. Average grade of three or more test, considered into "academic average."
2. Quizzes and submitted homework assignments; score averaged with test-average. ONE HALF of the participant's final grade results by this composite. Academic capability is weighted.
3. Laboratory grade; and average of three projects (minimum) and two laboratory tests. This score is ONE HALF of the final grade (academic score is the other half).
4. Final numerical score is the percentage of the academic score and laboratory score averages. See "General Grading policy," in this syllabus for numerical values, honor points, and letter grades. See also "Attendance."

Maximum attainable laboratory score shall not be greater than 94 percent.

Computer Room Facility:
Our computer room is available at anytime there is not a class in session and often open during evening hours. Adherence to the rule sheet as posted near computer room is mandatory and enforced. This assures our continuing freedom in use of this facility.

Work submitted through formal assignment requiring written word is expected to be completed employing a word-processing program unless otherwise stipulate. Only that student directly responsible for his own assignment must complete the work. If written work is specified as "hand written," do not submit paper torn from a spiral notebook. Any hand written assignment shall be considered as formal, done with your best penmanship and in ink.

Attendance:
Absences hinder technical development within the program or course of study. Attendance is required and punctuality expected. Leaving our lecture area or laboratory before class is dismissed shall count as an non-excused absence; your grade can become reflective. Perfect attendance and punctuality is rewarded with a one point addition to academic average (see grading method).

One (1) day is called a "personal day" for this course. Do not misunderstand. That day is like money in the bank; interest gained is the experiences developed (by not using it). If you must attend a wedding as member of the brides party (or have a personal problem), this day is for such purpose. It's not an "earned" benefit. It is mandatory to inform the instructor with such day pending. It could be the same day a quiz is planned (quizzes can be given with out prior notice), so be careful! If you decide to take a day as personal, it will be considered a non-excused absence.

For each two (2) non-excused absences beyond personal day, One (1) Point deduction will be made from AVERAGE final grade (see Grading Policy; Distribution).

Excused Absence:
What would count as an excused absence? How about a broken leg . . . an accident . . . a needed operation . . . or a communicable sickness. Documentation is required to gain privilege of an excused absence. Consult with your instructor for arrangement of make-up. He will do what he can to assist.

Have a safe and productive semester, and the best to you!

Laboratory Folders:
Two laboratory-related assignments are required:

1. Main Project
2. 2. Laboratory "hands-on" Test

Each project challenged by a student (refrigeration unit or any related project requiring submission of a folder), is followed by a formally submitted report, protected within a folder cover of the ACCO type. A report outline, prescribing format for all reports will be given to you well in advance of any first-time submitted report folder.

Two (2) evaluation sheets are to be placed within submitted folders (sample furnished with this paper). Copies will be inserted before the cover page (the first page normally seen after the front cover is turned). One copy will be retained for your record after project folder is graded and returned to you. Evaluation sheets are furnished by the instructor as you need them.

Laboratory experiences are critical within this course. A minimum of two (2) individual lab test shall be administered, testing your mechanical, electrical, and troubleshooting skills. Tests rendered will not be considered part of your min project report. All lab tests are treated as a separate assignment. Include required evaluation page when LAB TEST report is submitted, inserted as described above. A protective cover o appropriate type is required (the ACCO fastener type of folder is not necessarily required). Further direction is presented prior to laboratory tests assignments and administered tests.

General Grading Policy; distribution:

Percent	HP	Grade
100-94	4.0	A
93-90	3.7	A-
89-87	3.3	B+
86-84	3.0	B
83-81	2.7	B-
80-78	2.3	C+
77-75	2.0	C
74-73	1.7	C-
72-71	1.3	D+
70-69	1.0	D
68-67	0.7	D-
66-below	0.0	F

Evaluation standards for Laboratory Grading:

Excellent
Student met or exceeded criteria. All parts of the item presented in the project was presented with little question that item was completed in a very effective manner, both in the hands-on situation and by the written word.

Good
Student performed necessary tasks in an effective manner, generally meeting stated criteria. Most parts of item presented in the paper. Errors made were properly corrected before allowed be become a mistake.

Fair
Student was unable to perform this item acceptably, but did exhibit some ability to perform it. Item needs additional work or follow-through to become acceptable. This grade can be absorbed through better performance.

Poor
Student was unable to perform item, or has limited ability to perform it. Item need additional work and perhaps over-haul to be acceptable.

EVALUATION PAGE

NAME: ______________________ PROJECT: ______________________

DATE OF SUBMISSION: ______________ UNIT NUMBER: __________

COURSE: ______________________

		EXCELLENT	GOOD	FAIR	POOR
I.	PRESENTATION:				
	1. Was logically organized, written according to prescribed format and formally presented.	20 19	18 17	16 15	14 13
	2. Was attractive and professional in appearance.	10 9	8 7	6 5	4 3
	3. Was free from spelling and grammatical errors	5	4	3	2
	4. Included a title page, properly addressed.	5	4	3	2
II	CONTENT:				
	1. Written clearly, free from misunderstanding of concepts, and reflects attention to detail.	20 19	18 17	16 15	14 13
	2. Thoughts were consistent, clearly organized, inter-related and logically developed.	10 9	8 7	6 5	4 3
	3. Paper flowed with good bridging between paragraphs, sentences, and sections.	10 9	8 7	6 5	4 3
	4. Correct usage of terms, clearly describing both concept and method.	10 9	8 7	6 5	4 3
	5. Demonstrated analytical approach to problem solving and person incentive, exercising skill and preparedness. (Laboratory experience.)	10 9	8 7	6 5	4 3

NOTE:
Folder evaluation sheet scores shall be inclusive and indicative of over-all PROJECT GRADE. Score appears as a possible 100 percent. Maximum laboratory grade is 94 percent.
Multiply sum of evaluation for all categories listed by .94 for resultant project grade. Average of grades for each project becomes your laboratory composite score for final grading purposes.

See "Grading," in this syllabus. Also, see definition of "Excellent," "Good" "Fair" and "Poor."

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 208
Date: August 1991
Dept. **Approval**

COURSE TITLE: Air Conditioning Applications

COURSE DESCRIPTION: A study of mechanical air conditioning equipment used in comfort cooling and heat pump applications. Hands on laboratories cover electrical systems, capacity testing, mechanical and electrical troubleshooting of residential and light commercial applications.

Semester Hours: 5 hours

Contact Hours
Lecture 3 hours / week
Laboratory 6 hours / week

Prerequisites: HVAC 117 and HVAC 102

Textbook Required: Modern A/C Practice, by Harris

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Introduction	1	0
II.	A study of the mixture of dry air and water vapor with the use and application of the partial pressure laws that apply to these mixtures	2	0
III.	An introduction to the effects of humidity on air conditioning equipment and how it effects the total heat load and system operations	2	0
IV.	Uses and application of humidity devices along with the appropriate nomenclature and definitions of technical terms	2	0
V.	Psychrometric chart application which deal with any changing air conditions such as heating, cooling, humidification and dehumidification	6	3
VI.	System classification	1	5
VII.	A/C refrigerants	1	5
VIII.	A/C systems & classifications	6	30
IX.	Heat pump systems	6	20

X.	Liquid chillers	2	10
XI.	Cooling towers	2	6
XII.	Evaporative condensers	2	3
XIII.	H_2O treatments	2	3
XIV	Capacity control and unloading	2	3
XV.	Overloading devices	2	2
XVI.	Centrifugal compressors	1	
XVII.	Screw type compressors	1	
XVIII.	Absorption Refrigeration	2	
IXX.	Tubing & installation procedures	2	
	Total	45	90

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction and Orientation

II. Air and Water as a Mixture, Along with Pressure Laws, Nomenclature, and Definitions of Technical Terms

A. Dalton's law of partial pressures
B. Definition and application of technical terms
   1. Barometric pressure
   2. Atmospheric moisture
   3. Specific humidity

III. Humidity and its Effects on A/C Equipment Along with Nomenclature and Definitions of Technical Terms as They Apply to Humidity

A. Definitions and nomenclature of terms
   1. Saturation
   2. Humidity
   3. Relative humidity
   4. Specific humidity
   5. Dew point temperature
   6. Dry bulb temperature
   7. Wet bulb temperature
   8. Sensible heat
   9. Latent heat
   10. Enthalpy (total heat)

IV. Uses and Application of Humidity Measuring Devices

A. Sling psychrometer
B. Hygrometer
C. Humidiguides
D. Charts incorporating the wet bulb depression

V. The Psychrometric Chart

A. Introduce and apply chart mechanics

1. Wet bulb axis
2. Dry bulb axis
3. Relative humidity lines
4. Specific humidity index
5. Specific volume lines
6. Enthalpy index
7. Dew point temperature index
8. Saturation line

B. Application of the psychrometric chart with changing air conditions
   1. Heating without the addition of moisture
   2. Heating with humidification
   3. Cooling with constant enthalpy (evaporative cooling)
   4. Cooling with constant moisture content
   5. Cooling with dehumidification

C. Emphasize cooling with dehumidification (summer air conditioning)
   1. Apparatus dew point
   2. Bypass factors
   3. Sensible heat ratios
   4. Mixed air volumes and temperatures
   5. Air quantities
   6. Tons of refrigeration

VI. System Classifications

A. Central station

B. Unitary/packaged systems
   1. Roof top units
   2. Split systems
   3. Self contained units
   4. Window a/c

C. Air handling unit

D. Advantages/disadvantages

VII. A/C Refrigerant Properties, Characteristics and Applications

A. Refrigerants of the past HCFC and CFC

B. Refrigerants of the future HFC

C. Refrigerant handling, capture and containment

VIII. Air Conditioning Systems

A. A/C processes

B. Temperature and pressure ranges

C. Air volume requirements

D. Psychrometric review and application

E. Air and system tests (manu. specs.)

F. Electrical/mechanical troubleshooting

G. Capacity measurements and system performances

H. MegoHm meter application

I. Electrical and mechanical system diagramming
J. Various service contracts

IX. Heat pump Systems

A. Classifications
   1. Air to air
   2. Water to air
   3. Ground to air
B. Heat pump theory
C. Performance ratings
   1. C.O.P. (Carnot vs. Actual)
   2. Hp/ton
   3. E.E.R. rating
   4. Critical unbalance
D. Electrical/mechanical troubleshooting
E. Air and physical system testing (mann. specs)
F. Capacity measurements
G. Mechanical/electrical system diagramming
H. Defrosting systems
   1. Time
   2. Temp
   3. Pressure

X. Chillers

A. Chiller types
   1. Dry expansion (dx)
   2. Flooded type
B. Chiller applications and construction
C. Refrigerant system
   1. Evaporator types
   2. Condenser types
   3. Associated controls
D. Water systems
   1. 2- and 3-way water regulating valves
   2. Cooling tower applications
   3. City water application
E. Safety controls
   1. Oil safety controls
   2. Freeze controls
   3. Pressure controls
   4. Compressor cycling
F. Elect./mech. System diagramming
G. Elect./mech. System testing and troubleshooting
H. Capacity measurements
   1. GPH calculations
   2. P-H diagram
   3. Freon flow calculations

I. Advantages/disadvantages

XI. Cooling Towers

A. Applications and theory
B. Advantages/disadvantages
C. Tower loads and capacity calc.
D. Tower range and approach
E. Tower efficiencies
F. Water treatment and make-up
    1. Chemicals
    2. Drift
    3. Bleed-off
    4. Evaporation
G. Tower classification
    1. Natural draft (atmospheric)
    2. Mechanical draft
H. Tower construction/components
I. Condenser by-pass
J. Tower maintenance

XII. Evaporative Condensers

A. Application and theory
B. Components
C. Loads, capacity, and performance
D. Water consumption
E. Water treatment
F. Maintenance
G. Heat transfer and efficiencies
H. Controls
I. Winter operation
J. Disadvantages/advantages

XIII. Water Treatment

A. Application to water cooled equipment
B. Application to cooling towers and evaporative condensers
C. Scale and scale analysis (identification)
D. Scale removers
E. pH and pH testing
F. Slime, algae, dirt, sand, corrosion
G. Preventative maintenance

XIV. Capacity Control Systems

A. Types of capacity control
    1. Hot gas bypass
    2. Hydraulic unloading (cylinder)
    3. Electric unloading (cylinder)
    4. Cylinder cut-off methods

5. Variable speed motors

B. Operation and application of capacity control systems
C. Problems of short cycling
D. Advantages/disadvantage
E. Wiring of capacity control systems

XV. Overload Devices

A. Description, operation, repair and replacement of overloads
   1. Current sensing overloads
   2. Solid state time delay devices
   3. Thermal sensing overloads

XVI. Centrifugal Compressors

A. Application to chillers
B. Operating characteristics
   1. Speeds
   2. Pressure
   3. Reliability
   4. Maintenance
   5. Capacities
   6. Air purgers
C. Refrigerant used
D. Advantages/disadvantages
E. Efficiencies
F. Construction
G. Lubrication

XVII. Screw Type Compressors

A. Screw compressor theory and application
B. Screw compressor construction
C. System lubrication and oil cooling
D. Capacity control (mech. slide valve)
E. Compression ratios
F. Advantages/disadvantages

XVIII. Absorption Refrigeration

A. Basic absorption theory
   1. Lithium bromide and water
   2. Ammonia and water
B. System components
   1. Concentration
   2. Condenser
   3. Evaporator
   4. Absorber
   5. Pumps
   6. Economizers

C. System fluid concentration
   1. Dilute
   2. Intermediate
   3. Strong
D. Equilibrium charts
E. Crystallization and causes
F. Capacity control
G. System purging and troubleshooting

XIX. Tubing and Installation Procedures

A. Installation considerations of a split A/C system on forced air furnace
B. Wiring requirements
C. Air volume requirements
D. Pre-charged tubing and assorted parts
   1. Stub kits
   2. Line sets
E. Coil selection

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given lecture/demonstration, psychrometric charts, sling psychrometer, and worksheets, the student will relate to the properties of air including percent RH, We and DB temperatures, dew point, grains of moisture/lb. and cu. ft. of air. The student will also relate to the effect that humidity has on unit capacity, condensate and frost.

2. Given the psychrometric chart, standard air conditions, and standard formulas, the student will plot conditions, calculate Btu/#, Btu/hr, "mixed" air conditions, find apparatus dew point, S.H.F. and relate to system performance or problems.

3. Given centrifugal and axial fans, multi-speed and variable sheave, the student will identify type of fan, application, loading cavities, and with instrumentation determine the CFM from Grills or unit discharge.

4. Given various duct systems, the student will recognize appropriate types of residential distribution systems and their applications.

5. Given charges in initial A/C the student will determine effects in temperature differences, evaporating temperatures, and moisture removal of an A/C system.

6. Given ASHRAE winter and summer comfort zones and variable room conditions, the student will relate these conditions to an (E.T.) effective temperature and recognize what percentage of people will be comfortable at these conditions. Students will also relate to the factors which effect human comfort such as DBT, WET, RH, air velocity, and air freshness.

7. Given the properties of air and water mixtures the student will calculate and prove ideal gas laws.

8. Given split A/C systems with pre-charged tubing and stubkits the student will describe the installation considerations, wiring, air volume requirements and customer relations required with a split system to conventional forced air furnace without a cooling package.

9. Given a Megohm meter and work sheet, the student will test compressor windings for moisture, and or acidity, and make maintenance recommendations.

10. Given cooling towers, evaporative condensers, handouts, and instruction, the student will describe the operation, maintenance and calculate the efficiency.

11. Given water cooled equipment, the student will describe the problems involved with scale, corrosion, slime and algae, and treatment systems used to prevent such problems.

12. Given 2-way and 3-way water regulating valves, the student will properly adjust, describe operation, sizing and maintenance thereof.

13. Given service contract, the student will identify the type and limitations of such contract, and describe their use.

14. Given solid state time-delay devices, current sensing overload protection devices and thermal overload sensing devices, the student will describe the operation, the troubleshooting sequence and repair/replacement of each.

15. Given conventional room A/C, the student will identify electrical and reference characteristics of compressor, complete testing procedure of PSC compressor and components.

16. Given instrumentation, A/C and heat pump units, and work sheets, the student will perform air and system tests, calculate Btuh, compare and justify to manufacturers specs.

17. Given split A/C systems with adequate name plate data, the student will identify capacity, list application, given correct nomenclature, explain advantages and disadvantages of units per application, and identify unitary, combination systems and central station equipment.

18. Given models, overheads and instruction of screw compressors, the student will demonstrate and understanding of the fundamental compression and oil system and the application and operation of mechanical slide valve for capacity control.

19. Given overheads, reading assignments and field trip, the student will describe the operation of a centrifugal compressor air purger, typical operation speeds, pressure and operation as applied to chillers.

20. Given handouts and lecture, the student will describe the basic operation of the steam ejector and absorption system as applied to air conditioning,

21. Given various types of compressor systems, the student will describe the advantages and disadvantages of: open and semihermetic, serviceability and replacement policies, as well as types of drive, direct, belt, gear and coupling alignment.

22. Given a reciprocating compressor of 5 H.P. or larger with a oil pump, the student will describe the operation of the oil pump and oil safety control, calculate and read net oil pressure and test.

23. Given handouts, lecture and a demonstration, the student will describe the operation, setting, wiring, and advantages and disadvantages of <u>capacity control systems</u>.

24. Given cooling systems representative of the field, with electrical and mechanical problems, the student will systematically troubleshoot the unit, repair and/or replace to original operation and test.

25. Given D/X chillers, handouts and lecture, the student will describe the application, operation, troubleshoot an electrical bus, do a complete across-the-line and explain the safety controllers.

26. Given lecture, text and slide presentation, the student will describe problems caused by short cycling, compressor capacity control devices and hot gas bypass systems used for capacity control.

27. Given a heat pump the student will be able to construct a pictorial diagram and an across-the-line schematic and explain in full detail the electrical sequence in both the heating and cooling modes.

28. Given a heat pump that is inoperative and the proper tools, the student will be able to trouble-shoot and locate the faulty component and replace if necessary.

29. Given air-to-air, water-to-water, and ground-to-air heat pumps, the student will trace the mechanical system, identify components and function of, draw and read an A.T.L., and properly wire and trouble-shoot problems.

30. Given air-to-air heat pumps, the student will identify the type of defrost control system, explain operation and test.

Attendance Policy:

All students are expected to attend each class session unless prior arrangements have been made. In case of emergency, illness, or prior arrangement, any test may be made up without penalty. If the student misses a test or exam for reasons other than previously stated, the student will not be allowed to make up the test.

Grading Scale:

1)	Weekly Quizzes	40% of quiz grade
2)	Midterm & Final	60% of quiz grade = 40% of total grade
3)	Laboratory Requirements	60% of total grade

Grading Policy Is As Follows:

S+ Extra effort
S Expected effort
S- Less than expected effort

Grade	HP	Grade
100-94	4	A
93-90	3.7	A-
89-87	3.3	B+
86-84	3.0	B
83-81	2.7	B-
80-78	2.3	C+
77-75	2.0	C
74-73	1.7	C-
72-71	1.3	D+
70-69	1.0	D
68-67	0.7	D-
66-BELOW	0.0	F

Final Term Grade Based On:
Testing Procedures:

A weekly test on sections covered, usually set for Friday, but sometimes determined by student progress. A 1-day notice will be given as to test date.

A midterm test will be administered during the middle of the quarter. A 1-day notice will be given as to test date.

A final test during the last week of the quarter with a two-day notice. The final will be a comprehensive test

1) Approximately six (6) weekly quizzes
2) 1 midterm
3) 1 final

LABORATORS REQUIREMENTS:
INSTRUCTOR JOE NOTT

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 225
Date: Dec 91
Dept. Approval

COURSE TITLE: Duct work

COURSE DESCRIPTION: The layout and fabrication of sheet metal and fiberglass ductwork used in air-conditioning and heating systems. Components used, proper use of hand tools and machines will be emphasized.

Semester Hours: 1

Contact Hours Lecture 0
Laboratory 3 hours/wk

Textbook Required: "Sheet Metal Blueprint Reading for Building Trades, by Zinnegrabe and "Sheet Metal Shop Practice, "4th Edition, by Meyer.

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

			TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction, Orientation		0	1
II	Hand Tools and Metals		0	1
III.	Seams and Layout Practices		0	25
IV.	Specialty Layout, Estimation and Fiberduct		0	18
		Total	0	45

TOPICAL OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction, Orientation, and Safety

A. Syllabus
1. Explain course goals
2. Grading policy
3. Attendance
4. Shop/lab safety-absolutely no horseplay
5. Alcohol and tobacco

II. Hand Tools and Metals

A. Metal types
1. Air ductwork-galvanized
2. Health related-stainless
3. Ornamental-copper, etc.
4. Black iron not used in hvac

B. Gauges
1. United States gauge size (G.S.G.)
2. Duct standards (SMACNMA)
3. Proper gauging

C. Hand tools and their uses
1. Various bench snips
2. Hammers
3. Rules
4. Square
5. Dividers/trammels
6. Awls
7. Compound and power machines-safety of each

D. Brake
1. Rolls
2. Foot shear
3. Pittsburgh machine
4. "Easy Edger"

III. Seams and Layout Practices

A. Common seams of industry
1. groove lock
2. Pittsburgh
3. Drive and S-cleat combination
4. Dovetail
5. Button-lock
6. Notching

B. Layout of common duct components
1. Plenum
2. Top/end cap
3. Straight duct
4. Transition and several methods
5. Riser
6. Elbow

C. Common Connections
1. Drive/s cleat
2. Flange
3. Standing S

IV. Specialty Layout, Estimation and Fiberduct

A. Four layout techniques

1. Parallel line development
2. Radial line development
3. Triangulation
4. "Rollation"

B. Job cost estimation

C. Fiberglass fabrication techniques
1. Hidden and real cost emphasized
2. Computer assisted estimation

D. Computer layout systems
1. Desk mode
2. Automated cutout machine

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given a U.S. standard sheet metal gauge and various gauges of sheet steel and galvanized sheet metal, the student will be able to gauge the sample given him.

2. Given instruction, hand tools, and machines used in the sheet metal trade, the student will be able to fabricate the various types of metal joints used in the sheet metal trade.

3. Given sizes and dimensions of six different duct components, hand tools and machines, the student will be able to fabricate the duct components and make drive and "S" cleats to assemble into one complete duct system.

4. Given instructions on how to make development drawings of various duct fittings, using parallel line, radial line and triangulation methods, sheet metal hand and machine tools, the student will be able to make a stretch-out development pattern and be able to fabricate the fittings out of sheet metal.

5. Given various hand tools, machines and instructions for fiberglass duct board, the student will layout and fabricate a duct.

6. Given a set of mechanical prints with a duct system requiring a heating and cooling system, the student will be able to make a cost and material estimation of all material needed to complete the required job.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 234
Date:	June 1991
Dept.	**Approval**

COURSE TITLE: HVAC 234, Residential Air and Fossil Fuel Systems

COURSE DESCRIPTION: Topics include mechanical and electrical operation, residential and light commercial controls, fuel consumption and air movement, & fuel conversion. Laboratory work covers testing, adjusting for efficient operation and trouble shooting electrical and mechanical problems on gas fired equipment.

Semester Hours: 3

Contact Hours
Lecture 2 hours/week
Laboratory 3 hours/wk

Prerequisites: HVAC 132 and 117

Textbook Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson, Delmar Publishers, Inc. ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Equipment Location and familiarization	1	1
II.	Gas Furnace and Boiler	1	2
III.	Operating Cycle of Gas Furnace	2	4
IV.	Gas Pilot Burner and Thermocouple	2	3
V.	Gas Pressure Regulators	2	2
VI.	Electrical Controllers	3	3
VII.	Heat Transfer	3	3
VIII.	Gas Controllers and Combination Valves	3	3
IX.	Draft and Combustion Air	2	2
X.	Combustion Testing	3	2
XI.	Troubleshooting Boiler/Furnace (Standard Model)	4	10
XII.	Troubleshooting Boiler/Furnace (High efficiency)	4	10
	Total	30	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Equipment Location and Familiarization

A. Type of unit
B. Fuel
C. Components

II. Aquatint with Gas Furnace or Boiler

A. Name plate data
B. Type of flue
C. Wiring diagram

III. Operating Cycle of Gas Furnace or Boiler. (Standard) (High Efficiency)

A. Components function
B. Air distribution or water flow
C. Wiring and controls

IV. Gas Pilot Burners and Thermocouple

A. Type of pilot
B. Thermocouple
C. Thermopile

V. Gas Pressure Regulators

A. Type of regulator
B. Component
C. Individual

VI. Electrical Controllers

A. Safety
B. Limit
C. Cycling
D. Zone
E. Temperature

VII. Heat Transfer

A. Air temperature
B. Cubic feet per minute (CFM)
C. Temperature rise
D. Gallons per minute (GPM)
E. Water temperature

VIII. Gas Controllers and Combination Valves

IX. Draft and Combustion Air

A. Proper venting
B. Codes

C. Combustion air requirement

X. Combustion Testing

A. Draft
B. Smoke
C. Carbon dioxide
D. Flue temperature

XI. Troubleshooting Boiler/Furnace (Standard Model)

A. Mechanical
1. Gas valves
2. Regulators
3. Pilots/thermocouples
4. Gas pressure
5. Burners
6. Pumps

B. Electrical
1. Gas valves
2. Safeties
3. Fan controls
4. Aqua stats
5. Thermostats
6. Motors

XII. Troubleshooting Boiler/Furnace (High Efficiency)

A. Mechanical
1. Gas valves
2. Regulators
3. Gas pressure
4. Burners
5. Condensate drains
6. Pumps

B. Electrical
1. Gas valves
2. Safeties
3. Solid state components
4. Electronic ignition
5. Power vents
6. Pumps

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given an existing heating unit and the proper tools and gauge the student will be able to identify the pressure regulator, determine the proper operating pressure, install gauges to test pressure, and adjust to proper pressure if present setting is not correct.

2. Given an existing heating unit the student will be able to identify all the automatic operating gas valves, he will be able to determine if each valve is electrically operated or mechanically operated. He will be able to explain the difference in operation between an electrical and a non-electrical operated gas valve. If the gas valve is electrically operated he will be able to determine which type of electrical operator is being used and whether its total operation is electrical or a combination of electrical-diaphragm mechanism.

3. Given a unit with an operable electric gas valve, the student will measure the amperage draw of the gas valve.

4. Given an existing heating unit, proper tools and the proper test equipment the student will be able to determine which proving device is being used, he will also be able to test the proving device to determine if it is operating properly. If the proving device is not functioning properly he will be able to adjust or replace as necessary.

5. Given an existing heating unit and the proper charts the student will be able to take name plate data from unit and determine if the correct size orifices are installed in the unit.

6. Given an existing heating unit with a gas meter installed and the proper charts the student will be able to collect name plate data, orifice size, and operating pressure. With this information he will be able to determine if unit is firing at the proper rate, and if not which adjustments or replacement has to be made to remedy the problem.

7. Given a high efficiency unit, such as, a pulse furnace or boiler, reclaimer condensing unit, etc., the student will be able to explain its operation and the difference between it and a conventional unit.

8. Given an existing heating unit the student will be able to measure temperature rise across the heat exchanger and determine if the rise is within the specifications, if not he will be able to determine why not and correct the problem.

9. Given an existing gas fired unit, whether natural gas or LP gas the student will be able to convert the unit to the opposite fuel by resizing the orifices and making the proper pressure adjustments.

10. Given an existing unit that is not operating properly and the proper tools and test equipment the student will attempt to fire the unit and observe all operating and non-operating functions of the unit, with these operating and non-operating functions he will eliminate all components that are not a probable cause and will list all components that are probable causes, he will then use his test equipment to actually determine and locate the actual cause, after locating actual cause he will make proper adjustments or replace faulty component and check unit for proper operating.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 235
Date:	August 1991
Dept:	**Approval**

COURSE TITLE: Hydronic Residential Oil Heating

COURSE DESCRIPTION: The study of hydronic systems and oil burners that includes the operating sequence for safe, efficient combustion and flame safety. Laboratory work covers troubleshooting electrical/electronic control systems, flame safety and mechanical problems on oil-fired boilers, hydronic systems, or furnaces.

Credit Hours: 5

Semester Hours: Lecture 3 hours/week
Laboratory 6 hours/week

Prerequisites: HVAC 117 and HVAC 132

Textbooks Required: Refrigeration Air Conditioning Technology, 3rd Edition, by William C. Whitman and William M. Johnson, Delmar Publishers, Inc.
ISBN 0-8273-5646-3

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

		<u>**TIME**</u>	<u>**WEIGHT**</u>
		Lecture /	**Lab. Hrs.**
I.	Introduction	1	0
II.	Operation of High Pressure Gun Type Oil Burner	2	4
III.	Fuel Oil Pumps	2	1
IV.	Nozzles	2	1
V.	Primary Controls	5	4
VI.	Operation & Troubleshooting Complete Unit	6	58
VII.	Combustion Chambers	1	1
VIII.	Combustion Testing and Efficiency	2	3
IX.	Hydronics	3	4
X.	Flame Safe Guard	2	2
XI.	Series 90 Modulating Control	4	12
	Total	30	90

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION:

I. **Introduction**
   A. Explain course goals
   B. Grading scale
   C. Attendance policy
   D. Safety

II. **Operation of High Pressure Gun Type Oil Burner**
   A. Review the parts and their function
   B. Explain sequence of operation
   C. Assemble and disassembly
   D. Replacement and adjustments of necessary components

III **Fuel Pumps**
   A. Functions
      1. Cleaning section
      2. Pumping section
      3. Regulating system
   B. One and two stage
   C. One and two line systems
   D. Check out, test and adjust

IV. **Nozzles**
   A. Review functions of nozzle
   B. Sizing to particular unit
      1. GPH
      2. Angle
      3. Pattern

V. **Primary Controls**
   A. Stack controls
   B. Cad cell controls
   C. Sequence of operation
      1. Constant or intermittent IGN
      2. Recycling or non-recycling
   D. Testing and troubleshooting

VI. **Operation and Troubleshooting Complete Unit**
   A. Point-to-point wiring diagram
   B. Across-the-line diagram
   C. Sequence of operation
   D. Troubleshooting and repairing

VII. Combustion Chambers

A. Purpose
B. Types of liners
C. Sizing
D. Repairing

VIII. Combustion Testing and Efficiency

A. Test measurements
   1. CO_2
   2. Draft
   3. Stack temp
   4. Smoke
B. Proper adjustment and selection of components
   1. Air adjusting collar
   2. Barometric damper
   3. Chimney size
C. Recommendation for efficiency improvement

IX. Hydronics

A. Types of systems
   1. One pipe
   2. Two pipe
B. System components
   1. Function
   2. Placement
   3. Specifications and settings
C. Operation of total system
D. Filling and draining system
E. Troubleshooting and repair

X. Flame Safe Guard

XI. Series 90 Modulating Controls

A. Uses
B. Direct and reverse acting
C. High and low limits
   1. Modulating
   2. SPST
   3. SPDT
D. Economizing
   1. Advantage
   2. Components
   3. Electrical circuit
   4. Operation

MINIMUM REQUIRED STUDENT LAB ACTIVITIES:

1. **High Pressure Gun Burner:** Disassemble a high pressure gun burner completely, identify all components, reassemble all components, make proper adjustment and test fire burner in test bed.

2. **Fuel Pumps:** Disassemble a fuel pump, identify each section and component and reassemble.

3. **Nozzles:** Disassemble three nozzles of different capacity, identify each part and compare the metering section of each nozzle to each other and reassemble each nozzle.

4. **Primary Controls:** Bench test one stack and one cad cell primary control, test will include safety timing, sequence, constant or intermittent IGN and recycling or non-recycling.

5. **Operation and Troubleshooting a Complete Unit:** Complete wiring diagrams, sequence of operation and troubleshoot three complete units in lab during the total course.

6. **Combustion Testing:** Take a combustion test, analyze the results, make adjustments and recommendations on how to improve efficiency.

7. **Combustion Chamber:** Inspect combustion chamber, determine type of material used for liner, and determine proper repair procedures when necessary.

8. **Hydronics:** Identify components, drain expansion tank, fill system and extract all air and put system in operation.

Syllabus
HVACR 235
Hydronic Residential Oil Heating

The course outline shows the units of instruction, objectives, and the minimum required student activities. You are expected to complete all homework and laboratory assignments on time. Homework assignments will be due at the beginning of the first class period after the homework has been assigned unless otherwise instructed by the instructor. Laboratory assignments and projects will normally be due at the beginning of each laboratory period after the project has been assigned unless otherwise instructed by the instructor.

Homework and laboratory assignments that are not turned in at the due date and on time will have points automatically deducted for lateness, so keep up on your work on a daily basis to prevent losing unnecessary points.

Grading and Grading Scale

Written examinations will account for 50 percent of your final grade, and homework, quizzes, laboratory projects and laboratory exams will account for another 50 percent of your final grade.

94-100=A	90-93=A-	87-89=B+	84-86=B	81-83=B-	78-80=C+
75-77=C	73-74=C-	71-72=D+	69-70=D	67-68=D-	66 and BELOW =F

Absentee Policy

It is a proven fact that people who do not miss classes usually attain better grades than people who do miss classes, therefore you are required to attend class every scheduled day.

However, emergencies do arise and missing class becomes a necessity so you will be allowed two absences without any penalty as long as you makeup any work missed during your absence. Any days missed after two absences you will receive a zero score on any work that was due or any work that you missed. If you are absent more than five days during the semester you will be removed from the class and receive an F grade. Showing up late for class three times will equal an absent day.

Safety

It is everyone's responsibility to conduct themselves in a safe manner at all times, so I expect everyone to use good safety practices during the course. These safety practices include:

1. Wearing of safety glasses whenever in lab.
2. No goofing around with each other inside the lab.
3. Make sure the tools you are using are in good shape and use the right tool for the right job.

4. Observe the layout of the lab and know where the "Quick Kill" buttons are to secure the electrical power going to the workbenches.
5. Remember the color code of the gas and air piping inside the lab.
6. Report any broken or dangerous equipment to the instructor.

Final Examination

The last week of the semester has been designated "Examination Week" and there is a schedule for administering exams in accordance with which days the classes meet. The schedule indicates that the final examination for this class should be administered on _________ from _________.

The final examination will not be comprehensive.

COURSE OBJECTIVES:

1. Given all the necessary parts the student will construct a high pressure gun oil burner, he will then take it to the testing area and make necessary electrical and fuel connections and test fire it.

2. Given an existing unit, the proper tools, and test equipment the student will be able to check for proper cut-off pressure, proper capacity of the pumping gears and whether the suction line has a leak or not, if one of these is not correct the student will be able to make proper adjustments or replacement.

3. Given an existing unit the student will remove the nozzle assemble and then will be able to determine the gallons per hour that the unit will use, the spray angle of the oil spray, the pattern of the oil spray and the manufacture of the nozzle.

4. Given a stack control and the proper tools and test equipment the student will test the control for proper sequence and proper operation and if the operation is not correct he will make proper adjustments and then determine if the control is faulty or not.

5. Given a Cad cell operated primary control and the proper tools and test equipment the student will test the control for proper sequence and proper operation and if the control is not operating correctly he will make the proper adjustments then determine if the control if faulty or not.

6. Given any primary control and the correct wiring diagram the student will determine if the control is constant or intermittent ignition and whether the control is a recycling or non-recycling control.

7. Given an existing unit that is not operating properly, the proper tools and test equipment the student will attempt to fire the unit and observe all operating and non-operating functions of the unit, with these operating and non-operating functions he will eliminate all components that are not a probable cause and will list all components that are probable causes, he will then use his

test equipment to actually determine and locate the actual cause, after locating actual cause he will make proper adjustments or replace faulty component and check unit for proper operating.

8. Given a unit with a faulty combustion chamber liner the student will be able to repair or replace the liner, whichever is necessary.

9. Given an existing unit and the proper test equipment the student will be able to take a combustion test to determine the combustion efficiency of the combustion process, if the combustion efficiency is below normal he will be able to make proper adjustments or replacement to bring the combustion efficiency within normal.

10. Given an existing hydronic system the student will be able to determine whether it is a series loop, monoflo, two pipe direct return or a two pipe reverse return system, or a combination of any of the four.

11. Given and existing hydronic system the student will be able to fill the system with water, bleed all air from the system, and check all functions to make sure all components are operating properly.

12. Given series 60, 80 and 90 controls and components, the student will wire and test simple heating and cooling control circuits with high and low limits and minimum position potentiometers.

13. Given a control board with a flame safe guard control and all the other appropriate controls and components, the student will construct a point to point electrical diagram and then convert to an across the line diagram.

14. Given a control board with a flame safe guard control and all the other appropriate controls and components, the student will test the system for proper operation, record necessary data and troubleshoot the system.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 237
Date:	Jan 92
Dept.	Approval

COURSE TITLE: Mechanical and Electrical Systems for Buildings

COURSE DESCRIPTION: Awareness of heating, ventilating and air conditioning systems, water supply, sanitary and storm sewers, fire protection, electrical distribution, lighting and acoustical systems for buildings. Emphasis is placed upon systems integration, energy considerations and their effects upon building planning, detailing and construction. Discusses equipment, code requirements and building applications.

Semester Hours: 3

Contact Hours Lecture 3 hours/week

Prerequisites: None

Textbook Required: "Mechanical and Electrical Systems for Construction" by Riley Shuttleworth (1983, McGraw Hill).

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

			TIME WEIGHT	
			Lecture	**/ Lab. Hrs.**
I.	Energy Units, Terms and Psychrometry		4	0
II.	Field Trip #1		1	0
III.	Load Calculation (HVAC)		6	0
IV.	HVAC System and Equipment			0
	Air Systems and Ductwork		3	0
			3	0
	Hydronic System and Piping		3	0
VI.	Hydronic System Design Procedure			0
VII.	Balancing Hydronic Systems		1	3
VIII.	Air System Configurations		2	0
IX.	Applied Psychometrics		23	0
X.	Fan Selection and Performance		2	0
XI.	Ductwork		9	0
XII.	Air System Pressure Loss Calculations		3	0
XIII.	Air Diffusion		5	0
		Totals	60	0

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Energy Units, Terms and Psychrometry
II. Field Trip #1
III. Load Calculation (HVAC)
IV. HVAC System and Equipment
- A. Types
- B. Pump curves
  1. Flow
  2. Head
  3. Impeller size
  4. Efficiency
  5. Horsepower
  6. NPSH
- C. Closed systems
- D. Open systems

V. Terminal Devices
- A. Radiators
- B. Finned tube
- C. Convectors
- D. Cabinet
- E. Unit heaters
- F. Air handling unit coils
- G. Converters or heat exchangers

VI. Flow Control Devices

A. Service valves

1. Gate valves
   a. Rising stem
   b. Non-rising stem
1. Globe valves
2. Ball valves
3. Butterfly valves
4. Check valves

B. Modulating flow valves

1. Heat transfer vs. flow rate
2. Valve plug configuration
   a. Quick opening
   b. Linear or v-port
   c. Equal percentage
3. Valve type
   a. Two-way
   b. Three-way
      1) Mixing
      2) Diverting
4. Flow coefficient (cv)
5. Applications
   a. Hot water heating control
   b. Chilled water control
   c. Indoor/outdoor reset

VII. Hydronic System Design Procedure

A. Calculate heat loss

B. Size heating devices

C. Calculate required flow by zone

D. Determine piping arrangement

E. Layout preliminary piping

F. Calculate friction loss

1. Pipe sizing
2. Equivalent length of fittings
3. Other circuit losses
   a. Heating/cooling equipment
   b. Terminal units
   c. Balancing valves
   d. Control valves

G. Pump affinity laws

H. System curve

1. Operating point
2. Effect of control valve
3. Open systems

I. Select circulating pump

J. Parallel pump applications .

K. Series pump applications
L. Pumping characteristics for viscous fluids
M. Expansion tanks
   1. Purpose
   2. Location
   3. Sizing

VIII. Balancing Hydronic Systems
   A. Equipment check
   B. System check
   C. Pump testing
   D. System Balancing
      1. Instrumentation
      2. Formulas and calculations
      3. Pre-balancing hydronic circuits
      4. Flow measurement and balancing devices
      5. Energy savings calculations

IX. Air System Configurations
   A. Single Path Systems
      1. Single zone, constant volume
      2. Terminal reheat
      3. Variable volume a
         a. True VAV system
         b. VAV by-pass system
         c. VAV reheat system
         d. VAV induction system
         e. Fan powered VAV systems
            1) Series fan powered VAV boxes
            2) Parallel fan powered VAV boxes
      1. Induction
   B. Dual path systems
      1. Multizone
         a. By-pass multizone
         b. "Texas" multizone
      2. Dual duct
         a. Dual duct constant volume
         b. Dual duct vav

X. Applied psychrometric
   A. Properties of air
      1. Dry bulb temperature
      2. Wet bulb temperature
      3. Dew point temperature
      4. Relative humidity
      5. Specific humidity (humidity ratio)
      6. Specific volume
      7. Total heat content (enthalpy)
   B. ASHRAE comfort envelope

- C. Air conditioning processes
  1. Sensible heating and Cooling
  2. Cooling and dehumidification
  3. Heating and humidification
  4. Evaporative cooling
  5. Chemical dehydration
  6. Air mixing

XI. Fan Selection and Performance
- A. Flow and pressure equations
- B. Duct pressures
  1. Static pressure
  2. Velocity pressure
  3. Total pressure
- C. Fan performance curve development
- D. Fan categories and application
  1. Centrifugal fans
     - a. Forward curve
     - b. Backward inclined
     - c. Airfoil
     - d. Radial
     - e. Tubular centrifugal
  2. Axial fans
     - a. Vane axial
     - b. Tube axial
     - c. Propeller
- E. Fan laws
- F. Fan performance for non standard air conditions
- G. Fan volume control
  1. Riding the curve
  2. Discharge dampers
  3. Inlet dampers
  4. Inlet vanes
  5. Fan speed adjustment
     - a. Electrical
       - 1) Electrical speed control
       - 2) Dc drive
       - 3) Adjustable frequency
     - b. Mechanical
       - 1) Eddy current clutch
       - 2) Belt speed changer

XII. Duct Work
- A. Classification
  1. Function
  2. Path
  3. Velocity
  4. Pressure

5. Material
6. Shape

B. Duct sizing methods
1. Equal friction
2. Static regain
3. Constant velocity
4. Velocity reduction

XIII. System Pressure Loss Calculations
A. Duct system pressure changes
B. Fitting losses
C. Fan and duct system interface
D. Fan outlet system effect losses
E. Fan inlet system effect losses
F. Air side devices

XIV. Air Diffusion
A. Principles of room air diffusion
B. Zones of isothermal jet expansion
C. Surface effects on jets
1. Throw
2. Drop

D. Objectives of air diffusion
E. Types of outlets
1. Diffusion patterns
2. Effect upon heating and cooling applications

F. Air distribution performance index (ADPI)
G. Methods of outlet selection
1. Selection by comfort determination from jet performance
2. Selection by comfort criteria
3. Selection by noise criteria

XV. Duct System Design Procedure
A. Design CFM values
B. Select and locate air distribution devices
C. Locate the central equipment
D. Preliminary layout
E. Sizing calculations
F. Calculate the system total pressure loss
G. Select the fan
H. Noise
I. Final drawings and specifications

XVI. Testing and Balancing
A. Instruments and testing system balancing
1. Duct
2. Equipment
3. Distribution

XVII. Indoor Air Quality
A. Definition

B. ASHRAE Standard 62-89
C. Guidelines for selected air contaminants of indoor origin

MINIMUM REQUIRED STUDENT LAB ACTIVTIES DEFINED:

1-2. **Classification and Identification of Distribution:** Student will sketch and identify hydronic system piping arrangements and terminal units.

3. **Pumps and Pump Curves:** Student will use manufacturers catalogs and computer software to select centrifugal pumps and determine operating characteristics.

4. **Closed Hydronic System Analysis:** Student will manually calculate friction loss in chilled water loop and select circulating pump for the application.

5. **Open Hydronic System Analysis:** Student will manually calculate friction loss in cooling tower loop and select circulating pump for the application.

6. **Parallel Pump Analysis:** Student will use manufacturer's computer software to analyze a parallel pump application.

7. **Hydronic System Design:** Given a building layout and heat loss, friction chart and tables, the student will layout the system, select terminal units, size pipe, select pumps, plot system curve, and select an expansion tank.

8. **Test, Adjust and Balance:** Given an operating system and design operating conditions, the student will measure flow rates, analyze pump performance, and adjust balancing valves for maximum performance.

9. **Tour of HVAC Air Systems:** Instructor explanation of different system types.

10. **Air Measurement Exercise:** Student will determine air flow through ductwork by taking pitot tube traverse, hot wire anemometer readings, and airflow hood readings at the diffuser.

11. **Fan Law Exercise:** Student will observe effect upon motor horsepower, system pressure and air volume due to change in fan speed.

12. **Duct Design Exercise:** Layout duct system based upon type of system and building configuration. Student will size ductwork based upon air flow and calculate static pressure losses by ASHRAE method.

13. **Computerized Duct Design:** Student will utilize commercial software to size ductwork by equal friction and static regain methods.

14-15. **Air Balancing Exercise:** Utilizing methods of measuring air flow, student will adjust dampers and fan speed to produce air flow within 10 percent of design requirements.

TASK LISTING: The student shall be able to:

A. *System Classification*
1. Classify hydronic systems based upon flow generation, temperature, pressure, piping and pumping arrangement.
2. Explain the advantages and disadvantages of various piping and pumping arrangements.
3. Calculate primary and secondary flow rates and temperatures in primary-secondary pumping arrangements.

B. *Centrifugal Pumps*
1. Identify the components and summarize the operation of a centrifugal pump.
2. Explain the relationship between flow rate and total dynamic head in a closed hydronic system.
3. Explain the difference between open and closed hydronic systems.

C. *Terminal Devices*
1. Determine type, size and location of finned tube radiation units.
2. Determine type, size and location of hot water convector units.
3. Determine type, size and location of cabinet unit heaters.
4. Determine type, size and location of unit heaters.
5. Determine type and size of air handling unit hot water coils.
6. Determine type, size and location of hot water heat exchangers.

D. *Flow Control Devices*
1. Explain the application of various service valves in hydronic systems.
2. Explain the relationship between heat transfer, temperature differential and flow through a terminal convection element.
3. Explain the relationship between valve port configuration and stem travel.
4. Explain the relationship between energy transfer and valve stem travel for various valve types.
5. Define the control flow coefficient (Cv).
6. Select two-way modulating and three-way mixing and diverting valves using the flow coefficient (Cv).

E. *Hydronic System Design*
1. Calculate the required flow of water for each temperature control zone.
2. Determine pipe size required to carry desired water flow rate based upon friction loss and velocity.
3. Calculate equivalent length of pipe fittings in piping network.
4. Calculate friction loss of piping circuits.
5. Determine pressure losses of equipment and terminal unit from manufacturer's data.

6. Calculate total head loss in closed loop piping systems.
7. Use pump affinity laws to plot system curve on pump performance curve for closed loop piping system.
8. Select a circulating pump from manufacturer's performance data for closed loop piping system.
9. Calculate total head loss in open loop piping systems.
10. Use pump affinity laws to plot system curve on pump performance curve for open loop piping system.
11. Select a circulating pump from manufacturer's performance data for closed loop piping system.
12. Select proper motor horsepower for circulating pump from manufacturer's performance data.
13. Develop parallel pump performance curves and identify operating points.
14. Develop series pump performance curves and identify operating points.
15. Analyze the effects of glycol on pump performance.
16. Determine the type, size and location of the system expansion tank.

F. *Computer Applications for Hydronic Systems*
1. Utilize manufacturer's computer software to calculate piping system friction loss.
2. Utilize manufacturer's computer software to proper circulating pump.
3. Utilize manufacturer's computer software to select proper expansion tank size.

G. Balan*cing Hydronic Systems*
1. Identify and summarize the function of instruments used to balance hydronic systems.
2. Determine circulating pump impeller size.
3. Determine actual operating characteristics of circulating pump.
4. Determine flow rates of hydronic circuits using various flow measuring devices.
5. Calculate resistance necessary to pre-balance hydronic circuit.
6. Determine new impeller size to produce required flow rate.

H. *System Classification*
1. Describe the components and operating characteristics of a single zone air system.
2. Describe the components and operating characteristics of a terminal reheat air system.
3. Describe the components and operating characteristics of a dual-duct air system.
4. Describe the components and operations characteristics of a multizone air system.
5. Describe the components and operating characteristics of a variable air volume.
6. Describe the components and operating characteristics of a variable volume, variable temperature (VVT) system.
7. Describe the components and operating characteristics of an induction air system.

I. *Applied Psychrometric*
1. Describe the psychrometric process that occurs during the heating and humidifying cycle.
2. Describe the psychrometric process that occurs during the cooling and dehumidifying cycle.
3. Calculate the mixed air conditions resulting from mixing different volumes of outdoor and return air.

J. *Fan Performance*

1. Identify two main categories of fans.
2. Describe performance characteristics of forward curve fans.
3. Describe performance characteristics of backward inclined and air foil fans.
4. Describe performance characteristics of radial blade fans.
5. Describe performance characteristics of propeller fans.
6. Describe performance characteristics of vane-axial fans.
7. Describe performance characteristics of tube-axial fans.
8. Select a fan from manufacturer's performance data.
9. Use fan laws to plot system curve on fan performance curve.
10. Select proper motor horsepower for circulating fan.
11. Describe effects of varying fan volume on fan performance curve.

K. *Ductwork Design and Selection*

1. Calculate cross-sectional area of a duct.
2. Calculate velocity of air in a duct.
3. Calculate volume of air in a duct.
4. Determine space air flow requirements.
5. Determine type, size and routing of duct system (including ventilation air intake and exhaust ducts).
6. Determine type, sire and location of diffusers and grilles.
7. Determine location and size of ventilation air intake.
8. Determine location and size of exhaust air grille.
9. Find fitting loss coefficients from tabular data.
10. Calculate friction loss in duct system.
11. Utilize manufacturer's computer software to calculate duct system friction loss.

L. *Testing and Balancing*

1. Measure CFM air flow in duct.
2. Measure pressure drop across coil or filter using manometer and probes.
3. Measure airflow at register.
4. Determine relative humidity.
5. Adjust fan speed for correct CFM output.
6. Balance duct system for correct CFM at each register.
7. Adjust variable air volume boxes for correct CFM at each zone.
8. Adjust fresh air intake.
9. Check static pressure at fan discharge.
10. Set V-Belt tension.
11. Align belt sheaves.
12. Check motor speed.

M. *Indoor Air Quality*

1. Define indoor air quality
2. Describe the important aspects of ASHRAE Standard 62-89.

GRADING POLICY

94-100=A	90-94=A-	87-90=B+	84-87=B	81-84=B-	78-81=C+
75-78=C	73-75=C-	71-73=D+	69-71=D	67-69=D-	66 and below F

EXAM WEIGHT

Exams one (1) through three (3) each account for 15 percent of final grade (45 percent total).
Final exam accounts for 20 percent of final grade.
Homework accounts for 10 percent of final grade.
Laboratory submittals account for 25 percent of final grade.

NOTE:
Late submittals will be reduced one full grade for each calendar day beyond submittal date.
Laboratory assignments are due on Monday of the week following the lab period.

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WRITTEN OCCUPATIONAL PROFILE FOR HVACLR ENGINEERING TECHNOLOGY

Students interested in HVACR Engineering Technology (HVT) (CIP Code 15.0501 and 15.0503) should be aware of the following characteristics possessed by personnel working within the trade. These characteristics are based upon survey and observation of HVT personnel in their work environments.

HVT personnel should possess good reasoning skills. They must be able to analyze client energy consumption by studying energy use patterns and comparing the results with similar facilities in the same geographical region. They must be able to determine the type of heating, ventilating and air conditioning (HVAC) system present within the facility and determine whether the system is performing satisfactorily. If problems exist with the HVAC system they must be able to make recommendations to return the system to peak performance. They must be able to analyze control systems whether they be electric, pneumatic or microprocessor based and troubleshoot and repair them if necessary. They must be capable of recommending retrofit measures to conserve energy and then follow up with measurements to determine if the recommendations are in fact saving energy.

These personnel must posses a high degree of mathematical development. Mastery of algebra is a requirement and should include the areas of linear, quadratic, exponential, logarithmic, angle and circular functions in order to develop graphical relationships for numerous applications. Geometry is also a requirement since HVT personnel must understand spatial relationships of building components when analyzing working drawings. They must apply these mathematical concepts to assess performance of control systems, analyze problems involving fluid mechanics (air and water) and perform life cycle cost analysis.

A high degree of skill in communications is necessary for those in HVACR Engineering Technology since most personnel will act as a liaison between the technician and the engineer. While performing energy auditing and system analysis, HVT personnel must be capable of describing the building including the envelope and usage, the mechanical and electrical systems, explain control strategy, discuss operational and maintenance items and recommend energy saving measures. They must be capable of describing highly complex systems in layman's terms and must be persuasive both verbally and in writing in order to sell management on the idea of investing to save energy and money. They must be capable of reading and interpreting highly technical information contained in trade journals and literature published by professional societies in order to stay in step with technological advances.

The formal training program usually requires four years of classroom instruction which includes a minimum ten week internship program between the third and fourth year of study. The graduates although capable of holding a multitude of titles are generally classified as engineering technologists and may find employment with utility companies, the controls industry, mechanical contractors, engineering design firms and manufacturers equipment representatives. They possess basic skills of the HVAC industry and will receive additional specialized training usually dictated by the specialty in which they are ultimately employed.

Physical demands of the job are considered to be light. When analyzing HVAC systems, HVT personnel may be required to climb ladders and negotiate tight spaces in order to gain information about equipment. Instruments utilized are generally hand-held and can be easily negotiated on an individual basis. These would include such items as pressure gauges, thermometers, volt-ammeters, watt meters, power factor meters, air flow hoods and light level meters. An exception would be the use of inclined manometers to read air pressure where an assistant is best utilized to record readiness. Manual dexterity and good eye-hand coordination are required to setup test equipment. Near visual acuity is important in obtaining accurate readings and color perception may also be critical when tracing control wiring that is color-coded.

Working conditions are good with most work being performed indoors. Exceptions would include analysis of equipment that may be roof-mounted. HVT personnel may be subject to noise encountered in mechanical rooms and industrial environments and although the intensity may not be of sufficient levels to cause harm, may be detrimental if exposure is prolonged. Other hazards may include the risk of electrical shock, proximity to equipment operating at high-speed and dusts produced by asbestos fibers which remain prevalent in some areas as an insulation from hot surfaces. High pressure steam systems may also produce hazards.

HVT personnel should possess above average intelligence and a high numerical aptitude. They should also have good verbal skills along with good abilities regarding spatial relationships, form perception regarding objects and graphic material. They should also have good aptitudes for clerical work and motor coordination. HVT personnel should be capable of analyzing multiple tasks and have the ability to determine the impact of change on the overall system. They must also be able to sift through a significant amount of data and determine what is important.

Individuals considering entering the field of HVACR Engineering Technology should have a good mechanical background and the desire to understand what makes things "tick".

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 245
Date: Aug.1991
Dept. **Approval**

COURSE TITLE: Design of Heating, Ventilating, and Air Conditioning Systems

COURSE DESCRIPTION: The study of heat gain and loss of residential and light commercial structures with both forced air and hydronic systems implementation. Computerized and manual Load calculations and air system instrumentation will be explored in the lab sessions.

Credit Hours: 5 Credit Hours

Contact Hours Lecture 4 hours/week
Laboratory 3 hours/week

Prerequisites: Math 116

Textbook Required: Air Conditioning contractors of America (ACCA) Manuals "J," "D," and "N"

Reference: ASHRAE, Bell & Gossett, IBR Michigan Dept. of Health, Dunhan-Bush, Copeland, Michigan Codes – International Mechanical Codes.

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction	1	0
II.	Load Calculations Residential	4	3
III.	System Design Residential	4	3
IV.	Load Calculations Commercial	4	3
V.	System Design Commercial	4	3
VI.	System Design Hydronic	4	3
VII.	Load Calculation Commercial	3	4
VIII.	Refrigeration System Design	3	4
IX.	Humidification	2	1
X.	Make-Up Equipment	2	2
XI.	Heat Recovery Methods	1	2

XII.	Insulation	2	3
XIII.	Computer	6	8
XIV.	Fans; Laws and Application	5	2
XV.	Calculation, Design and Troubleshooting Air Systems	5	1
XVI.	Restaurant Ventilation Requirements	5	1
XVII.	Sound and Measurement	3	1
	Total	60	45

TOPICAL OUTLINE OF MAJOR UNITS OF INSTRUCTUION

I. Introduction

A. Syllabus
B. Importance of fundamental principles of hvac design
C. Comments on energy saving devices
D. Fuel costs

II. Load Calculations Residential

A. Building components
B. Heat loss of structure
C. Heat gain of structure
D. Annual energy consumption

III. System Design Residential

E. Factors affective system design
F. Economics of design
G. Design principles
H. Types of systems

IV. Load Calculations Commercial

A. Solar radiation
B. Occupancy
C. Infiltration/ventilation
D. Dehumidification/humidification
E. Equipment selection
F. Annual energy consumption

V. System Design Commercial

A. Factors affective system design
B. Types of systems
C. Equipment selection
D. Economics of design

VI. System Design Hydronic

A. Types of systems
B. Selection of equipment

C. Layout of piping and accessories
D. Material cost

VII. Load Calculation Commercial Refrigeration

A. Job survey
B. Wall loads
C. Air change
D. Product type
E. Miscellaneous

VIII. Refrigeration System Design

A. Selection of equipment
B. Sizing of pipe
C. Temperature requirements
D. Coil temperature difference
E. Refrigerant Selection

IX. Humidification

A. Terms and definitions
B. Benefits of humidification
C. Types of humidification
D. Sizing of equipment

X. Make Up Air Equipment

A. Direct fired
B. Indirect fired
C. Heat recovery

XI. Heat Recovery Methods

A. Heat wheel
B. Z duct
C. Heat exchangers

XII. Insulation

A. Types
B. R-value
C. U-value
D. Areas of use

XIII. Computer

A. Use of computer in load calculation and design
B. Load estimating
C. Duct design
D. Operating cost
E. Equipment selection

XIV. Fans-Laws and Applications

A. Fan basics
   1. Types within 2 families
   2. Nomenclature of moving air
      a. Pressures-related formulas
      b. Velocities-related formulas
   3. Three common fan laws and their limitations
B. Instruments for measuring air movement
   1. Inclined water gauge
   2. Alnor
   3. Pilot tube
   4. Velometer
C. Calculate variables using friction chart

XV. Calculation, Design and Troubleshooting Air Systems

A. Ideal balanced system
   1. Flows in each trunkline
   2. Pressures in each trunkline
B. Problem systems
   1. Oversize
   2. Restrictions
   3. Flow changes
   4. Pressure changes
C. Effects of external accessories
   1. Diffusers
      a. Energy usage
   2. Flow changes
   3. Pressure changes

XVI. Restaurant Ventilation Requirement

A. Michigan restaurant code book
   1. Proper ventilation for each type of kitchen equipment
   2. Proper make-up air
      a. Energy usage
   3. Sizing ductwork for optimum flows, statics
B. Measurements for ventilation balance
C. Exhaust systems
   1. Kitchen
   2. Industrial

XVII. Sound and Measurement Techniques

A. Terminology of basic sound technology
B. Governing organizations and their functions within the industry
   1. AABC, AMCA, and ASA
C. Proper use of sound level meter
D. Proper attenuation techniques

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Given proper reference material, code manuals, and handouts the student will be able to use correct procedures in selecting warm air equipment and component parts for a commercial system and a residential system.

2. Given proper reference material, instructor handouts and product guides, the student will be able to select Hydronic equipment and component parts for a commercial and a residential application.

3. Given ACCA manuals and recognized code regulations the student will be able to determine load calculations for residential and commercial buildings to ACCA manual guidelines. (BTUH) Warm air and Hydronic.

4. Given proper code and regulation manuals, the student will design warm air and hydronic systems by code in both residential and commercial applications.

5. Given manufacturer manuals, product guides and instructor handouts, the student will correctly determine the proper radiation, diffusers or registers for application of both warm air and hydronic systems.

6. Given proper textbooks and manuals, the student will properly select air flow in CFM for warm air and gallons per minute for hydronic systems.

7. Given air cleaning reference material and handouts, the student will be able to determine size and capacity of a unit, its efficiency and proper installation.

8. Given handouts, ACCA manuals, ASHRAE manuals, insulation, and manufacturer specifications, the student will be able to correctly identify R-values, calculate values of insulation and determine proper insulation for commercial and residential structures.

9. Given a micro computer (TRS-80, etc.), appropriate software, and building plans, the student will run programs to determine heat loss and gain of a residential and commercial building.

10. Given proper manuals, codes and handouts, the student will design proper venting systems for the removal of flue gasses produced by the combustion of fuels.

11. Given manuals, code books, manufacturer specification sheets and utility companies' reference materials, the student will be able to design both radiant and resistance electric heat systems.

12. Given manuals for leading refrigeration manufacturers and worksheets provided by the instructor, the student will properly design and size refrigeration equipment, size refrigerant pipe, and follow correct piping practices.

13. Given worksheets and humidity calculation sheets, the student will follow the proper procedures in calculating humidity by formula and determine the proper application of commercial and residential humidifiers.

14. Given the Michigan Department of Health Code and manufacturers' recommendations, the student will be able to design exhausting systems for residential, commercial and industrial buildings to meet Michigan Department of Health requirements.

15. Given the ASHRAE Guide, B0CA Code, make-up air references and hand-outs, the student will properly design a make-up air unit for a commercial or industrial building.

16. Given a building and a set of blueprints the student will be able to select the most efficient and practical type of system, such a VAV, dual duct, terminal heat, single zone and induction systems.

17. Given a micro-computer (TRS-80 or similar unit), appropriate software and building plans the student will run programs to design air distribution systems, select proper equipment and compute energy costs.

18. Given commercial heating and air conditioning systems such a VAV, dual duct, terminal reheat, single zone and induction systems the student will describe methods for making the system more energy efficient.

19. Given a residential or commercial building plan the student will calculate the correct amount of humidification needed and select the proper type of humidifier.

20. Given manuals or manufacturer specification sheets the student will be able to design infrared heating systems.

21. Given manufacturer specifications sheets and instructor handouts the student will become familiar with methods of heat recovery.

22. Given worksheets, manuals, and hand-on laboratory units, the student will perform tests and properly adjust units to specifications.

23. Given instrumentation, specifications, air system and out, the student will properly adjust for maximum comfort.

24. Given a duct work system design, the student shall determine resistance of various external accessories.

25. Given fan law equations the student shall be able to calculate the unknown quantities relating to the various laws.

26. Given the friction chart the student shall demonstrate his ability to determine duct airing, velocity, static pressure, and cubic feet per minute directly from the chart.

27. Given a unit A M C A manual and handout from the ASHRAE guide, the student will use sound meters and testing devices to test for maximum sound levels.

28. Given friction chart specifications, and existing unit the student will be able to determine proper air flow and make proper adjustments to correct faulty air flow problems.

29. Given lecture, standards of the ventilation codes for restaurants in Michigan, a classroom project and test questions, the student will demonstrate an understanding for the following areas, noise, balancing, sizing and make-up air for kitchen exhaust systems

30. Given blueprints of the building and proper instruments the student will adjust the flow of air out for proper heating or cooling requirements.

31. Given a blueprint and instrumentation, the student will balance the exhaust and make-up air to Michigan Department of Health Codes.

32. Given the Michigan Department of Health Code and manufactures recommendations, the student will be able to design exhausting systems for restaurants, and commercial and industrial buildings to meet Michigan Department of Health requirements.

Attendance Policy:
All students are expected to attend each class session unless prior arrangements have been made. In case of emergency, illness, or prior arrangement, any test may be made up without penalty. If student misses a test or exam for reasons other than previously stated, the student will not be allowed to make up the test.

Grading Scale:

1. Weekly Quizzes	40 percent of quiz grade
2. Midterm and Final	60 percent of grade = 40 percent of total grade
3. Laboratory Requirements	60 percent of total grade

GRADING POLICY:

S+ S-	Extra effort
S	Expected effort
S-	Less that expected effort

Grade	HP	Grade
100-94	4.0	A
93-90	3.7	A-
89-87	3.3	B+
86-84	3.0	B

83-81	2.7	B-
80-78	2.3	C+
77-75	2.0	C
74-73	1.7	C-
72-71	1.3	D+
70-69	1.0	D
68-67	0.7	D-
66-Below	0.0	F

FINNAL TERM GRADE BASED ON:

Testing Procedures:
A weekly test on sections covered, usually set for Friday, but sometimes determined by student progress - a 1-day notice will be given as to test date.

A midterm test will be administered during the middle of the semester. A 1-day notice will be given as to test date.

A final test during the last week of the semester with a two-day notice. The final will be a comprehensive test.

1. Approximately six (6) weekly quizzes
2. One (1) midterm
3. One (1) final

Laboratory Requirements:
1. Heating cooling design residential
2. Hydronic design residential
3. Heating cooling design commercial
4. Refrigeration design commercial
5. AIP testing fan and system curves

Instructor:
Joe Nott

HVACR ENGINEERING TECHNOLOGY
BACHELOR OF SCIENCE DEGREE
FALL SEMESTER
Curriculum Guide Sheet

NAME OF STUDENT________________________________ STUDENT I.D.________________

Total semester hours required for graduation: 64/65

NOTE: Meeting the requirements for graduation indicated on this sheet is the responsibility of the student. Compliance with this agreement will assure the student completion of the program in the time frame indicated. Your advisor is available to assist you.

THIRD YEAR - FALL SEMESTER			CREDITS	COMMENTS/GRADE	
HVAC	331	HVAC Secondary Equiq. Selection & Design (HVAC 235,245)	5		
____	___	Scientific Understanding Elective	3-4		
MATH	126	Algebra and Analytic Trigonometry	4		
ISYS	204	Basic Programming	3		
THIRD YEAR - WINTER SEMESTER					
HVAC	342	HVAC Load Calculations and Energy Code (HVAC 331)	3		
HVAC	312	HVAC Control Theory and Applications (HVAC 331)	4		
ECON	221	Principles of Economics 1	3		
____	___	Cultural Enrichment Elective**	3		
ARCH	109	Introduction to Computer Graphics in Architecture*	2		
THIRD YEAR - SUMMER SEMESTER					
HVAC	393	Summer Internship	4		
FOURTH YEAR - FALL SEMESTER					
HVAC	415	HVAC Dig. Control Systems(HVAC 312,MATH 126/130,ISYS 204)	4		
HVAC	462	Primary HVAC Equipment Selection (HVAC 342)	4		
HVAC	451	Energy Analysis and Audit (HVAC 312 & 342)	5		
COMM	221	Small Group Decision Making****	3		
FOURTH YEAR - WINTER SEMESTER					
HVAC	499	Commercial HVAC System Design (HVAC 451)	5		
____	___	Social Awareness Elective (300+)***	3		
____	___	Cultural Enrichment Elective (200+)**	3		
____	___	Directed Elective	3		

OPTIONAL COURSES :

HVAC 490 Special Topics in HVACR
HVAC 497 Special Studies in HVACR

***** **One-half semester course**
****** **Three Cultural Enrichment courses from at least 2 different prefixes**
******* **Three Social Awareness courses from at least 2 different prefixes**
******** **Two Writing Intensive Courses MUST be taken in addition to COMM 221**

From among the Cultural Enrichment and Social Awareness coursework, at least one global consciousness course must be taken.

5/00 (OVER)
pm\cksh00f\hvac

CURRICULUM REQUIREMENTS
HVACR ENGINEERING TECHNOLOGY
BACHELOR OF SCIENCE DEGREE
FALL SEMESTER

ENTRY CRITERIA:

AAS degree in HVAC Technology.

MINOR OPTION: Computer Information Systems Minor - 18 credits.

Required Courses:	ISYS 202 + 204		
Elective Courses:	HVAC 415 **AND**	TRACK I:	ISYS 305, 310 & 350 - Recommended Track
		TRACK II:	ISYS 301, 305 & 400
		TRACK III:	ISYS 212, 305 & 312

See your HVACR Advisor and contact ISYS department in BUSN 212 (ext. 2434) to sign up for this minor option to HVACR Engineering Technology.

TECHNICAL	CREDIT HOURS	GENERAL EDUCATION	CREDIT HOURS
HVAC 331 HVAC Second. Equip. Sel. & Design	5	Communication Competence	
HVAC 312 HVAC Control Theory & Applica.	4	COMM 221 Small Group Decision Making	3
HVAC 342 HVAC Load Calcula. & Engy. Code	3		
HVAC 393 Summer Internship	4	Scientific Understanding	
HVAC 415 HVAC Digital Control Systems	4	Elective	3/4
HVAC 451 Energy Analysis and Audit	5		
HVAC 462 Primary HVAC Equip. Selection	4	Quantitative Skills	
HVAC 499 Commercial HVAC System Design	5	MATH 126 Algebra & Analytic Trigonometry	4
Technical Related		Cultural Enrichment	
ARCH 109 Intro. to Comp. Graphics in Arch.	2	Elective	6
ISYS 204 Basic Programming	3		
		Social Awareness	
Technical Elective		Elective	3
Directed Elective	3	ECON 221 Principles of Economics 1	3

B.S. Degree Minimum General Education Requirements in Semester Hours:

Cultural Enrichment Credits - 9
Communications Credits - 12
Social Awareness Credits - 9
Scientific Understanding Credits - 7/8

5/00 (OVER)
pm\cksh00f\hvac

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 312
Date:
Dept.

COURSE TITLE: HVAC 312 HVAC Control Theory and Application

COURSE DESCRIPTION: The study of control loop theory related to commercial and industrial comfort, process and safety applications. The course focuses on analog electronic and pneumatic control components and their systems used in new and existing installations. Lab exercises concentrate on control system operation and analysis.

Semester Hours: 4

Contact Hours Lecture 3 hours/week
Laboratory 3 hours/wk

Prerequisites: HVAC 331

Textbook Required: HVAC Control Theory and Applications, by Thomas Horan

LECTURE SCHEDULE / TOPICS

WEEK	TOPIC
NO. 1	Lec. 1 - Introduction
	Lec. 2 – Background & terminology
	Lec. 3 – Background & terminology
NO. 2	Martin Luther King Day – No Class
	Lec. 4 – Background & terminology
	Lec. 5 – Loop Components & Configuration
NO. 3	Lec. 6 – Loop Components & Configuration
	Lec. 7 - Loop Components & Configuration
	Lec. 8 - Loop Components & Configuration
NO. 4	Lec. 9 – Transfer Functions – Elements
	Lec. 10 – Transfer Functions – Elements
	Lec. 11 – Transfer Functions – Application

N0. 5	Lec. 12 – Transfer Functions – Application Lec. 13 – EXAM #1 Lec. 14 – Transfer Functions – Application
NO. 6	Lec. 15 – Transfer Functions – Application Lec. 16 – Transfer Functions – Application Lec. 17 – Sensors
NO. 7	Lec. 18 – Sensors Lec. 19 – Sensors Lec. 20 – Controllers
Spring Break	
NO. 8	Lec. 21 – Controllers Lec. 22 – Controllers Lec. 23 – Controllers
NO. 9	Lec. 24 – Modulating Final Control Devices Lec. 25 – EXAM #2 Lec. 26 – Modulating Final Control Devices
NO. 10	Lec. 27 – Modulating Final Control Devices Lec. 28 – Modulating Final Control Devices Easter Recess
NO. 11	Lec. 29 – Control Valve Sizing and Selection Lec. 30 – Control Valve Sizing and Selection Lec. 31 – Control Valve Sizing and Selection
NO. 12	Lec. 32 – Damper Sizing and Selection Lec. 33 – Actuator Selection Lec. 34 – Control Mode and Process Characteristics
NO. 13	Lec. 35 – Control Mode and Process Characteristics Lec. 36 – Control Mode and Process Characteristics Lec. 37 – EXAM #3
NO. 14	Lec. 38 – Calibration and Response of Modulating Control Loops Lec. 39 - Calibration and Response of Modulating Control Loops Lec. 40 - Calibration and Response of Modulating Control Loops
NO. 15	Lec. 41 - Calibration and Response of Modulating Control Loops Lec. 42 - Calibration and Response of Modulating Control Loops Lec. 43 - Calibration and Response of Modulating Control Loops

NO. 16	FINAL EXAM

LAB SCHEDULE / TOPICS

WEEK	TOPIC
NO. 1	Lab Overview
NO. 2	Lab 1 System Control Configuration
NO. 3	Lab 2 Building Heating System Basic Control Layout
NO. 4	Lab 3 Verification of Control Layout (Air Handling Unit)
NO. 5	Lab 4 Verification of Control Layout (Hydronic Heating System)
NO. 6	Lab 5 Calibration and Verification of a Control Loop
NO. 7	Lab 6 Calibration and Verification of a Control Loop (Number 2)
NO. 8	Lab 7 Calibration of a Controller and Thermostat
NO. 9	Lab 8 Control Project General Overview
NO. 10	Lab 9 Control Project Component Identification
NO. 11	Lab 10 Control Project Schematic & Accurate Description of Operation
NO. 12	Lab 11 System Identification & Control Strategies
NO. 13	Lab 12 System Identification & Control Strategies
NO. 14	Lab 13 Field Trip
NO. 15	Lab 14 Field Trip

ADDITIONAL COURSE INFORMATION

GRADING POLICY

A	**94-100**
B	**90-93**
B+	**87-89**
B	**84-86**
B-	**81-83**
C+	**78-80**
C	**75-77**
C-	**73-74**
D+	**71-72**
D	**71-72**
D-	**66-68**
F	**65 and below**

GRADE BASED ON:

Exam 1-15% of final grade
Exam II-15% of final grade
Exam III-15% of final grade
Final Exam – 25% of final grade

Labs & Quizzes – 30%

All labs must be attended to avoid an incomplete. Assignments are due at the beginning of the class period. If the assignment is not turned in on time, the grade will be zero (0) for that assignment. NO LATE ASSIGNMENTS WILL BE ACCEPTED.

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 331
Date:
Dept.

COURSE TITLE: HVAC-331 HVAC Secondary Equipment Selection and Design

COURSE DESCRIPTION: A study of water and air systems used in commercial and industrial buildings. Course emphasizes system design, equipment and component selection and selected problems and solutions. Instrumentation, testing and balancing will be emphasized for optimum energy conservation and maximum comfort.

Semester Hours: 5

Contact Hours

Lecture	4 hours/week
Laboratory	3 hours/wk

Prerequisites: Enrolled in HVACR Engineering Technology

Textbook Required:

Handbook of Fundamentals, by American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE).

Modern Heating, Ventilating, and Air Conditioning, by George Clifford, Prentice-Hall, 1990.

HVAC Systems and Equipment, by American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).

References:

Manual Q Commercial Low Pressure Low Velocity Duct System Design, Theory and Applications Duct Sizing and Fan Selection, by Air Conditioning Contractors of America, (ACCA) 1990.

Testing and Balancing HVAC Systems Manual, by Herb Wendes, Wendes Engineering and Contracting Services, 1981.

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Introduction	1	0
II.	Hydronic System Definition and Classification	3	3
III.	Pumps	1	3
IV.	Terminal Devices	2	3
V.	Flow Control Devices	4	0
VI.	Hydronic System Design Procedure	8	12
VII.	Balancing Hydronic Systems	3	3
VIII.	Air System Configurations	3	3
IX.	Applied Psychometrics	2	0
X.	Fan Selection and Performance	4	6
XI.	Ductwork	6	0
XII.	Air System Pressure Loss Calculations	12	0
XIII.	Air Diffusion	2	0
XIV.	Duct System Design Procedure	2	6
XV.	Air System Testing and Balancing	0	6
XVI.	Indoor Air Quality	2	0
	Exams	5	0
	Totals	60	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction

II. Hydronic Systems Definition

III. Classification

A. Flow generation
1. Gravity system
2. Forced circulation

B. Temperature and pressure
1. Low temp water systems (LTW)
2. Medium temp water systems (MTW)
3. High temp water systems (HTW)
4. Chilled water systems (CW)
5. Dual temp water systems (DTW)

C. Piping and pumping arrangement
1. One pipe
2. Two pipe
    a. Direct return
    b. Reverse return
3. Three pipe
4. Four pipe
5. Series loop

6. Primary-secondary pumping arrangement
    a. Tee law
    b. Common piping
    c. Configuration
        1) Start-stop pump control
        2) Injection pump control
        3) Modulating three-way valve

IV. Pumps

A. Types
B. Pump curves
    1. Flow
    2. Head
    3. Impeller size
    4. Efficiency
    5. Horsepower
    6. NPSH
C. Closed systems
D. Open systems

V. Terminal Devices

A. Radiators
B. Finned tube
C. Convectors
D. Cabinet
E. Unit heaters
F. Air handling unit coils
G. Converters or heat exchangers

VI. Flow Control Devices

A. Service valves
    1. Gate valves
        a. Rising stem
        b. Non-rising stem
    1. Globe valves
    2. Ball valves
    3. Butterfly valves
    4. Check valves
B. Modulating flow valves
    1. Heat transfer vs. flow rate
    2. Valve plug configuration
        a. Quick opening
        b. Linear or v-port
        c. Equal percentage
    3. Valve type
        a. Two-way
        b. Three-way
            1) Mixing
            2) Diverting

4. Flow coefficient (cv)
5. Applications
    a. Hot water heating control
    b. Chilled water control
    c. Indoor/outdoor reset

VII. Hydronic System Design Procedure

A. Calculate heat loss
B. Size heating devices
C. Calculate required flow by zone
D. Determine piping arrangement
E. Layout preliminary piping
F. Calculate friction loss
    1. Pipe sizing
    2. Equivalent length of fittings
    3. Other circuit losses
        a. Heating/cooling equipment
        b. Terminal units
        c. Balancing valves
        d. Control valves
G. Pump affinity laws
H. System curve
    1. Operating point
    2. Effect of control valve
    3. Open systems
I. Select circulating pump
J. Parallel pump applications .
K. Series pump applications
L. Pumping characteristics for viscous fluids
M. Expansion tanks
    1. Purpose
    2. Location
    3. Sizing

VIII. Balancing Hydronic Systems

A. Equipment check
B. System check
C. Pump testing
D. System Balancing
    1. Instrumentation
    2. Formulas and calculations
    3. Pre-balancing hydronic circuits
    4. Flow measurement and balancing devices
    5. Energy savings calculations

IX. Air System Configurations

A. Single path systems
    1. Single zone, constant volume
    2. Terminal reheat

3. Variable volume a
    a. True VAV system
    b. VAV by-pass system
    c. VAV reheat system
    d. VAV induction system
    e. Fan powered VAV systems
        1) Series fan powered VAV boxes
        2) Parallel fan powered VAV boxes
1. Induction

B. Dual path systems
1. Multizone
    a. By-pass multizone
    b. "Texas" multizone
2. Dual duct
    a. Dual duct constant volume
    b. Dual duct vav

X. Applied Psychrometrics

A. Properties of air
1. Dry bulb temperature
2. Wet bulb temperature
3. Dew point temperature
4. Relative humidity
5. Specific humidity (humidity ratio)
6. Specific volume
7. Total heat content (enthalpy)

B. ASHRAE comfort envelope

C. Air conditioning processes
1. Sensible heating and cooling
2. Cooling and dehumidification
3. Heating and humidification
4. Evaporative cooling
5. Chemical dehydration
6. Air mixing

XI. Fan Selection and Performance

A. Flow and pressure equations

B. Duct pressures
1. Static pressure
2. Velocity pressure
3. Total pressure

C. Fan performance curve development

D. Fan categories and application
1. Centrifugal fans
    a. Forward curve
    b. Backward inclined
    c. Airfoil
    d. Radial

        e. Tubular centrifugal
    2. Axial fans
        a. Vane axial
        b. Tube axial
        c. Propeller
- E. Fan laws
- F. Fan performance for non standard air conditions
- G. Fan volume control
    1. Riding the curve
    2. Discharge dampers
    3. Inlet dampers
    4. Inlet vanes
    5. Fan speed adjustment
        a. Electrical
            1) Electrical speed control
            2) Dc drive
            3) Adjustable frequency
        b. Mechanical
            1) Eddy current clutch
            2) Belt speed changer

XII. Duct Work

- A. Classification
    1. Function
    2. Path
    3. Velocity
    4. Pressure
    5. Material
    6. Shape
- B. Duct sizing methods
    1. Equal friction
    2. Static regain
    3. Constant velocity
    4. Velocity reduction

XIII. System Pressure Loss Calculations

- A. Duct system pressure changes
- B. Fitting losses
- C. Fan and duct system interface
- D. Fan outlet system effect losses
- E. Fan inlet system effect losses
- F. Air side devices

XIV. Air Diffusion

- A. Principles of room air diffusion
- B. Zones of isothermal jet expansion
- C. Surface effects on jets
    1. Throw
    2. Drop

D. Objectives of air diffusion
E. Types of outlets
    1. Diffusion patterns
    2. Effect upon heating and cooling applications
F. Air distribution performance index (ADPI)
G. Methods of outlet selection
    1. Selection by comfort determination from jet performance
    2. Selection by comfort criteria
    3. Selection by noise criteria

XV. Duct System Design Procedure

A. Design CFM values
B. Select and locate air distribution devices
C. Locate the central equipment
D. Preliminary layout
E. Sizing calculations
F. Calculate the system total pressure loss
G. Select the fan
H. Noise
I. Final drawings and specifications

XVI. Testing and Balancing

A. Instruments and testing system balancing
    1. Duct
    2. Equipment
    3. Distribution

XVII. Indoor Air Quality

A. Definition
B. ASHRAE Standard 62-89
C. Guidelines for selected air contaminants of indoor origin

MINIMUM REQUIRED STUDENT LAB ACTIVTIES DEFINED:

1-2. **Classification and Identification of Distribution:** Student will sketch and identify hydronic system piping arrangements and terminal units.

3. **Pumps and Pump Curves:** Student will use manufacturers catalogs and computer software to select centrifugal pumps and determine operating characteristics.

4. **Closed Hydronic System Analysis:** Student will manually calculate friction loss in chilled water loop and select circulating pump for the application.

5. **Open Hydronic System Analysis:** Student will manually calculate friction loss in cooling tower loop and select circulating pump for the application.

6. **Parallel Pump Analysis:** Student will use manufacturer's computer software to analyze a parallel pump application.

7. **Hydronic System Design:** Given a building layout and heat loss, friction chart and tables, the student will layout the system, select terminal units, size pipe, select pumps, plot system curve, and select an expansion tank.

8. **Test, Adjust and Balance:** Given an operating system and design operating conditions, the student will measure flow rates, analyze pump performance, and adjust balancing valves for maximum performance.

9. **Tour of HVAC Air Systems:** Instructor explanation of different system types.

10. **Air Measurement Exercise:** Student will determine air flow through ductwork by taking pitot tube traverse, hot wire anemometer readings, and airflow hood readings at the diffuser.

11. **Fan Law Exercise:** Student will observe effect upon motor horsepower, system pressure and air volume due to change in fan speed.

12. **Duct Design Exercise:** Layout duct system based upon type of system and building configuration. Student will size ductwork based upon air flow and calculate static pressure losses by ASHRAE method.

13. **Computerized Duct Design:** Student will utilize commercial software to size ductwork by equal friction and static regain methods.

14-15. **Air Balancing Exercise:** Utilizing methods of measuring air flow, student will adjust dampers and fan speed to produce air flow within 10 percent of design requirements.

TASK LISTING: The student shall be able to:

A. System Classification
1. Classify hydronic systems based upon flow generation, temperature, pressure, piping and pumping arrangement.
2. Explain the advantages and disadvantages of various piping and pumping arrangements.
3. Calculate primary and secondary flow rates and temperatures in primary-secondary pumping arrangements.

B. Centrifugal Pumps
1. Identify the components and summarize the operation of a centrifugal pump.
2. Explain the relationship between flow rate and total dynamic head in a closed hydronic system.
3. Explain the difference between open and closed hydronic systems.

C. Terminal Devices
1. Determine type, size and location of finned tube radiation units.
2. Determine type, size and location of hot water convector units.

3. Determine type, size and location of cabinet unit heaters.
4. Determine type, size and location of unit heaters.
5. Determine type and size of air handling unit hot water coils.
6. Determine type, size and location of hot water heat exchangers.

D. *Flow Control Devices*

1. Explain the application of various service valves in hydronic systems.
2. Explain the relationship between heat transfer, temperature differential and flow through a terminal convection element.
3. Explain the relationship between valve port configuration and stem travel.
4. Explain the relationship between energy transfer and valve stem travel for various valve types.
5. Define the control flow coefficient (Cv).
6. Select two-way modulating and three-way mixing and diverting valves using the flow coefficient (Cv).

E. *Hydronic System Design*

1. Calculate the required flow of water for each temperature control zone.
2. Determine pipe size required to carry desired water flow rate based upon friction loss and velocity.
3. Calculate equivalent length of pipe fittings in piping network.
4. Calculate friction loss of piping circuits.
5. Determine pressure losses of equipment and terminal unit from manufacturer's data.
6. Calculate total head loss in closed loop piping systems.
7. Use pump affinity laws to plot system curve on pump performance curve for closed loop piping system.
8. Select a circulating pump from manufacturer's performance data for closed loop piping system.
9. Calculate total head loss in open loop piping systems.
10. Use pump affinity laws to plot system curve on pump performance curve for open loop piping system.
11. Select a circulating pump from manufacturer's performance data for closed loop piping system.
12. Select proper motor horsepower for circulating pump from manufacturer's performance data.
13. Develop parallel pump performance curves and identify operating points.
14. Develop series pump performance curves and identify operating points.
15. Analyze the effects of glycol on pump performance.
16. Determine the type, size and location of the system expansion tank.

F. *Computer Applications for Hydronic Systems*

1. Utilize manufacturer's computer software to calculate piping system friction loss.
2. Utilize manufacturer's computer software to proper circulating pump.
3. Utilize manufacturer's computer software to select proper expansion tank size.

G. Balan*cing Hydronic Systems*

1. Identify and summarize the function of instruments used to balance hydronic systems.
2. Determine circulating pump impeller size.
3. Determine actual operating characteristics of circulating pump.
4. Determine flow rates of hydronic circuits using various flow measuring devices.
5. Calculate resistance necessary to pre-balance hydronic circuit.
6. Determine new impeller size to produce required flow rate.

H. *System Classification*

1. Describe the components and operating characteristics of a single zone air system.
2. Describe the components and operating characteristics of a terminal reheat air system.
3. Describe the components and operating characteristics of a dual-duct air system.
4. Describe the components and operations characteristics of a multizone air system.
5. Describe the components and operating characteristics of a variable air volume.
6. Describe the components and operating characteristics of a variable volume, variable temperature (VVT) system.
7. Describe the components and operating characteristics of an induction air system.

I. *Applied Psychrometric*

1. Describe the psychrometric process that occurs during the heating and humidifying cycle.
2. Describe the psychrometric process that occurs during the cooling and dehumidifying cycle.
3. Calculate the mixed air conditions resulting from mixing different volumes of outdoor and return air.

J. *Fan Performance*

1. Identify two main categories of fans.
2. Describe performance characteristics of forward curve fans.
3. Describe performance characteristics of backward inclined and air foil fans.
4. Describe performance characteristics of radial blade fans.
5. Describe performance characteristics of propeller fans.
6. Describe performance characteristics of vane-axial fans.
7. Describe performance characteristics of tube-axial fans.
8. Select a fan from manufacturer's performance data.
9. Use fan laws to plot system curve on fan performance curve.
10. Select proper motor horsepower for circulating fan.
11. Describe effects of varying fan volume on fan performance curve.

K. Ductwork Design and Selection

1. Calculate cross-sectional area of a duct.
2. Calculate velocity of air in a duct.
3. Calculate volume of air in a duct.
4. Determine space air flow requirements.
5. Determine type, size and routing of duct system (including ventilation air intake and exhaust ducts).
6. Determine type, sire and location of diffusers and grilles.
7. Determine location and size of ventilation air intake.

8. Determine location and size of exhaust air grille.
9. Find fitting loss coefficients from tabular data.
10. Calculate friction loss in duct system.
11. Utilize manufacturer's computer software to calculate duct system friction loss.

L. *Testing and Balancing*
1. Measure CFM air flow in duct.
2. Measure pressure drop across coil or filter using manometer and probes.
3. Measure airflow at register.
4. Determine relative humidity.
5. Adjust fan speed for correct CFM output.
6. Balance duct system for correct CFM at each register.
7. Adjust variable air volume boxes for correct CFM at each zone.
8. Adjust fresh air intake.
9. Check static pressure at fan discharge.
10. Set V-Belt tension.
11. Align belt sheaves.
12. Check motor speed.

M. *Indoor Air Quality*
1. Define indoor air quality
2. Describe the important aspects of ASHRAE Standard 62-89.

GRADING POLICY

94-100=A	90-94=A-	87-90=B+	84-87=B	81-84=B-	78-81=C+
75-78=C	73-75=C-	71-73=D+	69-71=D	67-69=D-	66 and below F

EXAM WEIGHT

Exams one (1) through three (3) each account for 15 percent of final grade (45 percent total).
Final exam accounts for 20 percent of final grade.
Homework accounts for 10 percent of final grade.
Laboratory submittals account for 25 percent of final grade.

NOTE: Late submittals will be reduced one full grade for each calendar day beyond submittal date. Laboratory assignments are due on Monday of the week following the lab period.

Telephone: 592-2747
Office: J-H 303

WRITTEN OCCUPATIONAL PROFILE FOR HVACR ENGINEERING TECHNOLOGY

Students interested in HVACR Engineering Technology (HVT) (CIP Code 15.0501 and 15.0503) should be aware of the following characteristics possessed by personnel working within the trade. These characteristics are based upon survey and observation of HVT personnel in their work environments.

HVT personnel should possess good reasoning skills. They must be able to analyze client energy consumption by studying energy use patterns and comparing the results with similar facilities in the same geographical region. They must be able to determine the type of heating, ventilating and air conditioning (HVAC) system present within the facility and determine whether the system is performing satisfactorily. If problems exist with the HVAC system they must be able to make recommendations to return the system to peak performance. They must be able to analyze control systems whether they be electric, pneumatic or microprocessor based and troubleshoot and repair them if necessary. They must be capable of recommending retrofit measures to conserve energy and then follow up with measurements to determine if the recommendations are in fact saving energy.

These personnel must posses a high degree of mathematical development. Mastery of algebra is a requirement and should include the areas of linear, quadratic, exponential, logarithmic, angle and circular functions in order to develop graphical relationships for numerous applications. Geometry is also a requirement since HVT personnel must understand spatial relationships of building components when analyzing working drawings. They must apply these mathematical concepts to assess performance of control systems, analyze problems involving fluid mechanics (air and water) and perform life cycle cost analysis.

A high degree of skill in communications is necessary for those in HVACR Engineering Technology since most personnel will act as a liaison between the technician and the engineer. While performing energy auditing and system analysis, HVT personnel must be capable of describing the building including the envelope and usage, the mechanical and electrical systems, explain control strategy, discuss operational and maintenance items and recommend energy saving measures. They must be capable of describing highly complex systems in layman's terms and must be persuasive both verbally and in writing in order to sell management on the idea of investing to save energy and money. They must be capable of reading and interpreting highly technical information contained in trade journals and literature published by professional societies in order to stay in step with technological advances.

The formal training program usually requires four years of classroom instruction which includes a minimum ten week internship program between the third and fourth year of study. The graduates although capable of holding a multitude of titles are generally classified as engineering technologists and may find employment with utility companies, the controls industry, mechanical contractors, engineering design firms and manufacturers equipment representatives. They possess basic skills of the HVAC industry and will receive additional specialized training usually dictated by the specialty in which they are ultimately employed.

Physical demands of the job are considered to be light. When analyzing HVAC systems, HVT personnel may be required to climb ladders and negotiate tight spaces in order to gain information about equipment. Instruments utilized are generally hand-held and can be easily negotiated on an individual basis. These would include such items as pressure gauges, thermometers, volt-ammeters, watt-meters, power factor meters, air flow hoods and light level meters. An exception would be the use of inclined manometers to read air pressure where an assistant is best utilized to record readiness. Manual dexterity and good eye-hand coordination are required to setup test equipment. Near visual acuity is important in obtaining accurate readings and color perception may also be critical when tracing control wiring that is color-coded.

Working conditions are good with most work being performed indoors. Exceptions would include analysis of equipment that may be roof-mounted. HVT personnel may be subject to noise encountered in mechanical rooms and industrial environments and although the intensity may not be of sufficient levels to cause harm, may be detrimental if exposure is prolonged. Other hazards may include the risk of electrical shock, proximity to equipment operating at high-speed and dusts produced by asbestos fibers which remain prevalent in some areas as an insulation from hot surfaces. High pressure steam systems may also produce hazards.

HVT personnel should possess above average intelligence and a high numerical aptitude. They should also have good verbal skills along with good abilities regarding spatial relationships, form perception regarding objects and graphic material. They should also have good aptitudes for clerical work and motor coordination. HVT personnel should be capable of analyzing multiple tasks and have the ability to determine the impact of change on the overall system. They must also be able to sift through a significant amount of data and determine what is important.

Individuals considering entering the field of HVACR Engineering Technology should have a good mechanical background and the desire to understand what makes things "tick".

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 337
Date: Jan 92
Dept. Approval

COURSE TITLE: Mechanical and Electrical Systems for Buildings

COURSE DESCRIPTION: Awareness of heating, ventilating and air conditioning systems, water supply, sanitary and storm sewers, fire protection, electrical distribution, lighting and acoustical systems for buildings. Emphasis is placed upon systems integration, energy considerations and their effects upon building planning, detailing and construction. Discusses equipment, code requirements, and building applications.

Semester Hours: 3

Contact Hours Lecture 3 hours/week

Prerequisites: None

Textbook Required: "Mechanical and Electrical Systems in Buildings" by William K. Y. Tao and Richard R. Janis (1997, Prentice Hall). ISBN Number 0130867292

UNITS OF INSTRUCTION AND STUDENT LEARING GOALS FOR EACH UNIT

		TIME WEIGHT	Lecture / Lab. Hrs.
I.	Energy Units, Terms and Psychrometry	4	0
II.	Field Trip #1	1	0
III.	Load Calculation (HVAC)	6	0
IV.	HVAC System and Equipment		0
	Air Systems and Ductwork	3	0
	Hydronic System and Piping	3	0
	Steam and Refrigeration	3	0
V.	Field Trip #2	1	
VI.	Plumbing	0	0
	Water Supply	2	0
	Sanitary and Storm Drains	3	0
	Fire Protection	2	0
VII.	Lighting and Electric Power Distribution	9	0
VIII.	Acoustics	3	0
IX.	Tests	5	0
	Totals	45	0

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Energy Units, Terms and Psychrometry

A. Understand definition of "H.V.A.C."
B. Understand basic forms of heat (sensible and latent).
C. Use terms and formulas for measurement of heat flow in air and water systems (i.e. BTU, DB and WB temp., % R.H., spec. heat, and tons).
D. Use terms and formulas for measurement of temp. and pressure in air and water systems.
E. Understand various factors (DB temp., air velocity, and % RH) which effect human comfort in a conditioned space.
F. Determine seven (7) different parameters for Psych. Chart given a minimum of two (2) initial conditions.

II. Field Trip #1

III. Load Calculation (HVAC) and Ventilation

A. Calculate heat loss by transmission using knowledge of thermal resistance of building material.
B. Calculate heat loss by infiltration using "crack-length" method of estimation.
C. Calculate fresh air and make-up air requirements and vent. Heat loss for a conditioned space using design tables.
D. Determine sources and calculate load of internal heat gain.
E. Calculate solar and conduction heat gain through glass.
F. Understand solar and design temperature effect upon wall and roof exposures.

IV. HVAC System and Equipment

A. Distinguish HVAC system types, heating system types, cooling system types and their associated major pieces of equipment and basic temperature control methods.
B. Identify shapes, materials and gauges of HVAC ductwork.
C. Calculate one variable (e.g. CFM of air flow) given other variables (e.g. duct dia., air velocity, etc.) of an HVAC duct system using the air friction chart.
D. Identify air terminal units (i.e. grills, registers and diffusers) and their application in conditioned space.
E. Read mechanical HVAC design drawing (ductwork).
F. Identify categories of steam and hot water boilers, their major components and their application to a commercial building.
G. Identify types of hydronic piping systems and terminal units and their applications.
H. Calculate heat flow through hydronic system by equation, calculate pressure drop, water velocity, and pipe size using water friction chart.
I. Identify components of a stem heating system.
J. Calculate pressure drop, velocity and pipe size given steam flow rate through a system.
K. Identify major components of an HVAC refrigeration system, fluids, handled and their primary energy requirements.
L. Read mechanical HVAC design drawings (piping).

V. **Field Trip #2**

VI. **Plumbing and Fire Protection**

A. Identify types of water sources and how they are treated for human consumption.
B. Identify components of a water service (e.g. piping materials and joints, meters) and components of utility water bill.
C. Calculate size of a water service based upon allowable pressure drop and S.F.U. load.
D. Identify water heater components and variables (heater and storage tank) and calculate each for applications.
E. Identify difference between pressure pipe and drainage pipe, materials and joining methods.
F. Identify key components and principles related to sanitary drainage piping.
G. Calculate drainage pipe and vent pipe size per D.F.U. load.
H. Size building roof drains and storm drain piping from rainfall intensity and duration tables.
I. Read a plumbing design drawing and fire protection design drawing.
J. Identify key components (sprinkler heads, pipes, and alarms) of a building fire protection system.
K. Calculate number of sprinkler heads for an occupancy using design tables.

VII. **Lighting and Electrical Power Distribution**

A. Use terms and formulas for measurement of electric power and lighting.
B. Identify types of lamps and their application.
C. Calculate required number of fixtures for an illuminated space.
D. Identify main components of building an electric power distribution system (e.g. meter, panel board, and transformer).
E. Identify wire types and their uses and advantages, calculate size of main and branch feeders and their protective devices (i.e. fuse or circuit breaker).
F. Read a set of building electrical and lighting plans.

VIII. **Acoustics**

A. Use terms and formulas for measurement of sound intensity, absorption, reflection, and transmission.
B. Identify noise sources in commercial buildings, and noise control methods and materials.

IV. **Tests**

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course:	HVAC 342
Date:	August 1991
Dept:	**Approval**

COURSE TITLE: HVAC Load Calculations and Energy Codes

COURSE DESCRIPTION: The layout and design of energy efficient combination systems (heating and cooling) found in commercial and industrial buildings. Complete heat loss and heat gain calculations will be performed both manually and through currently available computer software. Energy estimating methods will be studied and an analysis of an actual building conducted. State of the art equipment will be selected for maximum energy efficiency. Current federal, state and local codes and standards (ASHRAE) will be examined as they apply to HVAC systems.

Semester Hours: 3 Semester Credit Hours

Contact Hours: 2 Lecture - Hours/Week
3 Lab. - Hours/Week

Prerequisites: HVAC-331 HVAC Secondary Equipment and Design

Textbook Required: Clifford, George Modern, ***Heating, Ventilating, Air-Conditioning,*** Prentice-Hall, 1990

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ***Handbook of Fundamentals.*** ASHRAE, 1993

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ***HVAC Systems and*** **Equipment,** ASHRAE, 1992

Reference: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ***Cooling and Heating Load Calculation Manual,*** *Second Edition.* ASHRAE, 1992

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ***Energy Conservation in New Building Design, Standard 90.1-1989,*** ASHRAE, 1980

UNITS OF INSTRUCTION AND LEARNING GOALS FOR EACH UNIT

			TIME WEIGHT Lecture	/ Lab. Hrs.
I.	Introduction		1	
II.	Heat Loss Calculations		8	12
III.	Heat Gain Calculations		9	9
IV.	Psychometric Processes For Equipment Selection		3	3
V.	HVAC System Design			12
VI.	Energy Estimating Methods		6	9
VII.	Exams		3	
		Totals	30	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction

A. Course goals
B. Requirements for attendance and grading

II. Heat Loss Calculations

A. Summary of loads, equations and references
B. General procedure
   1. Outdoor design conditions
   2. Indoor design conditions
   3. Temperature in adjacent unheated spaces
   4. Heat transfer coefficients
   5. Area calculations
   6. Heat transmission losses
      a. Roof, ceilings, walls and glass
      b. Walls below grade
      c. Floors
         1. Above grade
         2. On grade
         3. Below grade
   7. Infiltration
   8. Ventilation
      a. Indoor air quality requirements
      b. Mechanical code requirements
   9. Total losses
   10. Internal gains
   11. Pick-up loads
C. Energy code compliance

III. Heat Gain Calculations

A. Heat flow rates
   1. Space heat gain
   2. Space cooling load
   3. Space heat extraction rate
   4. Cooling coil load

B. General procedure
   1. Characteristics of the building
   2. Location, orientation and external shading
   3. Outdoor design conditions
   4. Indoor design conditions
   5. Internal thermal loads
   6. Peak space cooling load determination
      a. External loads
         1. Roof
         2. Walls
         3. Glass
            a. Conduction
            b. Solar
         4. Partitions, ceilings, and floors
      b. Internal loads
         1. Lights
         2. People
            a. Sensible
            b. Latent
         3. Appliances
            a. Sensible
            b. Latent
         4. Power
         5. Ventilation and infiltration air
            a. Sensible
            b. Latent
            c. Total

D. Energy code compliance

IV. Psychrometric Processes For Equipment Selection

A. Apparatus dew point method

B. Calculations
   1. Air quantity
   2. Entering coil conditions
   3. Leaving coil conditions
   4. Coil load
   5. Coil sensible heat ratio

V. Energy Estimating Methods

A. Single measure methods
   1. Degree day method
   2. Equivalent full load method

B. Simplified multiple-measure method
   1. Bin method
   2. Modified bin method

C. Detailed simulation methods

D. ASHRAE Standard 90.1 Energy Cost Budget

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED

1, 2, and 3. Heat Loss Calculation: Student will manually calculate the heat loss of a commercial building utilizing the procedures as outlined in the ASHRAE Fundamentals Handbook.

4 and 5 Heat Gain Calculation: Student will manually calculate the heat gain of a commercial building utilizing the procedures as outlined in the ASHRAE Fundamentals Handbook.

6, 7, & 8 Computer Application: Student will utilize commercially available computer software to calculate heat gain and loss of a commercial building, analyze psychrometric process and select coils.

9, 10, & 11 HVAC System Design: Student will use results of load calculations to layout and design HVAC system for commercial building.

12, 13, & 14 Energy Estimation: Student will utilize commercially available computer software to estimate the annual energy consumption of a commercial building and to check for compliance with ASHRAE Standard 90.

TASK LISTING: (The student shall be able to . . .)

A. Heat,Loss Calculations

1. Select the proper outdoor design conditions for a given location.
2. Select the proper indoor design conditions for a given application.
3. Estimate temperatures in adjacent unheated spaces.
4. Determine heat transfer coefficients.
5. Calculate heat transmission losses through building components.
6. Calculate infiltration losses.
7. Determine ventilation requirements for various occupancies based upon indoor air quality and applicable codes.
8. Calculate heating requirements due to ventilation.
9. Calculate pickup loads for hydronic, air and steam heating systems.
10. Determine building envelope compliance with energy codes for heating.

B. Heat Gain Calculations

1. Select the proper outdoor design conditions for a given location.
2. Select the proper indoor design conditions for a given application.
3. Calculate heat gain through roof components.
4. Calculate heat gain through wall components.
5. Calculate heat gain due to glass conduction.
6. Calculate heat gain due to solar gains through glass.
7. Calculate heat gain through partitions, ceilings and floors.
8. Calculate heat gain due to lighting.
9. Calculate heat gain due to occupants.
10. Calculate heat gain due to appliances.
11. Calculate heat gain due to motors.
12. Calculate heat gain due to ventilation.
13. Calculate heat gain due to infiltration.
14. Explain the difference between peak and block loads for cooling.
15. Determine building envelope compliance with energy codes for cooling.

C. Psychometric Processes For Cooling Coil Selection

1. Determine cooling air quantity.
2. Determine the entering coil conditions.
3. Determine the leaving coil conditions.
4. Determine sensible, latent and total coil loads.
5. Determine coil sensible heat ratio.

D. Energy Estimating Methods

1. Calculate annual heating energy costs using the degree day method.
2. Calculate annual cooling energy costs using the equivalent full load method.
3. Calculate annual energy costs using the modified bin method.

E. Computer Applications For Load Calculations

1. Utilize manufacturer's computer software to calculate heating and cooling loads for a commercial building.
2. Utilize manufacturer's computer software to profile energy consumption for a commercial building.
3. Utilize manufacturer's computer software to select heating and cooling equipment
4. Utilize computer software to check for compliance with energy codes.

ADDITIONAL COURSE INFORMATION
COURSE: HVAC-342 HVAC Load Calculations and Energy Codes

GRADING POLICY

A	94-100
A-	90-94
B+	87-90
B	84-87
B-	81-84
C+	78-81
C	75-78

C-	73-75
D+	71-73
D	69-71
D-	66-69
F	66 and below

EXAM DATES

February 10, 1994
March 3, 1994
April 14, 1994

Final exam May 4, 1994; 12:00 1:40 PM

EXAM WEIGHT

Exams 1 through 3 each account for 15% of final grade (45% total)
Final exam accounts for 20% of final grade
Homework accounts for 10% of final grade
Laboratory submittals account for 25% of final grade

Homework may be corrected and resubmitted at any time for credit.
Late laboratory submittals will be reduced one full grade for each **class day** beyond submittal date. Re-submittals are not accepted.

OFFICE HOURS:

Johnson Hall 303
9:00 - 9:50 AM Monday and Wednesday **4:00 - 4:50** PM Tuesday 3:00 - 3:50 PM Thursday
by appointment at any other time.

Office Phone **592-2747**
Home Phone 796-0739

ENERGY SYSTEMS TECHNOLOGY

Internship - Energy Management

Preface: Your internship should offer a variety of system (commercial & industrial) and Energy related experiences. It has been placed between the third and fourth years so that your experiences can be related to the Senior year courses. Ideally, the following experience would constitute an excellent internship: System Design & Retrofication, System Trouble Shooting or problem solving, System Balance (Testing adjusting and Balances) Control Balancing & Control Work, Energy Audit & Payback work, and Energy related experiences. To include the entire list would be impossible, some of the list however should be accomodated in your internship.

Procedure:

A. The securing of an internship position (job) is the students responsibility, we will however be glad to assist you.

B. Before the internship begins:

1. Set up interview.
2. Report, by memo, to intern co-ordinator the: Company name, address, telephone number, person or persons interviewed, plus a critique or synopsis of the interview.
3. Salary, you must be on the Payroll for workman's compensation purposes, the rate is negotiable by you, and should be commensurate with responsibilities.
4. When job is imminent, a second memo to the co-ordinator stating your interpretation of the job function is necessary.
5. Time; 10 weeks minimum.
6. The intern co-ordinator will then make contact as soon as possible to apprase or disapprove;
    a. letter from perspective employer to intern co-ordinator stating what you will be doing and for how long.
7. Fill out E-M internship form.
8. If you live on campus - clear housing

C. During Internship.
1. Work for ten weeks minimum
2. Send to co-ordinator 10 weekly written reports of that weeks activities.
3. Co-ordinators visitation with intern and supervisor must be agreeable with employer. One will usually suffice.

D. After internship.
1. Final Report (may be required)
2. Grade

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 415
Date:
Dept: **Approval**

COURSE DESCRIPTION: The study of digital electronic control of HVAC mechanical systems to maximize their operating efficiency in commercial and industrial applications. The layout, programming and operation of the building management system will be emphasized.

Credit Hours: 4

Contact Hours: Lecture 3 hours / week
Laboratory 3 hours / week

Prerequisite: HVAC 312

Required Textbooks: "Programming Syntax for Microprocessor Based HVAC Control Systems" by Thomas Horan

"*Control Systems for Heating, Ventilating and Air Conditioning*" Fourth Edition by Roger Haines

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT:

		Time Weight Lecture	Time Weight Lab. Hrs.
I.	Introduction to course, DDC	1	3
II.	Numbering Systems	2	0
III.	Binary Logic	3	3
IV.	Microcomputers / DDC Systems	3	3
V.	Specifications and Hardware	3	3
VI.	DDC Database Information	5	6
VII.	Program Statements	5	3
VIII.	Writing DDC Programs	7	9
IX.	Load Management Functions	4	3
X.	Downloading Programs	2	6
XI.	Loop Editing and Tuning	4	3
XII.	Archiving Data	2	3
	Tests	4	
	Total	45	45

I. Introduction to Course

A. Course policies and requirements
B. Introduction to DDC systems

II. Numbering System

A. Binary
B. Decimal
C. Octal
D. Hexadecimal

III. Binary Logic

A. Logic gates
B. Truth tables

IV. Microprocessors / DDC Systems

A. Microprocessors
B. Memories
C. I/O Interfaces

V. Specifications and Hardware

A. Process of developing a submittal
B. Submittal prints
C. Complete package
D. DDC system hardware description
E. I/O devices, field wiring and termination

VI. DDC Database Information

A. Description of DDC point database
B. Development of a system database
C. Programming a database

VII. DDC Program Statements

A. Introduction to system program statements
B. Statement syntax

VIII. Writing DDC Programs

A. Sequence of HVAC system operation
B. Format of DDC programs
C. Flow charts
D. Control loop software strategies
E. Entering a program

IX. Load Management Functions

A. Load profiles, consumption, and demand
B. TOD, OSS, DLC, and DC

X. Downloading a Program

A. Accessing the DDC panel
B. Preparing the panel to accept a program
C. Downloading a program

XI. Loop Editing and Tuning

A. Accessing the system
B. Online editing
C. Loop Tuning

XII. Archiving Data

Minimum Required Student Activities Defined:

1. The student will be able to describe the differences, advantages and disadvantages of digital control systems when compared to analog control systems. (Unit 1)
2. Through tests, homework and lab 1, the student will demonstrate an understanding of the characteristics and applications of binary, octal and hexadecimal base numbering systems. (Unit 2)
3. Through tests, homework and lab 2, the student will demonstrate an understanding of the characteristics and applications of binary logic and truth tables. (Unit 3)
4. Through tests, homework and lab 3, the student will demonstrate an understanding of the characteristics and applications of various components which make up a microcomputer including the power supply, microprocessor, registers, memory (RAM and ROM), I/O interfaces (D/A and A/D converters). (Unit 4)
5. Student will demonstrate an understanding of the process of developing a proposal, job prints, description of operation and computer program for a DDC job. (Unit 5)
6. The student will be able to correctly identify and explain the purpose of various components which make up a DDC system. (Unit 5)
7. The student will demonstrate the ability to analyze DDC system hardware, software, point operation and field wiring to ensure the lab system is completely operable (lab 4). (Unit 5)
8. The student will be able to identify the different field I/O devices and know the correct way to terminate those devices at the termination board of the DDC system and at the field locations (lab 5). (Unit5)
9. The student will demonstrate the ability to accurately program a DDC database (lab 6). (Unit 6)
10. The student will be able to develop and test software strategies to control various HVAC processes (lab 7). (Unit 7)
11. The student will demonstrate his/her ability to develop flow charts and convert the chart into computer program instruction statements through homework assignments and test questions. (labs 8, 9 & 10). (Unit 8)
12. The student will demonstrate his/her ability to develop a DDC operating program from a description of operation, using correct statements, sequence and syntax. (Unit 8)

13. The student will demonstrate an understanding of the theory, application and software associated with the different energy management strategies, TOD, OSS, DLC, DC (lab 11). (Unit 9)
14. The student will be able to download, upload, enable, disable, edit and monitor a DDC program to operate the equipment in the lab (lab 12 and 13). (Unit 10)
15. The student will demonstrate the ability to correctly troubleshoot hardware and software problems within a digital control system (lab 14). (Unit 11)
16. The student will be able to tune DDC loops for proper operation (lab 14). (Unit 11)
17. The student will demonstrate the ability to archive information, set up point monitors and access points to override program control (lab 15). (Unit 12)

Lecture: ______________________ __________

Lab: ______________________ __________

Office: ______________________ __________

Office Hours: ______________________ ______________________________

Phone: ____________________ **Please leave a message on the phone mail**

____________________ **Home Weekdays,** ______________

Grading Criteria:

Three Tests	300 points	
Cumulative Final Exam	100 points	70%
Labs, Homework, and Quizzes		30%

Grading Scale:

A	95%	A-	90%		
B+	87%	B	84%	B-	80%
C+	77%	C	74%	C-	70%
D+	68%	D	67%	D-	65%
F	<65%				

You must have the equivalent of a C to avoid an academic warning.

You must be present at all labs and hand in all lab reports to avoid an "incomplete" for your final grade. If you miss a lab you will still have to make up the lab at the instructor's convenience.

Assignments are due at the beginning of the class period. If it's turned in before the end of the day you will lose an additional 3 points for being late. If you do not hand it in the day it is due, you will get a zero for the assignment.

FERRIS STATE UNIVERSITY
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COURSE OUTLINE

COURSE TITLE: HVT-451 Energy Analysis and Audit

COURSE DESCRIPTION: The survey of utility rate structures, billing energy consumption and energy profiling of commercial and industrial buildings. On-site audit projects will report on recommendations to building envelopes, HVACR systems and control systems with regard to payback. Oral and written presentations are requirement of this senior project course.

Credit Hours: 3 Semester Credit Hours

Contact Hours: Lecture 2 Hours/Week
Lab 1.5 Hours/Week

Required Textbooks: **Handbook of Energy Audits**, Third Edition, by Albert Thumann, published by the Fairmont Press, Inc., 1992.

References: ***The Financial Evaluation of Energy Costs and Projects***, by Reiter, Sydney Van Nostrand Reinhold, 1985.

Instructions for Energy Auditor, U.S. Department of Energy,

UNITS OF INSTRUCTION AND STUDENT LEARNING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction	1	0
II.	History - Oil Embargo	1	0
III.	National Energy Act	3	0
IV.	Units of Energy	2	0
V.	Efficiency Improvement Program	2	0
VI.	Electrical Utility Rate Structure	7	3
VII.	Natural Gas Utility Rate Structure	3	3
VIII.	Types of Energy Audits	1	0
IX.	Energy Audit Techniques	1	12
X.	Profiling Building Energy Consumption	5	12
XI.	Improving the Building Envelope	4	0
XII.	Improving the Building HVAC System	6	0
XIII.	Steam Heating Systems	6	0
XIV.	Improving Steam Heating Systems	4	0
XV.	Lighting Systems	6	0
XVI.	Improving Lighting Systems	3	0

XVII.	The Audit Report		1	15
	Exams		4	0
		Totals	60	45

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction

II. History - Oil Embargo

III. National Energy Act

IV. Units of Energy

V. Efficiency Improvement Program

A. Management decisions
B. Select team
C. Analyze present conditions
D. Goals
E. Check energy saving measures (ESM)
F. Estimate savings
G. Estimate investment
H. Decide priorities
I. Implementation
J. Evaluation

VI. Electrical Utility Rate Structure

A. Energy charge
B. Fuel adjustments
C. Demand charges
D. Ratchet clauses
E. Time of day metering
F. Power factor penalties
G. Taxes and surcharges

VIII. Natural Gas Utility Rate Structure

A. Monthly service charge
B. Distribution charge
C. Gas cost recovery
D. Surcharges

IX. Energy Audit Techniques

A. Action plan for an energy conservation program
B. Walk through audit

C. Technical assistance audit
   1. Building description
   2. Occupancy patterns
   3. Building envelope
      a. Exterior walls
      b. Windows/doors
      c. Roof
   4. Mechanical and electrical systems
      A. Primary heating system
      B. Primary cooling system
      C. Air HVAC system
      D. Domestic hot water
      E. Lighting
      F. Other electrical equipment
   5. Current energy consumption
   6. Building energy profile

D. Operation and maintenance recommendations

E. Feasible energy conservation measures

X. Profiling Building Energy Consumption

A. Energy estimating methods
   1. Degree day
   2. Bin
   3. Detailed

B. Energy management form

XI. Improving the Building Envelope

A. Insulate building envelope

B. Install heat absorbing and reflective glass windows

C. Reduce infiltration

XII. Improving the HVAC System

A. Install setback thermostats

B. Insulate hot water piping

C. Preheat water from waste hot water

D. Preheat combustion air

E. Use outdoor air for cooling

F. Replace absorption chiller with centrifugal chiller

G. Reduce exhaust fan operating time

XIII. Steam Heating Systems

A. Properties of steam

B. Classification
   1. Piping arrangement
      a. One pipe
      b. Two pipe

2. Pressure
    a. High pressure
    b. Low pressure

C. Traps
    1. Purpose
    2. Types
        a. Thermostatic
        b. Float and thermostatic
        c. Inverted bucket
        d. Thermodynamic

D. Sizing steam lines and condensate returns

F. Sizing condensate receivers

XIV. Improving Steam Heating Systems

A. Make steam from waste heat

B. Replace leaking steam traps

XV. Lighting Systems

A. Factors to consider

B. Definitions and terminology

C. Incandescent lighting

D. Fluorescent lighting

E. High intensity discharge lighting (hid)
    1. Mercury vapor
    2. Metal halide
    3. High pressure sodium

F. Lighting calculations
    1. Procedure
    2. Coefficient of utilization
    3. Maintenance factor
    4. Computer software

G. Lighting system audit

XVI. Improving Lighting Systems

A. Reduce daytime lighting

B. Change types of lamps

C. Reduce lighting time

XVII. **The Audit Report**

A. Preface and disclaimer

B. Executive summary

C. Technical report

D. Energy and economic analysis

E. Operational and maintenance items

F. Energy conservation measures

G. Items for future study

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1.	Utility Billing Analysis	Student will examine utility records for last three years and record information on energy management form.
2, 3, & 4.	Preliminary Energy Audit	Student will gather pertinent data regarding audited structure, describe the building and its mechanical and electrical systems.
5.	Energy Audit	Student will analyze energy consumption to determine percentage of each type used.
6, 7, & 8.	Computer Profile	Student will utilize commercially available software to calculate building heat loss and gain and determine the energy consumption based upon the bin method of analysis.
9, 10, & 11.	Technical Assistance Audit	Student will determine energy conservation measures (ECMs) and calculate savings. A prioritized list of ECMs will be developed based upon payback
12, 13, & 14.	Preparation of Audit Report	Student will utilize commercially available software to produce and publish audit report.
15.	Presentation of Report	Student will present results of Technical Assistance Audit to management.

TASK LISTING (The student shall be able to . . .)

1. History - Oil Embargo
   A. Describe the events leading to, and the causes of the world's major oil embargoes.
2. National Energy Act
   A. Describe the major provisions of the National Energy Act.
3. Units of Energy
   A. Identify the units used to account for energy.
4. Efficiency Improvement Program
   A. Explain the steps involved in an efficiency improvement plan.
5. Electrical Utility Rate Structure
   A. Describe the various rate structures for electricity.
   B. Calculate electrical demand billing
   C. Calculate power factor
   D. Determine the effect of power factor upon an electrical billing.
   E. Determine the effect of ratchet clauses upon electrical billing.
   F. Calculate fuel adjustment factors.
   G. Accurately read electrical consumption and demand meters.
6. Natural Gas Utility Rate Structure
   A. Calculate monthly distribution charges.
   B. Describe the effect of natural gas recovery costs.
   C. Identify the various surcharges such as insulation, MRCS and IFF conservation charges.

7. The Technical Assistance Audit
   A. Compile building annual energy use and cost data.
   B. Profile energy consumption in a structure utilizing available software.
   C. Describe the features of the building envelope.
   D. Identify and describe the components and features of the building mechanical systems.
   E. Identify and describe the components and features of the building electrical systems.
   F. Identify and describe the components and features of the HVAC control system.
   G. Describe the features of the building lighting system.
8. Methods for improving energy efficiency and calculation of savings through improvement of building envelope.
   A. Calculate energy savings produced by insulating building envelope.
   B. Calculate energy savings produced by installing heat absorbing and reflective glass windows.
   C. Calculate energy savings produced by reducing infiltration.
9. Methods for improving energy efficiency and calculation of savings through improvements in building HVAC systems.
   A. Calculate energy savings produced by installing setback thermostats.
   B. Calculate energy savings produced by insulating hot water piping.
   C. Calculate energy savings produced by preheating water from waste hot water.
   D. Calculate energy savings produced by preheating combustion air.
   E. Calculate energy savings produced by using outdoor air for cooling.
   F. Calculate energy savings produced by replacing absorption chiller with centrifugal chiller.
   G. Calculate energy savings produced by reducing exhaust fan operating time.
10. Steam heating systems.
   A. Classify steam systems based upon operating pressure.
   B. Classify steam systems based upon piping arrangement.
   C. Select a steam trap based upon application.
   D. Use manufacturer's software to select a steam trap.
   E. Size steam lines and condensate return piping.
11. Methods for improving energy efficiency and calculation of savings through improvements in steam heating systems.
   A. Calculate energy savings produced by making steam from waste heat.
   B. Calculate energy savings produced by replacing leaking steam traps.
12. Lighting Systems.
   A. Describe the advantages and disadvantages of incandescent light sources.
   B. Describe the advantages and disadvantages of fluorescent light sources.
   C. Describe the advantages and disadvantages of High Intensity Discharge (HID) light sources.
   D. Calculate required number of luminaries using the zonal cavity method.
   E. Measure lighting levels using a light meter.

13. Methods for improving energy efficiency and calculation of savings through improvements in lighting systems.
    A. Calculate energy savings produced by reducing daytime lighting.
    B. Calculate energy savings produced by changing types of lamps.
    C. Calculate energy savings produced by reducing lighting time.
14. Analysis of potential of energy conservation measures.
    A. Calculate cost of energy retrofit.
    B. Calculate simple payback of energy retrofit in years.
    C. Prioritize energy conservation measures.

HVT-451
Building and System Energy Audit
Master Task List

1. The Technical Assistance Audit
    A. Compile building annual energy use and cost data.
    B. Profile energy consumption in a structure utilizing available software.
    C. Describe the features of the building envelope.
    D. Identify and describe the components and features of the building mechanical systems.
    E. Identify and describe the components and features of the building electrical systems.
    F. Identify and describe the components and features of the HVAC control system.
    G. Describe the features of the building lighting system.
2. Methods for improving energy efficiency and calculation of savings through improvement of building envelope.
    A. Calculate energy savings produced by insulating building envelope.
    B. Calculate energy savings produced by installing heat absorbing and reflective glass windows.
    C. Calculate energy savings produced by reducing infiltration.
3. Methods for improving energy efficiency and calculation of savings through improvements in building HVAC systems.
    A. Calculate energy savings produced by installing setback thermostats.
    B. Calculate energy savings produced by insulating hot water piping.
    C. Calculate energy savings produced by preheating water from waste hot water.
    D. Calculate energy savings produced by preheating combustion air.
    E. Calculate energy savings produced by using outdoor air for cooling.
    F. Calculate energy savings produced by replacing absorption chiller with centrifugal chiller.
    G. Calculate energy savings produced by reducing exhaust fan operating time.
4. Steam heating systems.

A. Classify steam systems based upon operating pressure.
B. Classify steam systems based upon piping arrangement.
C. Select a steam trap based upon application.
D. Use manufacturer's software to select a steam trap.
E. Size steam lines and condensate return piping.
F. Size condensate receiver for steam systems.

5. Methods for improving energy efficiency and calculation of savings through improvements in steam heating systems.
   A. Calculate energy savings produced by making steam from waste heat.
   B. Calculate energy savings produced by replacing leaking steam traps.
6. Lighting Systems.
   A. Describe the advantages and disadvantages of incandescent light sources.
   B. Describe the advantages and disadvantages of fluorescent light sources.
   C. Describe the advantages and disadvantages of High Intensity Discharge (HID) light sources.
   D. Calculate required number of luminaries using the zonal cavity method.
   E. Measure lighting levels using a light meter.
7. Methods for improving energy efficiency and calculation of savings through improvements in lighting systems.
   A. Calculate energy savings produced by reducing daytime lighting.
   B. Calculate energy savings produced by changing types of lamps.
   C. Calculate energy savings produced by reducing lighting time.
8. Analysis of potential of Energy Conservation Measures.
   A. Calculate cost of energy retrofit.
   B. Calculate simple payback of energy retrofit in years.
   C. Prioritize Energy Conservation Measures.

HVAC 451(ATC): Energy Analysis & Audit
WINTER 1994
ADDITIONAL COURSE INFORMATION

COURSE TEXT: Handbook of Energy Audits, Third Edition, by Albert Thumann, published by The Fairmont Press, Inc., 1992.

INSTRUCTOR: ______________________

OFFICE: ______________________

PHONE NUMBER: ______________________

OFFICE HOURS: ______________________

GRADING:

Homework & Quizzes		33 1/3 %
Test #1		33 1/3%
Test #2 (Final Exam)		33 1/3 %
	Total	100 %

POLICY:

1. For all graded homework, quizzes, and test #1 students will be given the class high grade, the class low grade, and the class average grade. In addition they will be given a numerical range for the letter grades of A, B, C, and D. It is anticipated that from this information each student will have an accurate idea as to how they are doing in the course. If questions still exist, consult with the instructor.

2. Late homework will not be accepted; there will be no makeup for quizzes and tests; only under very extreme cases will the instructor consider deviations from these grading policies. Such will be done on a case-by-case basis.

HOMEWORK

All homework for this course is to be done on green "Engineer's Computation Pad" paper that has 5 squares per inch in each direction (National Brand or equivalent). This paper can be purchased at the FSU bookstore. Use a number 2 pencil or equivalent. Print clearly and legibly throughout. Use only one side of the paper. Staple all homework set pages together in the upper left most corner of the pages. Do not write in the margins. Across the top margin of every page the following information is to be given:

Homework Set	Problem from the problem set that appears on the particular page	Course Number	First and last names	Page # Total Pages

Example:

H.S. #3	Prob. #2	HVAC 451	Rich Nowak	1/3

Show all work in a neat and orderly fashion. Start each problem on a new sheet of paper. Paper turned in should be neat and of professional quality.

Each homework will only be accepted for credit when done per the above format and submitted by each student who attends that class. All homework transactions are done in the classroom only. Homework will be collected for grading at the beginning of class. Graded homework will be returned at the beginning of class only. Late homework will be given no credit. If a problem is not attempted, it will receive zero. Therefore, all assigned problems should be attempted.

Failure to follow the above instructions in any homework assignment will result in point deductions from homework grades and may even result in that homework not being accepted

GENERAL

The subject of HVAC 451 like many other technical subjects requires regular, systematic, and conscientious study habits. The topics are linked and related in such a manner that the grasp of each future topic depends upon comprehension of the former topics. Hence, students should keep up with the course progression. Regular course attendance is advised and expected as lectures may include topics not in the textbook. Class notes are recommended. Every student is required to bring the course text and calculator to every one of her/his class meetings. Student participation in class is encouraged. Students should be prepared to answer any questions and feel free to ask any questions they may have.

To test preparedness of students and their competence in the subject unannounced or announced quizzes may be given. The tests and quizzes will cover material from homework, reading materials, site visits, and lectures.

Students are expected to attend every scheduled class; those who cannot should consult with the instructor prior to missing any classes.

The class periods are devoted to the study of HVAC 451, Energy Analysis & Audit. Under no circumstances will students be allowed to read newspapers, do homework for other courses, etc. during the class period.

Students are expected to do all of their own work in HVAC 451. Plagiarism will not be tolerated. Students who plagiarize another person's work and/or aid and abet in the plagiarizing of work can expect to receive a final course grade of F. The incident may also be reported to higher school authorities, at the discretion of the instructor.

TENTATIVE SYLLABUS

Week	Class	Date	Topic
1	1	1/11	Introduction
2	2	1/18	Energy History
3	3	1/25	Energy Resources
4	4	2/1	Utility Rate Structures
5	5	2/8	The Energy Audit, Text Chap. 1
6	6	2/15	Site Weather Data
7.	7	2/22	Utility Bills
8	8	3/1	Test #1
-	-	3/8	No Class - Spring Break
9	9	3/15	Energy Management Forms
10	10	3/22	Estimating Energy Use Profiles, Text Chap. 2, Computer Model, Carrier E20-II
11	11	3/29	Cost Analysis, Economics, Text Chap. 4, Computer Model, Carrier E20- II
12	12	4/5	The Building Envelope, Text Chap. 6, Computer Model, Carrier E20- II
13	13	4/12	Building Mechanical Systems, Text Chap. 5, Computer Model, Carrier E20-II
14	14	4/19	Building Electrical Systems,Text Chap. 7, Computer Model, Carrier E20-II
15	15	4/26	Computer Model, Carrier E20-II
16	16	5/3	Exam Week, Test #2

FERRIS STATE UNIVERSITY
COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 462
Date: Jan 1991
Dept. Approval

COURSE TITLE: Thermodynamic of Refrigeration

COURSE TITLE: Primary Equipment Selection & Design

COURSE DISCRIPTION: The layout of state-of-the-art equipment and systems for commercial and industrial buildings. Emphasis will be placed upon the appropriate alternate energy sources with cost analysis and paybacks being performed.

SEMESTER HOURS: 4

CONTACT HOURS: Lecture 4 Hours

TEXTBOOKS REQUIRED: "Modern Heating, Ventilating and Air Conditioning" by George Clifford, Pi-entice-Hall, 1990

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

			TIME WEIGHT Lecture / Lab. Hrs.
I.	Introduction		1
II.	Chillers		12
III.	Cooling Towers		7
IV.	Boilers		8
V.	Heat Exchangers		5
VI.	Thermal Storage		6
VII.	Cogeneration		7
VIII.	Water-Source Heat Pump		5
IX.	Economic Analysis		5
X.	Tests		4
		Total	60

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTUCTION

I. Introduction

- A. Course goals
- B. Requirements for attendance and grading

II. Chillers

- A. Types and operating characteristics
  1. Reciprocating
  2. Centrifugal
  3. Screw
  4. Absorption
- B. Methods of condenser heat rejection
  1. Air-cooled
  2. Water-cooled
- C. Applications
  1. Manual selection per available catalog literature

III. Cooling Towers

- A. Types of evaporative cooling devices
  1. Indirect contact
     - a. Evaporative condenser
  2. Direct contact
     - a. Cooling tower
       1. Air/water flow pattern
          - a. Counter flow
          - b. Cross flow
       2. Mechanical draft
          - a. Forced draft
          - b. Induced draft
  3. Types of fill
- B. Cooling tower installation and perf. characteristics
  1. Siting effect on performance
  2. Performance characteristics
     - a. Approach temp.
     - b. Tonnage
     - c. Evaporation, blow-down, and drift
     - d. Effectiveness
- C. Application
  1. From available catalog literature, select a cooling tower

IV. Boilers

- A. Categorization
  1. Liquid handled
     - a. Steam
     - b. Water
  2. Fuel Used
     - a. Natural gas

        b. Fuel oil
        c. Electric
        d. Solid fuels
    3. Pressure
        a. High pressure
        b. Low pressure
    4. Material of construction
        a. Steel
            1. Firetube
            2. Watertube
        b. Cast iron sectional
        c. Copper fin
    5. Combustion air- handling method
        a. Atmospheric (natural) draft
        b. Mechanical draft

B. Boiler Accessories
    1. Boiler fittings
        a. Safety valve
        b. Pressure and temp. gauges
        c. Blowdown (steam)
        d. Water column (steam)
    2. Feedwater accessories (steam boiler)
        a. Feedwater regulator
        b. Low water cutoff
    3. Fuel system
        a. Fuel oil
        b. Natural gas
    4. Draft system
        a. Natural draft
        b. Mechanical draft
        c. Combustion air requirements
        d. Stacks

C. Performance Requirements
    1. Combustion efficiency
    2. Heater efficiency
    3. Boiler Efficiency
        a. Factors effecting boiler efficiency
            1. Fuel conditions and characteristics
            2. Excess air
            3. Thermal resistance of htr. surface
    4. Energy units (e.g. Boiler H.P., E.D.R., etc) and ratings

D. Applications
    1. Boiler selection per fuel availability, economics and load requirements (manual selection per catalogs)

V. Heat Exchanges

A. Types
   1. Shell and Tube
   2. Plate and frame
   3. Regenerative

B. Characteristics
   1. Fluid
      a. Water-to-water
      b. Steam-to-water
      c. Air-to-air
   2. Materials
      a. Gaskets
      b. Shells
      c. Tubes
   3. Flow arrangement
      a. Parallel flow
      b. Counterflow
      c. Complex

C. Performance characteristics
   1. Low mean temperature difference (LMTD)
   2. Heat exchanger effectiveness and NTU
   3. Fouling

D. Applications
   1. Bell & Gossett heat exchanger selection program

VI. Thermal Storage

A. Storage economics / electric rate structure
   1. Cooling load profile
   2. Load-matching approach
      a. Partial storage
      b. Full storage
   3. Operating modes

B. Storage media and technologies
   1. Water tank
      a. Materials, arrangements and locations
      b. Temp. range and size
      c. Tank insulation
   2. Ice Storage
      a. Ice builder
      b. Solid ice brine coil
      c. Ice in containers
      d. Ice harvester

C. Performance criteria and equipment selection
   1. Refrigeration equipment and heat exchange fluids
   2. Volumes, dimensions and energy units

        3. Storage effect on secondary equipment selection
    D. Applications
        1. System and equipment selection per available software

VII. Cogeneration

A. Cogeneration economics
   1. Thermal and elec. load profile / utilities rates and rate structure
   2. History and legislation

B. Cogeneration system equipment
   1. Prime movers
      a. Internal combustion engine
      b. Gas-fired combustion turbine
   2. Heat-recovery boilers
   3. Electric generations
   4. Absorption refrigeration

C. Performance criteria
   1. Thermal efficiency
   2. Electric efficiency
   3. Overall (fuel conversion) efficiency

D. Applications
   1. Generate thermal and electrical load profile using carrier software
   2. Size Cogeneration system using available catalogs

VIII. Water-Source Heat Pumps

A. System components and operating characteristics
   1. Systems components
      a. Water-source heat pump
      b. Boiler
      c. Cooling tower
      d. Piping and controls
   2. Operating characteristics
      a. Heating mode
      b. Cooling mode
      c. Comb. heating and cooling
      d. Performance

B. Applications
   1. Using Carrier software, generate a building peak and block load
   2. Using available catalog literature, select the proper water-source heat pump for the application
   3. Select the proper size boiler and cooling tower for application

IX. Economic Analysis

A. Financial terms
   1. Net present value
   2. Discount rate
   3. Rate-of-return (R.O.R.)
   4. Return-on-investment (R.O.I.)

5. Inflation
6. Depreciation
7. Taxes
8. Fuel cost escalation

B. Methods of cash flow analysis
1. Simple payback
2. Life cycle cash flow analysis
   a. Present worth method
   b. Annual cash flow method

C. Application
1. Utilize available software to perform cash flow analysis

HVAC 462 PERFORMANCE OBJECTIVES

1. Given lecture & homework, identify the types of chiller systems & operating characteristics of reciprocating, centrifugal, rotary and absorption chillers.
2. Given lecture & homework, identify methods of chiller heat rejection. (air & water)
3. Given lecture, handouts, and homework of chiller systems, explain the methods of capacity control.
4. Given building operating characteristics, select which type of chiller would be used for appropriate applications.
5. Given mfg.'s literature, building load characteristics, & fuel availability, size a chiller.
6. Given lecture & homework, identify types of cooling towers, (open & closed loop systems) & evaporative condenses.
7. Given lecture &homework, describe the proper siting & performance of cooling towers.
8. Given equipment, manufacture's literature, and system operating characteristics, select a cooling tower for free cooling application.
9. Given lecture & homework, identify types of boilers and application of each. Both water & steam boiler will be included.
10. Given boiler capacities, describe the method of boiler ratings & conversions of energy units.
11. Given manufacture's literature, building load characteristics, fuel availability & economics; select a boiler.
12. Given mfg.'s installation instruction & lecture, identify installation requirement for boiler installation.
13. Given mfg.'s literature, text material & lecture, identify types and characteristics of plate, shell & tube type heat exchangers.
14. Given loads, flow rates and or temperature differentials, calculate heat exchanger effectiveness.
15. Given mfg.'s literature, a mechanical system plan & available software select a heat exchanger.
16. Given manufactures literature, lecture, and handout material identify types of heat recovery heat exchangers (air to air, water to air, stack economizers, run around coils) and their applications.
17. Given lecture, handouts, & mfg.'s software, generate a building load profile.

18. Given lecture, handouts, & mfg's literature, identify system components and types of thermal storage used in HVACR applications.
19. Given lecture, mfg.'s literature & mfg's software, size a chiller based on chiller priority.
20. Given lecture, mfg.'s literature & mfg's software, size a chiller based on ice priority.
21. Given lecture, handouts, & mfg.'s literature, size a thermal storage system.
22. Given lecture, handouts, & mfg.'s literature, identify system components and operating characteristics of cogeneration systems.
23. Given manufacture's software, generate thermal and electrical load profiles (base and peak) of a building.
24. Given lecture, & handouts, describe the advantages & disadvantages of various prime mover-s used in cogeneration.
25. Given mfg.'s literature, size a cogeneration system.
26. Given lecture, handouts, & mfg.'s software, generate a building load profile based on peak & block loads.
27. Given lecture, handouts, mfg.'s literature, identify system components and operating characteristics of closed loop water source heat pump systems.
28. Given mfg.'s literature, select a water source heat pump for a closed loop application.
29. Given mfg.'s literature, select a cooling tower for a closed loop water source heat Pump application.
30. Given mfg.'s literature, select a boiler for a closed loop application.
31. Given lecture, and handouts, calculate depreciation based upon straight line, sum-of-the digits, and double declining balance.
32. Given homework, and handouts calculate discounted cash flow analysis.
33. Utilize available software to perform cash flow analysis.

COURSE OUTLINE

Course: HVAC 483
Date: January, 99
Department Approval:

COURSE TITLE: HVACR Building Systems

COURSE DESCRIPTION: HVACR systems and controls found in commercial and industrial buildings for facility managers: energy utilization, utility rates, and building management systems that optimize comfort and reduce energy costs for buildings. Includes site visitations and reports.

Credit Hours:	3	
Semester Hours:	Lecture	3 hours/week
	Lab.	0 hours/week
Prerequisites:	None	
Textbooks Required:	None	

TENTATIVE SCHEDULE OF TOPICS

1	12-Jan	Introduction
2	14-Jan	Heat Transfer – Background, Units of Energy, Definitions, HVACR Relationships
3	19-Jan	Utility Rates
4	21-Jan	Utility Rates
5	26-Jan	Utility Rates
6	28-Jan	Economic Analysis/Energy Audit and Accounting
7	2-Feb	Human Comfort
8	4-Feb	HVAC Building Systems
9	9-Feb	HVAC Building Systems
10	11-Feb	HVAC Building Systems
11	16-Feb	Exam #1
12	18-Feb	HVAC Building Systems
13	23-Feb	HVAC Building Systems
14	25-Feb	HVAC Building Systems
15	2-Mar	HVAC Building Systems
16	4-Mar	Control & Optimization of HVAC Systems
	9-Mar	SPRING BREAK, NO CLASS
	11-Mar	SPRING BREAK, NO CLASS
17	16-Mar	Control & Optimization of HVAC Systems
18	18-Mar	Field Visit – to be announced (place and time)
19	23-Mar	Optimization of Electrical Systems
20	25-Mar	Optimization of Electrical Systems
21	30-Mar	Exam #2

22	1-Apr	EASTER RECESS, NO CLASS
23	6-Apr	Miscellaneous HVAC Systems (Cogeneration, Thermal Storage, Waste Heat Recovery
24	8-Apr	Miscellaneous HVAC Systems (Cogeneration, Thermal Storage, Waste Heat Recovery
25	13-Apr	Preventative Maintenance
26	15-Apr	Preventative Maintenance
27	20-Apr	Preventative Maintenance
28	22-Apr	Preventative Maintenance
29	27-Apr	Field Visit – to be announced (place and time)
30	29-Apr	Open discussion on field visit, review for exam
	TBA	Final Exam

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED:

1. Students will describe the energy sources that are available to buildings and select sources from calculated economic analysis.

2. Students will identify the benefits and limitations of energy sources.

3. Students will have the opportunity to visit site installations of energy sources and report why it was used for that particular installation.

4. Students will identify the different types of HVAC systems found in buildings and describe the advantages and disadvantages of selected applications.

5. Students will be able to understand "Human Comfort" and what implications this may have on the typ0e of HVAC system chosen.. Students will identify the limitations of the systems for various installations. This area includes indoor air quality (IAQ).

6. Students will be able to identify the major components found in an HVAC system and describe the function of the components in relationship to the entire HVAC system.

7. Students will describe control sequences and control loops of HVAC systems. Identification of components will be required.

8. Students will have an understanding of utility billing and charges from utilities for building usage.

9. Students will have an understanding of energy budgets and importance of working with utilities, relative to minimum charges. Students will be able to identify each breakdown and how each impacts the budget.

10. Students will do economic analysis of energy costs of building applications. Students will relate savings to temperature setting standards, heat loss and heat gain, and what types of systems would give the facilities the most flexibility in the open office plan environment.

11. Students will analyze energy (building) management reports relative to energy consumption and the operation of HVAC system operations in buildings. Case studies will be incorporated.

12. Students will identify problems and solutions of buildings that exist in office settings relative to sick building syndrome, indoor air quality and other regulations that may have an impact on the office environment. Students will be able to report on the major causes and options available in solving the problems.

13. Students will have an appreciation for the preventative maintenance that is required for HVAC systems. Students will be exposed to preventative maintenance programs and costs that are involved in preventative maintenance.

14. Students will demonstrate an understanding of computer room requirements, which includes HVAC, uninterrupted power sources, generators, and clean room conditions.

15. Students will describe the types of co-generation systems, their application and economic advantages including payback relative to utility billings, rate structure and buy-back of power.

16. Students will describe the types of thermal storage systems, their application and economic advantages (payback) relative to utility billings and rate structure.

ADDITIONAL COURSE INFORMATION

Scoring:
2 Exams 50%
Final Exam 35%
Reports and Quizzes.... 15%
Total 100%

Grading scale

A	94 - 100
A-	90 - 93
B+	87 - 89
B	84 - 86
B-	81 - 83
C+	78 - 80
C	75 - 77
C-	73 - 74
D+	71 - 72
D	69 - 70
D-	66 - 68
F	65 -

Instructor .... Mike Feutz
Office................... CTC 102B
Office Hours........ Monday – Friday, 8:00 – 4: 30
Phone.................. 592-2351

COLLEGE OF TECHNOLOGY
CONSTRUCTION DEPARTMENT

COURSE OUTLINE

Course: HVAC 499
Date:
Dept.

COURSE TITLE: HVAC-499 Commercial HVAC System Design

COURSE DESCRIPTION: Given building architectural plans, appropriate software, codes and standards and owner's requirements, students will select appropriate HVAC system, conduct economic analysis, design system and produce working drawings, specifications and control sequences for evaluation.

CREDIT HOURS: 5 Semester Credit Hours

CONTACT HOURS: Lecture - 2 Hours/Week
Lab - 9 Hours/Week

COURSE PREREQUISITES(S): HVAC 312, HVAC 331, HVAC 342, HVAC 415, HVAC 462

REQUIRED TEXTBOOKS: Air Conditioning Contractors of America, ***Manual CS Commercial Applications, Systems and Equipment.*** ACCA, 1993.

REFERENCES:

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. **Air-Conditioning Systems Design Manual,** ASHRAE, 1993

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ***Handboodk of Fudnamentals.*** ASHRAE, 1997

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ***HVAC Systems and Equipment Handbook.*** ASHRAE, 1996

UNITS OF INSTRUCTION AND LEARING GOALS FOR EACH UNIT

		TIME WEIGHT Lecture	Lab. Hrs.
I.	Introduction and Project Overview	1	
II.	Design Procedure	1	
III.	System Analysis and Selection	2	9
IV.	Base Load Information	2	18
V.	Miscellaneous Base Load	2	9
VI.	Initial Design Load	2	9
VII.	Applied Load Analysis	2	9
VIII.	Equipment Selection	4	9

IX.	Building Simulation	2	9
X.	System Sizing and Layout	3	18
XI.	Working Drawings	2	27
XII.	Specifications	2	9
XIII.	Project Report	2	9
XIV.	Exams	3	
	Total	30	135

TOPICAL UNIT OUTLINE OF MAJOR UNITS OF INSTRUCTION

I. Introduction

A. Project Overview
B. Project Organization and Timeline

II. The Design Procedure

III. System Selection

A. Classification of Systems
B. Factors Affecting Zoning Decisions
C. Zoning Evaluation Table
D. Architectural Considerations
    1. Building Codes and Regulations
    2. Space Available for Ducts and Pipes
    3. Space Available for Equipment
E. Analyze Building Envelope
    1. Exterior
    2. Interior
F. Economics
G. Summary of System Performance
H. Analysis and Selection of System

IV. Applications by Building Type and Use

A. Indoor Design Conditions and Human Comfort
    1. Temperature
    2. Humidity
    3. Noise
B. Ventilation Requirements
    1. Indoor Air Quality
        a. Biological
        b. Chemical
        c. Particulate
    2. Outdoor Air Requirements
C. Effects of Variable Air Volume Systems Upon Ventilation Rates
D. Methods of Controlling Outdoor Air in Relationship to Occupancy

V. Load Analysis

A. Base Load Information
1. Space Data
2. Building Envelope Data
3. Lighting Requirements
4. Occupancy Patterns
5. Schedules

B. Miscellaneous Base Load
1. Infiltration
2. Ventilation
3. Human Comfort Requirements

C. Initial Design Load
1. Space Input Data
2. Zone Input Data
3. Air System Input Data
4. Heating Load Calculation
5. Cooling Load Calculation
6. Macro Analysis

VI. Applied Load Analysis

A. Terminology Equipment Sizing Loads
B. Equipment Sizing Loads
C. Ventilation Load Calculation Procedure
D. System Loads
E. Part-Load Analysis
F. Load Line Analysis
G. Control Strategies for Conditioned Spaces
1. Identify Control Modes (i.e. 2-position, floating point, proportional)
2. Identify Control Strategies (duty cycling, load shedding, demand limiting, optimal start-stop)

H. Humidity Control
I. Equipment Loads Versus Space Loads
J. Control Strategies for Equipment
K. Psychometric Analysis

VII. Selecting Cooling Equipment

A. Selection Data
1. Indoor Design Conditions
2. Outdoor Design Conditions
3. Sensible Load
4. Latent Load
5. Entering Coil Conditions
6. Approximate Air Volume

B. Coil Selection
C. Air Side Accessories
D. Controls
E. Fan Performance
F. Heat Rejection Devices

H. Chiller Selection

VIII. Selecting Heating Equipment

A. Sizing Requirements
 1. Heating Capacity
 2. Design Conditions
B. Coil Selection
C. Hot Water Terminal Equipment
D. Controls
E. Select Air Handling Equipment
F. Boiler Selection

IX. Utility Rate Structures

A. Electricity
B. Fossil Fuel
C. Energy Systems
 1. Cogeneration
 2. Thermal Storage
 3. Geothermal

X. Building Simulation

A. Utility Input
B. Plant Input Data
C. Building Data
D. Cost Output
 1. Component
  a. HVAC
  b. Non-HVAC
 2. Annual Energy

XI. System Sizing and Layout

A. Air System
 1. Ductwork
 2. Air Diffusion
 3. Ventilation/Exhaust
B. Pressure Loss Calculation
C. Water System
 1. Piping
 2. Terminal Devices
 3. Flowrates
D. Head Loss Calculation
E. Pump Selection

XII. **Development of Plans**

A. Piping Plan
B. Ductwork Plan

D. Details
E. Schedules

XIII. Specification
A. Mechanical
B. Electrical
C. Controls

XIV. Project Report
A. Project Management
B. Cost Analysis and Comparisons
C. Relationship to ASHRAE Criteria

XV. Presentation Development

MINIMUM REQUIRED STUDENT LAB ACTIVITIES DEFINED

1. **System Analysis and Selection**. The student will analyze building structure and layout and determine zoning requirements and system.

2-3. **Base Load Information.** Student will gather essential building information to perform load calculations for heating and cooling..

4-6. **Miscellaneous Base Load.** Student will gather information regarding infiltration and ventilation requirements and analyze their effect upon the building load.

7-9. **Initial Design Load.** Student will calculate design loads for building.

10-16. **Applied Load Analysis.** Student will use load information to develop load line analysis and recommend initial control strategies.

17-19. **Equipment Selection.** Student will select coils, controls, fans, heat rejection devices, air handling equipment and chiller.

20-28 **Building Simulation.** Student will utilize commercially available software to determine the energy consumption based upon the hour by hour method of analysis.

29-37. **System Sizing and Layout.** Student will develop schematics for air and water heating and cooling systems.

38-40. **Working Drawings.** Student will utilize commercially available software (AutoCAD) too produce working drawings.

41-44. **Specifications.** Student will use CSI format to develop specifications for mechanical and control systems.

45. **Presentation of Report.** Student will utilize present results of design to building owner.

TASK LISTING (The student shall be able to . . .)

A. Design Procedure
   1. Identify the process of HVAC Design

B. Systems Analysis and Selection
   1. Apply factors affecting zoning decisions to system

3. Evaluate system configuration an performance in relationship to building and zoning considerations
4. Evaluate economics in relationship to budgetary considerations (first cost and operating costs)
5. Summarize system performance
6. Identify potential systems to meet performance requirements

C. Applications by Building Type and Use
1. Identify indoor design requirements based upon occupancy and applicable codes
2. Identify indoor air quality requirements
3. Describe ventilation characteristics of various systems

D. Load Analysis
1. Assemble building base load information
2. Calculate building base load
3. Assemble building miscellaneous base load information
4. Calculate miscellaneous base load c
5. Calculate building load

E. Applied Load Analysis
1. Understand load analysis terminology
2. Calculate equipment sizing loads
3. Determine ventilation requirements for indoor air quality, economizer and building pressurization
4. Perform load line analysis based upon design load
5. Identify preliminary control strategies and modes
6. Identify methods to control humidity
7. Apply psychometric analysis

F. Selecting Cooling Equipment
1. Identify critical conditions for coil selection
2. Select coil
3. Identify miscellaneous accessories
4. Select air handling equipment
5. Select chiller
6. Select heat rejection equipment

G. Selecting Heating Equipment
1. Identify critical conditions for coil selection
2. Select coil
3. Identify miscellaneous accessories
4. Select air handling equipment
5. Select boiler

H. Utility Rate Structures
1. Identify availability and verify electrical rate structure

3. Analyze applicability of energy enhancing systems

I. Building Simulation
   1. Input utility data
   2. Input plant data
   3. Input building data
   4. Generate component and annual energy cost

J. System Sizing and Layout
   1. Select, size and layout air distribution system
   2. Calculate air pressure losses and select fan
   3. Select, size and layout water distribution system
   4. Calculate water pressure losses and select circulating pump

K. Development of Plans
   1. Identify standards and drawing arrangement
   2. Develop working drawings for piping, ductwork, details, schematics and control diagrams and schedules

L. Specifications
   1. Understand the purpose and format for mechanical specifications
   2. Understand the purpose and format for control specifications

ADDITIONAL COURSE INFORMATION

COURSE: HVAC-499 Commercial HVAC System Design

GRADING POLICY

A	94-100
A-	90-94
B+	87-90
B	84-87
B-	81-84
C+	78-81
C	75-78
C-	73-75
D+	71-73
D	69-71
D-	66-69
F	66 and below

EXAM DATES

March 4, 1998 (date approximate)
Arpil 8, 1998 (date approximate)

Week of April 27, 1998 (dates to be determined)

EXAM WEIGHT

Exams 1 and 2 each account for **15%** of final grade (**30%** total)
Final exam (presentation) accounts for **20%** of final grade
Project and labs account for **50%** of final grade

Note: Late laboratory submittals will be reduced one full grade for each **class day** beyond submittal date. Re-submittals are not accepted.

OFFICE HOURS:

Johnson Hall 303
Monday 3:00-3:50 pm
Tuesday-Thursday 10:00-10:50 am

B appointment at any other time

Office Phone **591-2747**
Home Phone 796-0739
E-mail:Office-LeClalire@cot01.ferris.edu
Home-LeClaire@tucker-usa.com

ENROLLMENT TRENDS

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY

2000

Enrollment trends show that recruiting by a HVACR marketing person caused a yearly increase in enrollment in both the AAS and BS programs. This enrollment in the AAS program reached near capacity in 1997 (AAS program capacity is 90). Since 1997, the HVACR programs has been without a marketing person and the effects of this is seen in the AAS program. The AAS program must compete with a number of other HVACR programs for students just out of High School. Recruiting at the High School level is the key to keeping the enrollment in the AAS increasing. The HVACR program has currently interviewed for a replacement in the Marketing position and the position should be filled by the end of the year. With recruiting back in place the program will again push the limits of the AAS program capacity.

The BS program is currently exceeding their capacity. The capacity is 68 students and there was an enrollment of 70 students in 1999. Without marketing, the BS program continued to grow to the limits of their capacity. There is virtually no competition from any other college, with only Penn Tech, to our knowledge, having a comparable program. Without more space and faculty, the BS program cannot accept anymore students into the program. Market analysis, advisory board input, employer input and graduate input all agree that the market for the BS degree in HVACR Engineering Technology is growing at a rapid rate. There would be no difficulty at all increasing the enrollment in this curriculum if there were adequate resources (facility and faculty).

Program/Department: AAS HVACR TECH and BS HVACR ENGR TECH Date Submitted: December 1, 1999

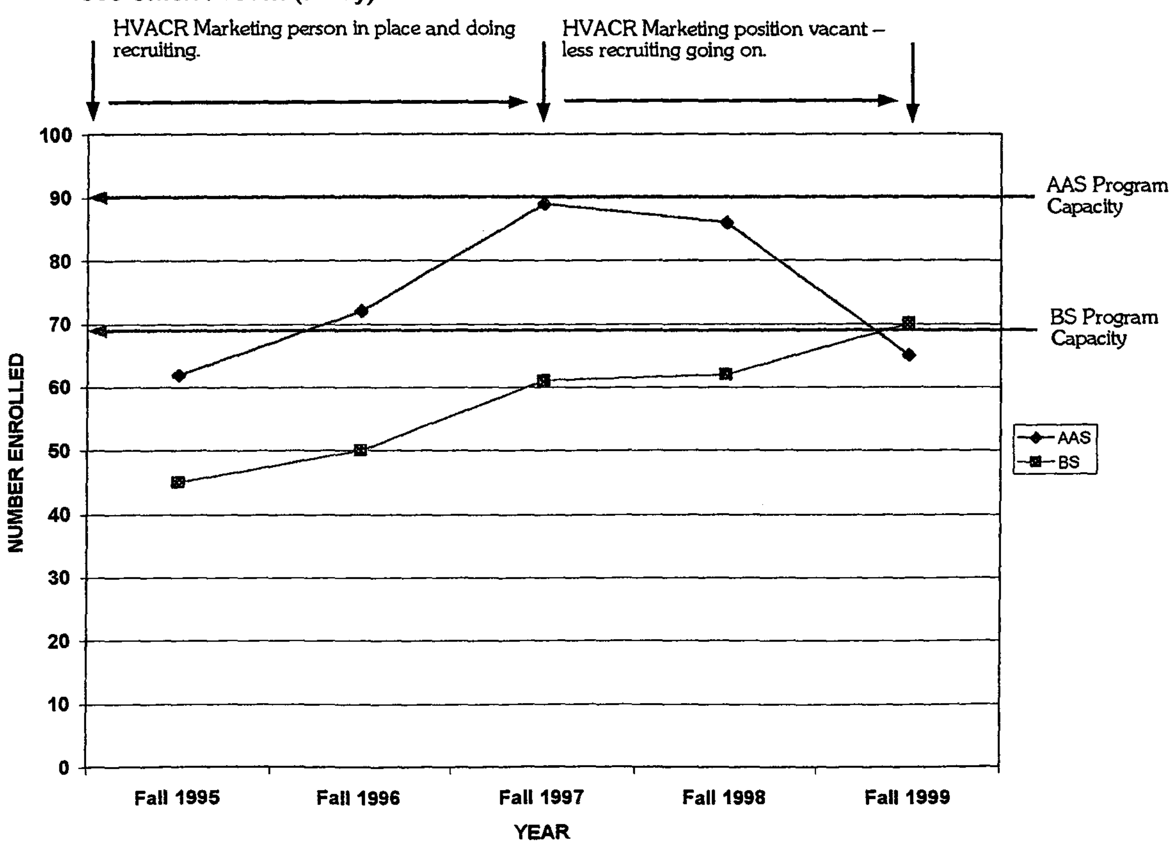
Dean: Technology

Please provide the following information:

Enrollment

	Fall 1995	Fall 1996	Fall 1997	Fall 1998	Fall 1999
Tenure Track FTE	7	7	6	7.5	7.5
Overload/Supplemental FTEF					
Adjunct/Clinical FTEF (unpaid)					
Enrollment on-campus total*	62 / 45	72 / 50	89 / 61	86 / 62	65 / 70
• Freshman	19 / 1	25 / 0	17 / 1	21 / 2	26 / 0
• Sophomore	19 / 0	25 / 1	38 / 1	41 / 4	32 / 2
• Junior	9 / 8	11 / 12	14 / 11	18 / 23	3 / 18
• Senior	6 / 27	5 / 22	6 / 38	6 / 33	4 / 50
• To be Determined	9 / 9	6 / 15	14 / 10		
• Doctoral					
• Pre-Professional Students					
Enrollment off-campus*					
• Traverse City					
• Grand Rapids (BS only)	20	23	18	23	23
• Southwest					
• Southeast					

*Use official count (7-day)



11

PROGRAM PRODUCTIVITY / COST

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY

2000

PROGRAM PRODUCTIVITY / COST

Productivity data for the AAS Heating, Ventilation, Air Conditioning and Refrigeration course prefix (HVACR) is tabulated below. Data for Ferris State University, the College of Technology and the three departments within the college are included for comparison purposes.

PRODUCTIVITY REPORT
SCH/FTEF
1994 - 1999

AREA	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999
FSU	466	464	447	442	457
College of Technology	334	339	333	323	331
Transportation & Electronics Department	287	325	304	297	301
Design, Manufacturing & Graphic Arts Department	361	324	324	306	323
Construction & Facilities Department	352	380	384	384	378
HVAC Prefix Courses	340	324	380	420	374

PROGRAM TEACHING COSTS, ACADEMIC YEAR 1998-1999

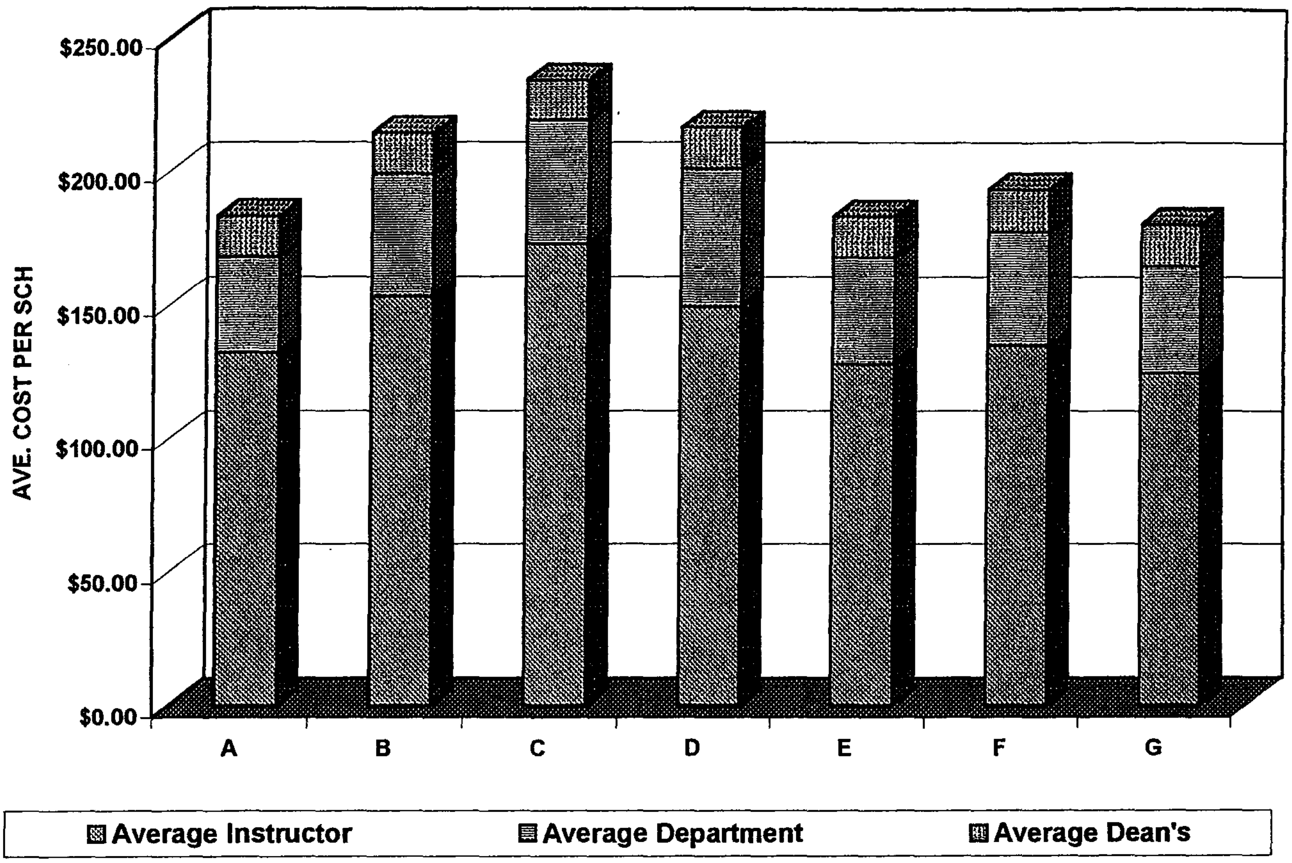
Academic year 1998 – 1999 program teaching costs for the AAS Heating, Ventilation, Air Conditioning and Refrigeration Technology and the BS Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology are tabulated below. Data for Ferris State University, the College of Technology and the three departments within the college are included for comparison purposes.

	Average Instructor Cost per SCH	Average Department Cost per SCH	Average Dean's Cost per SCH	Total Cost per SCH
FSU	$132.12	$35.81	$14.97	$182.90
College of Technology	$152.95	$45.75	$15.33	$214.03
Transportation and Electronics Department	$172.68	$45.93	$15.28	$233.90
Design, Manufacturing and Graphics Arts Department	$149.08	$51.55	$15.42	$216.05
Construction and Facilities Department	$127.75	$39.80	$15.31	$182.86
AAS HVACR T	$134.61	$42.66	$15.68	$192.95 69th out of 183 programs
BS HVACR ET	$124.70	$39.81	$15.50	$180.00 89th out or 183 programs
19 HVAC courses	$138.23 48th out of 135 course prefixes			

Total program costs per SCH for the AAS HVACR Technology is below the College of Technology average, and slightly above the university average. Total program cost per SCH for the BS HVACR Engineering Technology is below both the College of Technology and university averages.

S&E funding for the AAS HVACR Technology cannot be separated from the S&E funding for the BS, HVACR Engineering Technology. Nevertheless, S&E funding is marginal. S&E data is tabulated in Appendix A. Two major areas of concern exist. First, the AAS program is highly dependent on Voc Ed funding, which cannot be relied upon year after year. Both programs depend on special or year-end equipment funds, which are becoming scarcer, given the new budget procedures in the Office of the Vice President Academic Affairs.

PROGRAM TEACHING COSTS CHART
ACADEMIC YEAR 1998-1999



A	FSU
B	College of Technology
C	Transportation & Electronics Department
D	Design, Manufacturing & Graphics Arts Department
E	Construction & Facilities Department
F	AAS HVACR Technology
G	BS HVACR Engineering Technology

COLLEGE of TECHNOLOGY DEGREE PROGRAM COSTS
1998-1999

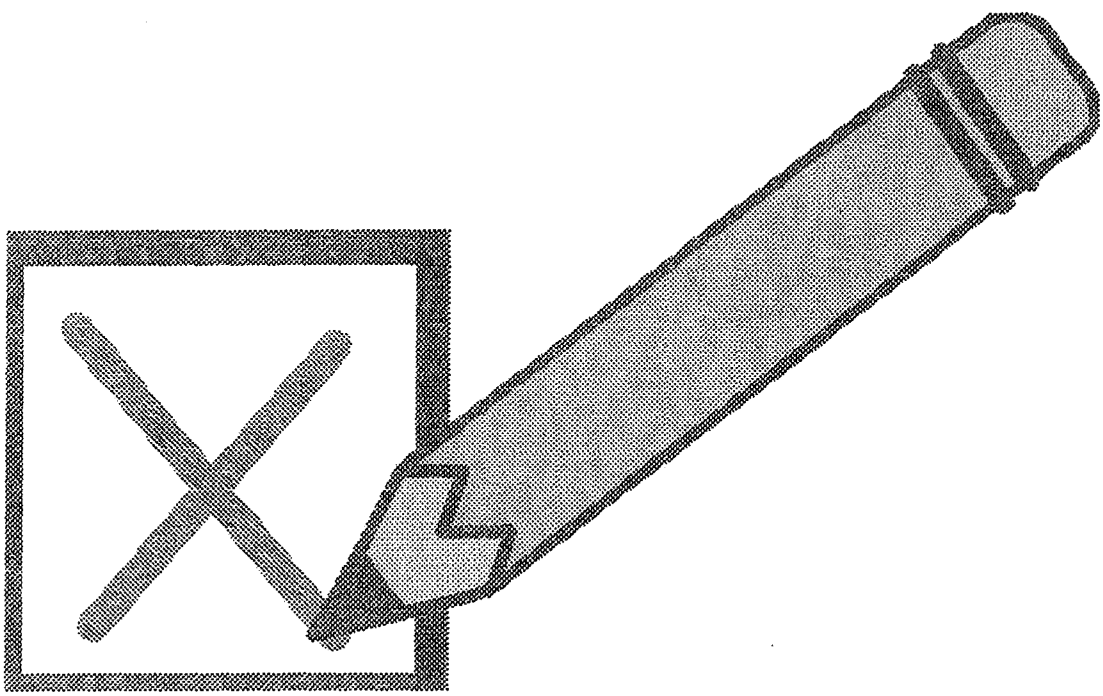
Program	Total Cost per SCH	Rank Among 183 Programs
Optometry	$561.00	1
Quality Technology Certificate	$340.82	8
Printing & Digital Graphic Imaging Technology AAS	$313.91	11
Computer Networks & Systems BS (Embedded Systems)	$289.91	15
Automotive Service Technology AAS	$265.56	17
Heavy Equipment Technology AAS	$259.75	18
Manufacturing Engineering Technology BS (Yrs 3 & 4)	$248.74	22
Elect/Electron Engr Tech BS (Yrs 3 & 4) (Communications)	$240.24	24
Elect/Electron Engr Tech BS (Yrs 3 & 4) (Indust Automation)	$240.24	25
Computer Networks & Systems BS (Communications)	$238.77	26
Computer Networks & Systems BS (Indust Automation)	$237.44	27
Automotive Body AAS	$235.28	28
Technical Drafting and Tool Design AAS	$232.06	31
Quality Engineering Technology BS (Yrs 3 & 4)	$229.44	32
Plastics Engineering Technology BS (Yrs 3 & 4)	$229.14	33
Automotive Service Technology AAS (Ford ASSET opt)	$228.21	34
Automotive Service Technology AAS (General Motors ASEP opt)	$228.21	35
Automotive Service Technology AAS (Chrysler Apprenticeship Program CAP)	$228.21	36
Manufacturing Tooling Technology AAS	$224.86	41
Computer Networks & Systems BS (Information Systems)	$224.34	42
Elect/Electron Engr Tech BS (Yrs 3 & 4) (Digital)	$223.85	44
Welding Technology AAS	$223.22	45
Industrial Electronics Technology AAS	$215.40	48
Facilities Management BS (Yrs 3 & 4)	$214.88	49
Surveying Engineering BS	$214.56	50
• **College of Technology Average**	**$214.03**	
Heavy Equipment Service Eng Tech/Maint Opt BS (Yrs 3 & 4)	$213.13	51
Architectural Technology AAS	$210.00	52
Surveying Technology AAS	$201.57	60
Advanced Construction Management Certificate	$201.24	61
Mechanical Engineering Technology AAS	$196.26	65
HVACR Technology AAS	$192.95	69
Product Design Engineering Technology BS (Yrs 3 & 4)	$191.17	71
Welding Engineering Technology BS (Yrs 3 & 4)	$189.83	74
Rubber Engineering Technology BS (Yrs 3 & 4)	$189.14	76
Plastics Technology AAS	$184.70	80
• **FSU Average**	**$182.90**	
Heavy Equipment Service Eng Tech/Mfg Opt BS (Yrs 3 & 4)	$180.83	88
HVACR Engineering Technology BS (Yrs 3 & 4)	$180.00	89
• **Median**	**$176.48**	
Rubber Technology AAS	$175.94	93
Construction Field Engineering Certificate	$173.79	95
Automotive and Heavy Equipment Mgt BS (Yrs 3 & 4)	$170.25	97
Civil Engineering Technology AAS	$169.57	99
Construction Administration Certificate	$166.07	105

CONCLUSIONS

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



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CONCLUSIONS

Centrality to FSU mission

The HVACR programs are central to the FSU mission.

> Ferris State University will be a national leader in providing opportunities for innovative teaching and learning in career-oriented, technological and professional education.

Uniqueness and visibility

The HVACR program is unique in that the upper level curricula is one of only two nationwide. Certification programs regarding refrigerant recovery and geothermal technician training have provided tremendous visibility throughout the nation.

Service to state and nation

Faculty are involved with committee work for professional societies on a national and international level. One faculty member serves as Regional Vice Chair for the Student Activities Committee for the American Society of Heating, Refrigerating and Air-Conditioning Engineers. Certification programs have certified over 450,000 technicians worldwide in refrigerant recovery. Four faculty members wrote the EPA certification manual titled: <u>Refrigerant Transition and Recovery Certification Program for HVACR Technicians</u>. Four faculty members were instrumental in producing a interactive CD-ROM training course in Electrical Troubleshooting that has been sold nation wide. Two faculty members wrote a design and application manual for geothermal, and gave nation wide seminars on the topic. Research is currently being done state-of-the-art geothermal which will ultimately save the state and nation valuable energy resources. Energy audits and HVAC design are provided as a community service to state and local facilities.

Demand by students

A high percentage of out of state enrollment indicates that demand by students for the BS degree program is extensive.

Quality of instruction

Quality of instruction remains high as experienced faculty transfer knowledge via the classroom to students. Students, graduate, employer and advisory survey results verify this.

Demand for graduates

Demand for graduates remains high and the program is unable to meet the requirements of the industry. The success of the internship program indicates that the students are well prepared to enter the workforce.

Placement rate and average salary of graduates

Placement rates continue to be at 100%. Starting salaries for the BS graduates are competitive with those in the mechanical engineering profession.

CONCLUSIONS – (cont.)

Service to non-majors

Faculty instruct all courses with HVAC prefixes including courses for the Architectural Technology, Building Construction Technology and Facility Management programs.

Facilities and equipment

Computer facilities are adequate. Laboratory equipment is a mix of old and state of the art. Crowded lab conditions harbor potential safety issues.

Library information resources

Library information resources are adequate.

Cost

The programs are lower cost than average in the college, and rank in the middle on a university-wide basis. See Section 11.

Faculty: professional and scholarly activities

Faculty are extensively involved in professional and scholarly activities. Faculty act as advisors to the student branches of the HVACR professional organizations. Faculty members hold positions in HVACR professional organizations. Faculty hold committee positions within the university. Faculty regularly attend professional development seminars. Faculty have written numerous articles, books and other educational material that are utilized world wide. Faculty act as outside consultants to industry and government (state and federal). Faculty have conducted research that has had international impact. Faculty have been instrumental in getting industry to donate state-of-the-art equipment. Faculty also hold various certifications, licenses and higher degrees.

Administrative effectiveness

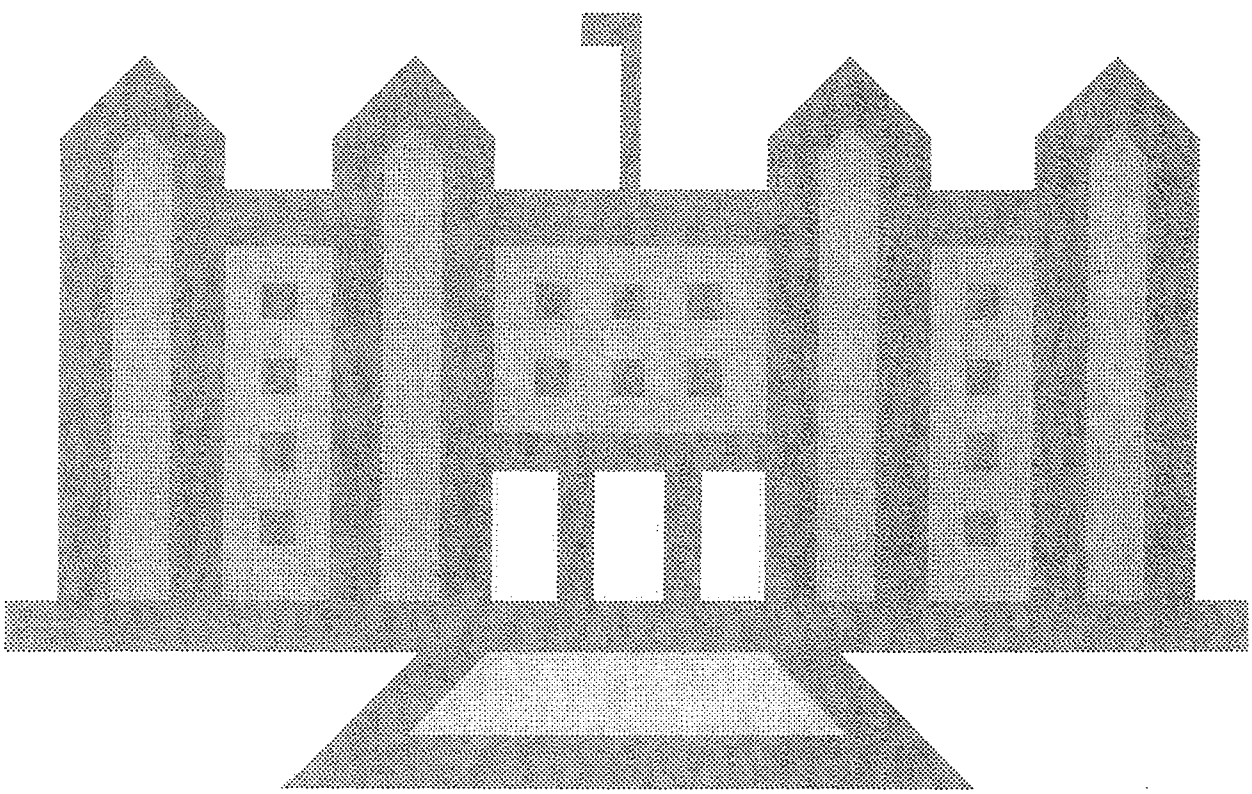
Administrative effectiveness is adequate.

PROGRAM REVIEW PANEL RECOMMENDATIONS

For

AAS in HVACR TECHNOLOGY

BS in HVACR ENGINEERING TECHNOLOGY



2000

PROGRAM REVIEW PANEL RECOMMENDATIONS

- Enhance the HVACR Programs by successfully receiving State of Michigan and industry funding for the current National HVACR Center / CTC renovation capital outlay project.
- That the faculty continue to review and revise the curriculum as appropriate to address issues raised in the student, graduate, employer and advisory committee surveys and to meet the continual changes in the profession. This effort is a current and continuing process.
- To enhance recruitment into the HVACR Programs by filling the vacant HVACR marketing position as soon as possible.
- To enhance recruitment into the HVACR Programs by working with the University's Admissions Office in regards to the Noel – Levitts Findings.
- To remain a state-of-the-art curriculum and to enhance the employability of graduates transitioning to the workforce by incorporating rapidly changing technical software in a timely fashion.
- That the HVACR Program be enhanced by developmental funding to explore expanding educational opportunities to reflect the changing needs of the professional, such as the use of the internet.
- To work within the university guidelines in continuing to partner with industry for program enhancement.

PROGRAM REVIEW PANEL EVALUATION

Program: AAS, HVACR Technology **Note:** (x) indicates the number of responses for that level.

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

1. Student Perception of Instruction

Average Score = 4.33

5 (3)	4 (6)	3 (0)	2 (0)	1 (0)
Currently enrolled Students rate instructional Effectiveness as extremely high.				Currently enrolled Students rate instructional Effectiveness as below average.

2. Student Satisfaction with Program

Average Score = 3.67

5 (0)	4 (6)	3 (3)	2 (0)	1 (0)
Currently enrolled students are very satisfied with the program faculty, equipment, facilities, and curriculum.				Currently enrolled students are not satisfied with the program faculty, equipment, facilities, and curriculum.

3. Advisory Committee Perceptions of Program

Average Score = 4.33

5 (4)	4 (4)	3 (1)	2 (0)	1 (0)
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 = 4.89

5 (8)	4 (1)	3 (0)	2 (0)	1 (0)
Graduates easily find employment in field.				Graduates are sometimes forced to find positions out of their field.

5. Use of Information on Labor Market

Average Score = 4.00

5 (0)	4 (9)	3 (0)	2 (0)	1 (0)
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 = 4.00

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

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 = 4.00

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

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 = 3.56

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

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 = 3.67

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

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 = 3.33

5 (0)	4 (6)	3 (0)	2 (3)	1 (0)

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

Staffing is inadequate to meet the needs of this program effectively.

PROGRAM REVIEW PANEL EVALUATION (Page 3)

11. Facilities **Average Score = 2.56**

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

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 = 3.67**

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

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 = 3.33**

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

Present equipment is sufficient to support a high quality program.

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

14. Adaptation of Instruction **Average Score = 4.00**

5 (1)	4 (7)	3 (1)	2 (0)	1 (0)

Instruction in all courses required for this program recognizes and responds to individual 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 = 4.00**

5 (1)	4 (7)	3 (1)	2 (0)	1 (0)

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.

PROGRAM REVIEW PANEL EVALUATION

Program: BS, HVACR Engineering Technology

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

1. Student Perception of Instruction

Average Score = 4.44

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

Currently enrolled Students rate instructional Effectiveness as extremely high.

Currently enrolled Students rate instructional Effectiveness as below average.

2. Student Satisfaction with Program

Average Score = 4.00

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

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

Currently enrolled students are not satisfied with the program faculty, equipment, facilities, and curriculum.

3. Advisory Committee Perceptions of Program

Average Score = 4.44

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

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 = 5.00

5 (9)	4 (0)	3 (0)	2 (0)	1 (0)

Graduates easily find employment in field.

Graduates are sometimes forced to find positions out of their field.

5. Use of Information on Labor Market

Average Score = 4.00

5 (1)	4 (7)	3 (1)	2 (0)	1 (0)

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 = 4.13

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

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.

*NOTE: no response from one survey.

7. Use of Student Follow-up Information

Average Score = 4.13

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

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 = 3.56

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

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 = 3.67

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

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 = 3.56

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

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 = 2.78

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

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 = 3.67

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

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 = 3.44

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

Present equipment is sufficient to support a high quality program.

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

14. Adaptation of Instruction

Average Score = 3.89

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

Instruction in all courses required for this program recognizes and responds to individual 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 = 3.89

5 (1)	4 (6)	3 (2)	2 (0)	1 (0)

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.