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A comparison of the engineering curricula of the junior college and the university lower division

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A COMPARISON OF THE ENGINEERING CURRICULA OF THE JUNIOR COLLEGE AND THE UNIVERSITY LOWER DIVISION

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A listing of the courses in engineering which are given in the junior colleges for transfer to the universities, showing which courses each junior college gives.

CHAPTER I

INTRODUCTION

As early as the 1850's some of the prominent educators were advocating a separation of the upper and lower divisions in the universities.[1] This, in effect, was the beginning of the junior college movement. Resistance was encountered as was also mere apathy, so it was not until about 1900 that the first junior colleges were established.

The first junior college to be established in California was at Fresno in 1910.[2]

The original purpose of the junior college was to do the work of the lower division of the university. The belief that there was a definite line of separation between the lower and upper divisions was not uncommon. The upper division was for specialization which perhaps would lead to graduate work and research. The lower division was merely preparatory for this and hence had no place in the university program.[3]

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[1] Walter Crosby Eells, The Junior College (Cambridge: Houghton Mifflin Company, 1931), p. 45.

[2] Ibid., pp. 92-95.

[3] Ibid., pp. 45-65.

Though there was considerable agreement on this score, there was also a growing feeling that the junior college should do more than just the lower division work. Vocational training, therefore, was added to the curriculum, and in some of the junior colleges this has become a very large program. This training is generally referred to as a terminal program with terminal courses. Also included in the curriculum now are courses for general education. These courses are intended to increase the students' general knowledge and broaden his background and understanding in areas outside of his field of special study beyond that which would be obtained if he studied only in his field of specialization. Many now feel that these latter services, vocational training and general education, are much more important than offering lower division work.[4]

I. THE PROBLEM

This study is an attempt to assemble the engineering curricula of all the junior colleges and many of the four year colleges and universities of California, and to determine to what extent the junior college engineering

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[4]Jesse Parker Bogue, The Community College (New York: McGraw-Hill Book Company, Inc., 1950), pp. 183-96.

curricula are similar to the lower division curricula of these four year institutions.

Perhaps the first question to arise in a study of this kind is, what training in engineering is being given by the junior colleges? Among the many other questions that might be answered are:

1. Is there a correlation between the size of a junior college and the number of engineering courses offered?

2. To what extent are terminal courses in engineering available in the junior colleges?

3. What effect does the junior college's location have upon its engineering curriculum?

4. Can a comparison of the engineering curricula of the university lower division and the junior college be made?

There are other questions, but these are the main ones to be considered in the material and tables that follow.

The engineering curriculum, for the most part, involves four subject areas. These are (1) mathematics, (2) chemistry, (3) physics, and (4) engineering. In order to reduce the sizes of tables, and also because it was found that a college which offers any engineering subjects

at all also offers the required mathematics, chemistry, and physics, it was decided to limit this study to the area of engineering.

There are a number of fields of specialized study in engineering, but the basic training for all is nearly the same. In most colleges the first year of training is the same for all engineering majors, but differences begin to occur in the second year. Most of the fields of specialized study in engineering are branches of Civil Engineering, Electrical Engineering, and Mechanical Engineering, so it was agreed that the inclusion of these three major areas would be sufficient for this study.

This study shall be limited to the State of California. All of the junior colleges which offer engineering work shall be included. All of the four year institutions should be included. However, because there are so many of the rather small private colleges, and some of them offer very little or no engineering, the four year schools shall be limited to the major universities, the state colleges, and two or three of the larger private institutions.

II. DEFINITION OF TERMS

Transfer course. A course in which the material covered is equivalent to that covered in a course given at the university is a transfer or parallel course.

Terminal courses. Those courses of non-transfer credit in which formal study is terminated at the junior college are called terminal courses. These courses generally are not recognized as leading toward a degree.

Technical courses. Technical courses are those courses which provide the necessary technical background in preparation for work in particular fields of engineering, though in some instances they might be accepted by some universities.

Professional courses. Professional courses are courses in engineering which will lead to the baccalaureate and higher degrees. They are courses which prepare a person to become a professional engineer.

Pre-professional courses. These courses are the same as professional courses; the distinction being that pre-professional applies to the lower division, while professional refers to upper division and graduate work.

CHAPTER II

THE UNIVERSITY LOWER DIVISION ENGINEERING CURRICULA

It is not necessary to tell those who are directly involved in the teaching of engineering that seldom do two institutions of higher learning have identical engineering curricula. This is shown in Table I where seven of the leading colleges and universities of the State of California show different curricula. The ten state colleges, also included in this table, likewise have different curricula. However, one of them, Humbolt State College, lists a curriculum like that of the University of California at Berkeley, except Humbolt is short two courses--number 42 and number 48. With one exception the engineering curricula for the lower division of the universities and colleges in California vary little from that of the University of California. This one exception is the California State Polytechnic College located at San Luis Obispo. Its difference lies in its approach to the problem of education, which is sometimes referred to as the "upside down" approach. This approach is based on the viewpoint that if a student has some actual "alive" experience in connection with his learning, it will better enable him to understand some of the theory involved in the application. Hence, this problem of education is

TABLE NO. I
LOWER DIVISION ENGINEERING CURRICULA

COURSE TITLES	U. C. BERKELEY				U. C. LOS ANGELES				U S C				CALIF. INST. of TECHNOLOGY					STANFORD				SANT
	Course No.	Hrs/wk lec.	Hrs/wk lab.	Sem unit	Course No.	Hrs/wk lec.	Hrs/wk lab.	Sem unit	Course No.	Hrs/wk lec.	Hrs/wk lab.	Sem unit	Course No.	Hrs/wk lec.	Hrs/wk lab.	Unit	Eq. S.U.	Course No.	Hrs/wk lec.	Hrs/wk lab.	Qtr. unit	Course No.
Plane Surveying	1A	2	3	3	1LA	2		2	CE 251L	2	3	3	CE 1	2	4	9	2	CE 20		8	3	6
" "	1B	2	3	3	1FA		3	1	CE 253L	3	1 wk	4										7
" "					1LB	2		2														57
" "					1FB		3	1														58
Materials of Engineering Construction	8	2		2																		
Properties of Materials					8	2		2														
Engineering Drawing	22	total=6		2					GE 104			2	D 1a		3	3	1 1/2	ME 8	2	6	4	GE 1
" "													D 1b		3	3	1 1/2					GE 2
" "													D 1c		3	3	1 1/2					
Descriptive Geometry	23	1	5	2	2	1	5	3	GE 106			2	D 2		6	6	1 1/3	ME 10	2	6	4	
" "																						
Advanced Engineering Drawing	24	1	5	2	6	1	5	3	GE 250	1	3	2										
Statics	35	3		3					GE 207			3	AM 1a	3	3	12	2 2/3	CE 99	3	2	5	GE 15
Elementary Mechanics					15A	2	3	3														
" "					15B	2	3	3														
Elementary Metallurgy	40	2	3	3																		
Manufacturing Processes	41	5*	3	4	10B	1	3	2														ME 11
" "																						ME 12
Mat'ls. & Processes of Manuf. (for E Es. only)	42	5*	3	4																		
Orientation	48	1		1	48	1		1	GE 101	1		1										GE 7
Engineering Problems																						
Elem. Analysis of Engr. Practices					97†	3		3														
Elementary Biotechnology					30	3		3														
Intro. to Electric Circuit Analysis									EE 261	3		3										
Metal Mining									GE 260			2										
Elementary Ore Dressing & Testing									GE 261L	1	3	2										
Engineering Materials & Processes									ME 216L	2	3	3	ME 3	3	3	9	2					
Mechanisms									ME 276L	1	3	2										
Empirical Design													ME 1a		3	3	2/3					
" "													ME 1b		6	6	1 1/3					
Forging & Welding																		ME 1	1	4	2	
Foundry Practice																		ME 2	1	4	2	
Machine Shop Practice																		ME 3	1	4	2	
Engr. Computations & Measurements																		ME 4	2	3	3	
Graphic Problems																						CE 17A
Electric, Magnetic, & Dielectric Circuits																						EE 125
Strength of Materials																						GE 16
Materials Laboratory																						GE 66
Mechanical Engineering Laboratory																						ME 15
Engineering Dynamics																						
Steam Power Plants																						
" " "																						
Internal Combustion Engines																						
Plumbing & Building Sanitation																						
Kinematics																						

* 2 Hrs. lecture & 3 hrs. demonstration.

† For Engineering students in the Co-operative work-study program.

...GY Unit	...GY Eq. S.U.	STANFORD Course No.	Hrs/wk lec.	lab.	Qtr unit	SANTA CLARA Course No.	Hrs/wk lec.	lab.	Sem unit	COLLEGE of the PACIFIC Course No.	Hrs/wk lec.	lab.	Sem unit
9	2	CE 20		8	3	6	2		2	CE 30	2	3	3
						7	1		1	CE 31	2	3	3
						57		6	2				
						58		3	1				
										CE 36	2		2
3	Safety Eng	ME 8	2	6	4	GE 1	total = 6		2	CE 11	1	5	2
3	Safety Eng					GE 2	total = 6		2				
3	Safety Eng												
6	1⅓	ME 10	2	6	4					CE 12	1	5	2
2	2⅔	CE 99	3	2	5	GE 15	3		3	CE 35	3		3
						ME 11	total = 3		1				
						ME 12	total = 3		1				
						GE 7	1		1	CE 10	1		1
										CE 37		3	1
2													
2⅔													
1⅓													
		ME 1	1	4	2								
		ME 2	1	4	2								
		ME 3	1	4	2								
		ME 4 4	2	3	3								
						CE 171A	total = 3		1				
						EE 125	3		3				
						GE 16	4		4				
						GE 66		3	1				
						ME 15	1	3	2				

CSPC (Calpoly) Course No.	Hrs/wk lec.	lab.	Qtr unit	CHICO STATE Course No	Hrs/wk lec.	lab.	Sem unit	FRESNO STATE Course No.	Hrs/wk lec.	lab.	Sem unit	HUMBOLT STATE Course No	Hrs/wk lec.	lab.	Sem unit	LONG BEACH STATE Course No.	Hrs/wk lec.	lab.	Sem unit	LOS ANGI STAT Course No.	Hrs/ lec.	l
ME 231	1	1	2	M 5 A	2	3	3	1			2	1 A	2	3	3							
ME 232	1	1	2	M 5 B	2	3	3	1 L			1	1 B	2	3	3							
ME 233	1	1	2					2			2											
								2 L			1											
				A Sc 94	2		2	32			2	8	2		2							
ME 121	1	1	2	I A 22	total = 4		2	20			2	22	total = 6		2							
ME 122	1	1	2																			
ME 123	1	1	2																			
ME 125	1	2	3	M 2	total = 6		3	21			3	23	2	4	2							
ME 126	1	2	3									24	total = 6		2							
Ps 201	3		3	A Sc 35			3	30			3	35	3		3							
												40	2	3	3							
												41	2	6	4							
ME 199	1		3																			
Ps 202	3		3																			
ME 101	2	1	3																			
ME 102	2	1	3																			
ME 103	2	1	3																			
ME 331	3	1	4																			
ME 223	2	1	3																			

m.

FRESNO STATE				HUMBOLT STATE				LONG BEACH STATE				LOS ANGELES STATE				SACRAMENTO STATE				SAN DIEGO STATE				SAN FRNSCO STATE			
Course No.	Hrs/wk lec.	lab	Sem unit	Course No	Hrs/wk lec.	lab	Sem unit	Course No.	Hrs/wk lec.	lab	Sem unit	Course No.	Hrs/wk lec.	lab	Sem unit	Course No.	Hrs/wk lec.	lab	Sem unit	Course No.	Hrs/wk lec.	lab	Sem unit	Course No.	Hrs/wk lec.	lab	Sem unit
1			2	1A	2	3	?													1A	2	3	3				
1L			1	1B	2	3	3													1B	2	3	3				
2			2																								
2L			1																								
32			2	8	2		2													23	2		2				
20			2	22	total = 6		2																				
21			3	23	2	4	2													21	1	6	3				
				24	total = 6		2													22	1	6	3				
30			3	35	3		3																				
				40	2	3	3																				
				41	2	6	4																				
																				A			1				

attacked through laboratory and field experiences rather than through a background of basic scientific knowledge. As a result, much of this school's lower division is made up of laboratory, shop, and field work, and, therefore, is quite different from that in a typical university. Because of this different approach to the problem of education, there are, in addition to the lower division courses shown in Table I, page 7, for California State Polytechnic College, fourteen electrical engineering courses and four mechanical engineering courses which no other school gives in the lower division.

There seems to be considerable variation in the number of engineering courses offered in the state colleges. For instance four of them, Long Beach, Los Angeles, Sacramento, and San Francisco, offer no lower division engineering work, while others, Chico, Fresno, San Diego, and San Jose offer a number of courses. There is one, Humbolt, that offers most of the lower division work that is given at the University of California.

The best way to see what each school does in the way of lower division engineering courses is to turn to Table I, page 7, on which are listed all courses offered as lower division, showing which ones are offered in each institution.

Abbreviated course titles are used in this table. In some instances it might seem that different courses are listed under a single title, but as far as can be determined from the course descriptions in the catalogs, the courses thus listed are of similar content. In order for the table to be of most value, the course numbers are included together with the number of class hours per week and the credit value of the course.

CHAPTER III

THE JUNIOR COLLEGE ENGINEERING CURRICULA

Of the sixty junior colleges in the State of California, fifty-three include in their curricula some engineering subjects. However, not all fifty-three junior colleges offer transfer work as can be seen in Table II. The same course titles are used in this table as were used in Table I, page 7. Table II includes the course numbers, class hours per week, and the units of credit received for each course. In this study it was found that most junior colleges pattern their programs after either the University of California at Berkeley or the University of California at Los Angeles. Those whose greater number of transferring students go to the Berkeley campus usually use the same course titles and numbers as are used at Berkeley, while those whose major portion of continuing students transfer to the Los Angeles campus often use the course titles and numbering system of that branch of the University. There are a few instances where the course numbers and titles correspond to those on the Berkeley campus, but the course description indicates that the content parallels that of a given course on the Los Angeles campus. There also is a case or two where the junior college courses parallel those given

TABLE NO. 2

JUNIOR COLLEGE ENGINEERING CURRICULA (TRANSFER)

COURSE TITLES	ANTELOPE VALLEY				BAKERSFIELD				CHAFFEY				CITRUS				COA
	Course No.	Hrs wk Lec.	Lab	Sem Unit	Course No.	Hrs wk Lec.	Lab	Sem Unit	Course No.	Hrs wk Lec.	Lab	Sem Unit	Course No.	Hrs wk Lec.	Lab	Sem Unit	Course No.
Plane Surveying	1A	2	4	3	1A	2	3	3	1A	2	3	3	1A	2	3	3	1A
" "	1B	2	4	3	1B	2	3	3	1B	2	3	3	1B	2	3	3	1B
" "																	
" "																	
Materials of Engineering Construction	8	2		2	8	2		2	8	2		2	8	2		2	8
Properties of Materials																	
Engineering Drawing	22		5	2	22	1	5	2	Dwg 1A	1	5	2	22		5-8	2-3	22
" "									Dwg 1B	1	5	2					
Descriptive Geometry	23		5	2	23	total 1-6		2	ME 2	1	6	3	23	2	3	2	23
" "																	
Advanced Engineering Drawing	24		5	2	24	1	5	2	ME 6A	1	5	2	24		5	2	24
" " "									ME 6B	1	5	2					
Statics					35	3		3	35	3		3	35	3		3	35
Elementary Mechanics																	
" "																	
Elementary Metallurgy					40	2	2	3									
Manufacturing Processes					41	2 L. 1 D.	3	4									
Orientation					48	1		1					48	1		1	
Engineering Problems																	
Dynamics																	
Strength of Materials																	
Machine Design																	
Mechanism																	
Empirical Design																	

	COALINGA				COMPTON				EAST CONTRA COSTA				EAST LOS ANGELES				EL CAMINO				FRESNO			FULLERTON	GLENDALE
Sem Unit	Course No.	Hrs wk Lec	Lab	Sem Unit	Course No.	Hrs wk Lec	Lab	Sem Unit	Course No	Hrs wk Lec	Lab	Sem Unit	Course No.	Hrs wk Lec	Lab	Sem Unit	Coarse No.	Hrs wk Lec	Lab	Sem Unit	Course No.	Hrs w Lec	La		
3	1A	2	3	3	34A	2	3	3	1A	2	3	3	1	2	3-6	3-4	20	2	3	3	1A	total=t			
3	1B	2	3	3	34B	2	3	3	1B	2	3	3	2	2	3-6	3-4					1B	total=t			
																					2A	total=t			
																					2B	total=			
2	8	2		2					58	2		2	8	3		2									
					44			2									23	2		2					
2-3	22		6	2	31	total=	5	3	22	1	5	2	12		6	2	1	2	4	3	15	2	3		
2	23	1	5	2	40	total=	5	3	23	1	5	2	6		6	2	4	2	4	3	21	2	2		
2	24		6	2	32	total=	5	3	74	1	5	2	15		6	2	8	2	4	3					
3	35	3		3					85	3		3					9A	3		3	25	3			
					42			3					35	3		3	9A	3		3					
					43			3					36	3		3	9B	3		3					
													40	2		2									
													41	2		2									
1					36			1					49	1		1									
																					26	3			
																					32	3			
																					20	2	3		
																					22	2	3		

em nit	FRESNO Course No.	Hrs Lec.	wk Lab	Sem Unit	FULLERTON Course No.	Hrs Lec.	wk Lab.	Sem Unit	GLENDALE Course No.	Hrs Lec.	wk Lab	Sem Unit	GRANT TECHNICAL Course No.	Hrs Lec.	wk Lab	Sem Unit	HARTNELL Course No.	Hrs Lec.	wk Lab	Sem Unit	JOHN MUIR Course No.	Hrs Lec.	wk La
3	1A	total=6		3	1A	2	3	3	11	2	3	3	1A	2	3	3	1A	1	6	3	71	1	6
	1B	total=6		3	1B	2	3	3	12	2	3	3	1B	2	3	3	1B	1	6	3	72	1	6
	2A	total=6		3																			
	2B	total=6		3																			
					8	2		2	8	2		2					8	2		2	78	2	
2																							
3	15	2	3	3	22	total=6		2	1		6	3	22		6	2	22	1	5	2	52	1	5
3	21	2	2	3	23	total=6		2	3		4	2	23	2	6	2	23	1	5	2	51	1	6
3					24	total=6		2	2		6	3					24	1	5	2			
3	25	3		3	35	3		3	10	3		3	35	3		3					73	3	
3																	15A	3		3			
3																	15B	3		3			
																	40	2	1	3			
																	48	2		1	50	1	
	26	3		3																			
	32	3		3																			
	20	2	3	3																			
	22	2	3	3																			
																					79		3

LASSEN

LONG BE

N MUIR			LASSEN				LONG BEACH				LOS ANGELES CITY COL.				LOS ANGELES HARBOR				LOS ANGELES VALLEY				MARIN	MENLO
wk Lab	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.		
6	3					1A	2	3	3	CE 1	3	3	4	S 1	1	4	3	1	2	3	3	1A		
6	3					1B	2	3	3	CE 2	2	3	3	S 2	1	4	3	2	2	3	3	1B		
	2					8	2		2	GE 2	3		3	C 5 A C 5 B	2 2		2 2	8	2	1	3	8L		
	2	22		5	2	D	1	5	3	GE 12		6	2	Dr. 1A	1	4	3	12	1	4	2	2		
														Dr. 1B	1	4	3							
	3	23A	1	4	2	2	1	5	3	GE 1	1	6	3	Dr. 4	1	4	3	3	1	5	3	23		
						6	1	5	3	GE 15	1	6	3					15	1	5	3	24		
						35	3		3													35		
										GE 16	2	3	3	C 15 A	2	2	3	17	2	3	3			
										GE 17	2	3	3	C 15 B	2	2	3	18	2	3	3			
																						40		
										ME 20	2	3	3									41		
										GE 18	1		1					48	1		1	48		
																						7	2	

LES	MARIN				MENLO				MODESTO				MONTERREY PENINSULA				MOUNT SAN ANTONIO				NAPA				OCEANSIDE-CARLSBAD				O
Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Cours No.
3	1A	2	3	3	1	2	3	3	1A	2	3	3	1A	1	6	3	1A	2	3	3	51A	2	3	3	1A	2	3	3	1A
3	1B	2	3	3					1B	2	3	3	1B	1	6	3	1B	2	3	3	51B	2	3	3	1B	2	3	3	1B
	8L	2	3	3					8	2		2																	
																	8	2	3	2					8	2		2	
	22	1	5	2	2	1	6	3	22	2	4	2	22	1	5	2	22	total = 6		2	50A	1	4	3	22	1	5	2	22
																					50B	1	4	3					
	23	1	5	2					23	2	4	2	23	1	5	2	23	total = 6		2					23	1	5	3	23
	24	1	5	2					24	2	4	2	24	1	5	2	24	total = 6		2									24
	35	3		3	5	3		3	35	3		3	35	3		3													35
	40	2	3	3																									41
	41	2	6	4													10B	2	3	2									4
	48	1		1																									
	7	2	3	3																									

CEANSIDE-ARLSBAD			ORANGE COAST				PALOMAR				PALO VERDE				PASADENA CITY				PORTERVILLE				REEDLEY				RIVERSID		
Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.
2	3	3	1A	2	4	3	1A	2	3	3					71	1	6	3	1A	2	3	3	1A	2	3	3	1A	2	3
2	3	3	1B	2	4	3	1B	2	3	3					72	1	6	3	1B	2	3	3	1B	2	3	3	1B	2	3
															78	2		2					8	2		2			
		2																									13	2	3
5	2		22	total=6		2	6	1	5	3					52	total=6		2	E1A	2	3	3	22	total=6		2	22	total=6	
		3	23	total=6		2	2	1	5	3					51	total=7		3	E1B	2	3	3	23	total=6		2	23	total=6	
			24	total=6		2													E1C	1	5	3	24	total=6		2	24	total=6	
			35	4		3									73	3		3	3A	3		3	35	3		3	35	3	
			40	2	3	3																							
			41	2	6	4																							
															50	1		1/4											
															79		3	1											

No Engineering

RIVERSIDE				SACRAMENTO				SAN BERNARDINO VALLEY				SAN FRANCISCO CITY				SAN JOSE				SAN LUIS OBISPO				SAN MATEO				SANTA ANA			
Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit
1A	2	3	3	1A	2	3	3	15A	2	3	3	1A	2	3	3					1A	2	3	3	1A	total=6		3	1A	2	3	3
1B	2	3	3	1B	2	3	3	15B	2	3	3	1B	2	3	3					1B	2	3	3	1B	2	4	3	1B	2	3	3
				8	2		2	30	2		2	8	2		2									8	2		2	8	2		2
13	2	3	3					8	2		2																				
22	total=6		2	22	total=6		2	22	total=6		2	22	total=6		2									22	total=6		2	24		6	2
23	total=6		2	23	total=6		2	23	total=6		2	23	total=6		2									23	total=6		2	23	1	6	3
24	total=6		2	24	total=6		2	24	total=6		2	24	total=6		2									24	total=6		2				
35	3		3	35	3		3	35	3		3	35	3		3									35	3		3	35	3		3
				40	2	3	3					40	2	3	3									40	2	3	3				
				41	2	6	4					41	2	6	4									41	2	6	4				
				48	1		1					48	1		1									48	1		1	48	1		1

No Engineering

ITA ANA			SANTA MARIA				SANTA MONICA				SANTA ROSA				SEQUOIAS				SHASTA				SIERRA				STOCKTON			
Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Course No.	Hrs Lec.	wk Lab.	Sem Unit	Cours No.
2	3	3	1A	2	3	3	1LA	2		2	1A	2	4	3	1A	3	3	3	1A	2	4	3	1A	1	6	3	1A	2	3	3	CE I,
2	3	3	1B	2	3	3	1FA		3	1	1B	2	4	3	1B	3	3	3	1B	2	4	3	1B	1	6	3	1B	2	3	3	CE II
							1LB	2		2																					
							1FB		3	1																					
2		2									8	2		2	8	2		2					8	2		2	8	2		2	
							8	2		2																					
	6	2	22	1	5	2					22	1	3	2	22	1	5	2	22	1	6	2	22		6	2	2A		6	2	2
1	6	3	23	2	4	2	2	total=6		3	23	1	3	2	23		6	2	23	1	6	3	23		6	2	2B		6	2	23
							6	total=6		3	24	1	3	2	24	1	5	2									6		6	2	24
3		3					35	3		3	35	3		3	35	3		3	35	3		3	35	3		3	35	3		3	
											40	3		3																
							10B			2	41	2	6	4																
1		1					4B			1																	10	1		1	

STOCKTON				TAFT				VALLEJO				VENTURA				WEST CONTRA COSTA				YUBA			
Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit	Course No.	Hrs wk Lec.	Lab.	Sem Unit
3	1A	2	3	3	CE 1A	2	3	3	53A	total = 6		3	5A	2	3	3	1A	2	3	3	1A	2	4	3
3	1B	2	3	3	CE 1B	2	3	3	53B	total = 6		3	5B	2	3	3	1B	2	3	3	1B	2	4	3
2	8	2		2									18	2		2	58	2	3	3				
2	2A		6	2	22	total = 7		3	51B	total = 5		3	2	1	5	2	22	1	5	2	22	1	3	2
2	2B		6	2	23	total = 7		3	52A	total = 5		3	3	1	5	2	23	1	5	2	23	1	3	2
	6		6	2	24	total = 7		3	52B	total = 5		3	4	1	5	2	74	1	5	2				
3	35	3		3									12	3		3	85	3		3	35	3		3
													13	2	3	3	90	2	3	3				
													16	2	3	4								
	10	1		1									1	1		1	48	1		1				

on the University of Southern California campus. Not many of the junior colleges offer the complete lower division work, but all offer some courses which are transferable to the state colleges and universities for full credit.

Many of the junior colleges offer more courses in engineering than just those which are transferable to the universities. These non-transfer courses are generally called "terminal" courses. The kinds of terminal courses and the number of them included in the curriculum depend upon the kinds of work and the amount of it available to students after completing one or two years of special study and training. This terminal program is discussed more fully on pages 16 to 19 in this report.

CHAPTER IV

A COMPARISON OF THE ENGINEERING CURRICULA IN THE UNIVERSITY LOWER DIVISION AND THE JUNIOR COLLEGE

Chapter II and Table I, page 7, show each college or university has its own engineering curriculum. Some junior colleges, Modesto, Marin, San Mateo, Shasta, and others, try to offer the same engineering curriculum as does the University at Berkeley, but they fall short by one or more courses. The same holds true for those junior colleges which try to follow the engineering curriculum of the University of California at Los Angeles, or any other four year institution. Since there is no such thing as <u>the</u> university lower division engineering curriculum or <u>the</u> junior college engineering curriculum, there can be no comparison between the two curricula as wholes. The lower division curriculum varies somewhat from one university to another, as does also the engineering curriculum in the junior colleges. For example, a junior college might offer the complete engineering program exactly as it is offered in the lower division of the University of California at Berkeley. In this case it would be possible to compare one program with the other, and to say that one program parallels the other, or one compares very favorably with the other. However, this same

junior college might not be able to say the same concerning the University of Santa Clara, or the California State Polytechnic College, or the California Institute of Technology because of a difference in course titles or possibly a different arrangement of courses. Sometimes a course which is offered as lower division in one school is included in the upper division work of another school. Situations like these make an over-all comparison impossible.

Basically the differences in the curricula at these various institutions are minor. There are differences in some of the course titles, but in many cases these are only apparent differences in course content. Generally there is very little or no difference in the subject matter. In order to be sure that there is no difference requires studying and comparing course descriptions and probably even contacting the two schools concerned. For example: The University of Santa Clara does not offer a course called Descriptive Geometry. In their course descriptions of General Engineering 1 and 2, it is found that the subject matter, as taught in most schools under the title of Descriptive Geometry, is taught at the University of Santa Clara under the title of Engineering Drawing.

Though there can be no comparison of university lower division and junior college as a whole, or by course

title, there can be a comparison by subject matter covered in the two years of study. With this method of comparison a person might believe the junior colleges to fare very favorably with the universities. Difficulty is encountered with a general and all-inclusive statement, because all junior colleges do not offer the same courses or the same number of courses. Consequently, the result is a direct course by course comparison on the basis of content, and this must be between a specific junior college and a certain university. On this basis then, nearly every junior college in the state offers some engineering courses which are equivalent to, or which parallel, courses at some university.

It seems to be the general practice, and a natural and logical procedure, for a junior college, from which a major portion of its graduates transfer to a given university, to pattern its program after that university.

CHAPTER V

THE JUNIOR COLLEGE ENGINEERING CURRICULA FOR TERMINAL STUDENTS

There are a large number of courses in the engineering field which can be included in a terminal program as is evident in the Appendix, pages 34 through 46. Some of the junior colleges which have quite an extensive program are: East Los Angeles Junior College, Los Angeles Harbor Junior College, Pasadena City College, Sacramento Junior College, San Bernardino Valley College, and San Francisco City College. Many of the junior college catalogues do not list any of their courses as terminal, but it is commonly understood that some of the transfer courses can be taken as terminal courses. Surveying, for instance, is a required course for those students in Civil Engineering, Mechanical Engineering, Mining Engineering, Agricultural Engineering, and Industrial Engineering, but the same course can serve terminal students also. A course in surveying for only terminal students, though, could be made more suitable to their needs. Some of the other courses which the terminal student probably would wish to take in conjunction with surveying could also be of transfer caliber. These courses would be drafting, mathematics, astronomy, and descriptive geometry.

There is a great need today for engineering technicians. This is evident in articles and advertisements in many of the engineering publications, in some of the other periodicals, and in the daily newspapers. In order for a person to qualify for a position as a technician, it is necessary that he have certain technical knowledge and skills; it is not necessary to have a degree in engineering. In fact, the training necessary for most of these jobs often can be acquired in two years or less. These terminal courses need not cater to the inferior student. Good students sometimes become technicians, so why should they spend time in school which will be of no particular benefit to them or their employers?

This type of program, since it is a rather specialized one and not particularly suited to the university set-up, is offered in most of the junior colleges. Because there is no formal schooling beyond the junior college, such a program is called a terminal program.

The purpose of a terminal program is to help the individual gain certain technical knowledge and develop certain skills which are essential to the proper performance of his vocational duties. The knowledge and skills vary with the field of study. In surveying, for instance, some of the things which are peculiar to this field are,

(1) astronomy, (2) how the early surveys were made, and (3) the manipulation and care of the surveying instruments. The student taking a course in drafting need not study these things. He needs other knowledge and skills, such as, (1) standard drafting room practices; (2) the methods, procedures, and standards as approved by the American Standards Association; and (3) the skill of using drafting equipment and supplies.

This knowledge and these skills which are developed in the terminal student are quite different from those acquired by a student who plans to attain the baccalaureate degree and perhaps some advanced degrees. Consequently many of the courses offered in a terminal program are different from those which make up a program for a student who plans to continue his formal training at a university.

Some of the junior colleges list no terminal engineering courses in their catalogues. This does not mean that the student cannot prepare himself for a vocation in engineering at these schools. In drafting, for instance, a junior college might offer only those courses which give transfer credit, Engineering Drawing, Descriptive Geometry, and Machine Drawing. Upon completion of these courses the student should have a complete knowledge of the basic fundamentals of drafting, good drafting

technique, and the ability to do a good job of freehand lettering. This student should be an asset in any drafting room after a minimum of on-the-job training.

Perhaps there is more terminal work offered in the field of drafting than in any other one field. There are courses in Engineering Drawing, Machine Drawing, Structural Drafting, Aeronautical Drafting, and Map Drafting to name a few. The field of electricity probably runs drafting a very close second. The most popular courses in this field are Radio, Television, and Electronics. Though nearly every junior college offers courses in radio and television, many of them teach them only as trade courses from the standpoint of trouble shooting and repairing. Consequently, they are not included in the list of engineering subjects. Some schools include these subjects in their electricity and electronics courses which are on either the technical or professional level.

CHAPTER VI

THE EFFECT OF THE SIZE OF ENROLLMENT UPON THE NUMBER OF ENGINEERING COURSES OFFERED

From the records available, it would seem that the size of the student body has little effect upon how many or which courses in engineering shall be offered. Some of the smaller junior colleges, such as Santa Rosa and Orange Coast, where the enrollment has been running well below one thousand students, have maintained curricula which are equivalent to that of the lower division of the University of California. There are also junior colleges whose enrollment has been around five thousand which have complete lower division programs. Most of the junior colleges fall short of a university lower division curriculum, however, by from two to five courses.

There are two rather definite reasons for this variation in junior college offerings, but neither one is directly related to the total enrollment in the school. One reason is the demand for a course, and the other is the financial condition of the district. The demand for a course is not a direct result of <u>total</u> enrollment, but is directly related to the enrollment in the department. The size of the department fluctuates somewhat as the total enrollment, but not in direct proportion.

Offerings in the engineering department, then, depend on the number of students in the department. Only indirectly is this related to the total enrollment.

A small engineering department is not a result of less total enrollment. Modesto Junior College is a typical example. In the fall of 1949 Modesto Junior College had a total enrollment of 1,234. The engineering courses offered that year were Engineering Drawing, Descriptive Geometry, Materials of Engineering Construction, Plane Surveying, and Statics. In 1950, the total enrollment went up slightly, but in 1951 it was down to 948. However, the same courses in engineering were offered as had been offered the preceding years. Since 1951 the total enrollment has been on the increase, and in 1954 it was 1,732. Still there has been no change in the course offerings. This shows that a fluctuating total enrollment need not affect the number of basic courses included in the curriculum.

CHAPTER VII

EFFECT OF THE JUNIOR COLLEGE'S LOCATION UPON ITS ENGINEERING CURRICULUM

It would appear that the geographical location of a junior college would affect its curriculum for these reasons:

1. Its proximity to a university would definitely have an affect upon the transfer curriculum because most junior college students who wish to continue their education by going on to the university usually transfer to the closest one.

Since all universities do not offer the same program, this means that the junior college should set up a transfer program equivalent to that of the closest university.

2. Terminal students are interested in employment. Consequently the availability of work in the area would affect the junior college's terminal program.

Therefore, in contacting the junior colleges, this question was asked, "Do you think the location of your junior college has any effect on the engineering curriculum?"

Fifteen of the junior colleges contacted said that their geographic location had a definite effect upon their

terminal program because opportunities for employment in industry after two years of training made it necessary to prepare persons for the jobs.

Eight junior colleges said that their proximity to a certain university made it necessary for them to set up a program comparable to that institution's lower division.

Two junior colleges indicated that their location was responsible for small enrollment and that the low enrollment affected their curricula.

Two junior colleges, each located in the same community with a state college, claim that proximity to the state college is the cause for a curtailed engineering curriculum in their schools.

Twenty-two junior colleges responded that their location had no effect upon their engineering curricula.

There were about four junior colleges which did not respond to the question.

CHAPTER VIII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Generally speaking, the junior colleges follow rather closely the patterns set by the universities. As was pointed out earlier, all colleges and universities are not alike, and consequently, any single junior college cannot be like all of them. The subject matter taught in the first two years of engineering study, however, is essentially the same in all universities. A student who has done lower division work in one university and transfers to do upper division work in another university finds the work difficult. It is likewise difficult for a junior college graduate to go to any other university than the one after which the junior college patterned its curriculum. All junior colleges do not offer the same courses or even the same number of courses. However, the courses that are offered in a junior college engineering curriculum, for transfer to a university, are comparable to those lower division courses in the university to which the major portion of the students transfer. Some junior colleges offer all courses that are offered as lower division by a particular university, while other junior colleges offer only one or two courses.

Reasons for the number of courses offered vary. One or two junior colleges claim that the number of their course offerings is reduced because of their proximity to a state college. Others say that industrial situations in the vicinity necessitate their emphasizing a terminal curriculum rather than one for transfer students. From these deductions it seems that the size and type of the curriculum is determined by the demand. The demand is determined by the enrollment in the department, which in turn is determined largely by facilities. This latter element, facilities, is a result of many factors, among which could be the instructor, the school administration, the board of education, and the financial condition of the district. Any one of these alone might be enough to deter some essential space, equipment, or condition. Finances, though, in all probability must be considered a major factor affecting these facilities.

Whether or not a junior college offers a terminal curriculum in engineering is determined by the need of industry and business in the rather immediate vicinity for such technically trained men. For other than the terminal program, it is doubtful that the location of a junior college has any effect.

This study shows that there is a slight difference in the lower division course work at the various

universities. There also is a difference in the credit value for apparently the same course. For illustration look at the course DESCRIPTIVE GEOMETRY.

University of California at Berkeley--1 hour lecture, 5 hours laboratory, 2 semester units

University of California at Los Angeles--1 hour lecture, 5 hours laboratory, 3 semester units

Stanford--2 hours lecture, 6 hours laboratory, 4 quarter units.

Now look at the course PLANE SURVEYING.

University of California--2 hours lecture, 3 hours laboratory, 3 semester units

California Institute of Technology--2 hours lecture, 4 hours laboratory, 2 semester units.

There seems to be no standard way of determining the number of units given for a course either at the university level or at the junior college level. The only way a junior college student can eliminate this inconsistency is to decide, before even entering a junior college, from which university he wishes to graduate. Then he can go to the junior college which offers courses paralleling those at the university to which he will transfer. This cannot always be done, however. Circumstances can change so that it would not be practical to try to attend what once was the university of first choice. Then what would

the student do?

Junior colleges, generally speaking, are young; they are still an "unknown" quantity. There seems to be a feeling that they are inferior to the university and the state college. Consequently, if it were necessary for a student to attend a junior college away from home in order to get the program he needed, he would more than likely go directly to a university instead of the junior college.

Recommendations. A certain number of specifically named engineering courses should be required for lower division work. These courses would be a minimum, but at the same time would be sufficient to give the student the proper background for upper division study. All schools need not be limited to these required courses, but any additional courses offered would be electives.

These courses which would make up the lower division engineering curriculum, should carry the same number of semester units at all schools. It would be possible then for a student who is graduating from a junior college to transfer to any university without losing units, as might be the case, or having to make up some units.

The evidence suggests that it would be desirable to have all formal training through the fourteenth grade given in a public school. This would result in the

university beginning at what is now their junior year. Instead of running the conventional two years from that point, they should have a three year program. This would make time for those additional courses which can only be recommended if the student has time. Otherwise these courses must be taken as postgraduate work. One year of postgraduate work, if one starts as a freshman in our present arrangement, means a fifth year of expensive schooling. Under the proposed arrangement it would mean only a fourth year of university work. The first two years would be completed at a public school at a very small fraction of the cost of attending a university. Also at the end of this time the student will have had six years of college training as against five years in the present system. This arrangement, in addition to being cheaper, probably would increase our output of engineering technicians which is necessary today, and at the same time would give us better trained graduate engineers.

At the present time, courses in the junior colleges are divided into these four categories, vocational, terminal, technical, and transfer or parallel. The first two of these categories should have no place in the terminology for engineering courses. The term "vocational," if used at all, should be reserved for those courses which

prepare students for employment in the trades. "Terminal," though it is perfectly logical and legitimate, still has a tone of finality about it which makes it undesirable. The latter two categories, technical and transfer, are sufficient for referring to engineering courses. However, the last one should be changed from "transfer" to "pre-professional." The work of the engineer is either technical or professional. The courses he studies should be classified accordingly.

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University of California, Berkeley
University of California, Los Angeles
University of Southern California

California Institute of Technology
Stanford University
University of Santa Clara
College of the Pacific
California State Polytechnic College
Chico State College
Fresno State College
Humbolt State College
Long Beach State College
Los Angeles State College
Sacramento State College
San Diego State College
San Francisco State College
San Jose State College

APPENDIX

TERMINAL COURSES OFFERED IN THE JUNIOR COLLEGES

ANTELOPE VALLEY JUNIOR COLLEGE

None

BAKERSFIELD COLLEGE

Industrial electronics

Principles of Air Conditioning

Principles of Refrigeration

CHAFFEY COLLEGE

Airplane drafting

Electronic engineering

Detail drawing

CITRUS JUNIOR COLLEGE

None

COALINGA COLLEGE

None

COMPTON COLLEGE

Industrial drafting

Engineering drawing

EAST CONTRA COSTA JUNIOR COLLEGE

Electricity

Electronics

Sanitation

Petroleum Refining Instrumentation

EAST LOS ANGELES JUNIOR COLLEGE

Electronics

Electricity

Elementary Mechanics

Strength of Materials

Piping drafting

Pressure Vessel Design (drafting)

Instrumentation

Reinforced Concrete Design

Engineering Materials and Shop Practices

Structural drafting

Estimating

Elementary Hydraulics

Industrial Safety

Practical Soil Mechanics

Heating and Air Conditioning

Construction Inspection

Structural Design

EL CAMINO COLLEGE

Aircraft drafting

Electronics and electronic instruments

Industrial and Aircraft hydraulics

Vocational drafting

Industrial drafting

EL CAMINO COLLEGE (Continued)

Marine drafting

Refrigeration and Air Conditioning

Metallurgy

Principles of Hydraulics

Industrial Safety

FRESNO JUNIOR COLLEGE

Electricity

Architectural drawing

FULLERTON JUNIOR COLLEGE

Structural drafting

Electronic drafting

Electricity

Related drafting including freehand sketching

GLENDALE COLLEGE

Trade drafting

Materials and Processes

GRANT TECHNICAL COLLEGE

Aircraft Mechanics

HARTNELL COLLEGE

Aircraft Engines

JOHN MUIR COLLEGE

Industrial drafting

Production drafting

JOHN MUIR COLLEGE (Continued)

Applied Mechanics

Strength of Materials

LASSEN JUNIOR COLLEGE

Engineering drawing

Machine drafting

LONG BEACH CITY COLLEGE

Mechanical drawing

Drafting for Naval Trade

Drafting for Marine Trade

Blueprint Reading, layout, and Development for Shipfitters

Electricity

Generation, Transmission, and Distribution of Electrical Power

Industrial Electronics

LOS ANGELES CITY COLLEGE

Electronics

Aerodynamics

Airplane design

Aircraft Power Plants

Aircraft Control Mechanisms

Aeronautical drafting

Aircraft Descriptive Geometry

LOS ANGELES CITY COLLEGE (Continued)

Aviation drawing

Civil Engineering drawing

Structural Design

Elementary Hydraulics

Surveying--Route, City, Property, and Mapping

Electrical Drafting

Electricity

Applied Mechanics and Strength of Materials

Elementary Mechanical Principles

Heat Engineering

Machine Design

Mechanism

Elementary Thermodynamics

Refrigeration

Heating and Ventilating

LOS ANGELES HARBOR JUNIOR COLLEGE

Electricity

Internal Combustion engines

Instrumentation

Structural detailing

Materials of Construction

Estimating

LOS ANGELES HARBOR JUNIOR COLLEGE (Continued)

Strength of Materials

Drafting

Descriptive Geometry

Schematic drawings

Surveying--Plane, Route, City, Mapping

Properties of Metals

Metal Processing

LOS ANGELES VALLEY JUNIOR COLLEGE

Aircraft drawing

Drafting Room Techniques

Mechanics and Statics

Stress Analysis

Strength of Materials

City Surveying

Structural drafting

Estimating

Elementary Hydraulics

Aircraft Hydraulics

Thermodynamics

Aerodynamics

Aircraft Stresses

Aircraft Structures

Applied Electricity

MARIN, COLLEGE OF

Internal Combustion Engines

Principles of Refrigeration

MENLO JUNIOR COLLEGE

None

MODESTO JUNIOR COLLEGE

None

MONTEREY PENINSULA COLLEGE

Mechanical drawing

MT. SAN ANTONIO COLLEGE

Materials of Construction

Aircraft drafting

NAPA COLLEGE

Technical drafting

Machine drafting

Vocational electricity

OCEANSIDE--CARLSBAD COLLEGE

None

ORANGE COAST COLLEGE

Machine design (drafting)

Electricity

Electronics

PALOMAR COLLEGE

None

PALO VERDE COLLEGE

Engineering drawing

Descriptive Geometry

Mechanical drawing

PASADENA CITY COLLEGE

Aeronautical drafting

Aeronautical Descriptive Geometry

Airplane Materials of Construction

Aircraft design drafting

Industrial drafting

Production drafting

Design drafting

Industrial electricity

Electrical drafting

Heating and Ventilating

Plane Surveying

Applied Mechanics

Metallurgy

Strength of Materials

PORTERVILLE COLLEGE

None

REEDLEY COLLEGE

None

RIVERSIDE COLLEGE

None

SACRAMENTO JUNIOR COLLEGE

Aircraft drafting

Electricity

Electronics

Engineering and Architectural drafting

Elementary Mechanics

Map drafting

Industrial Heat Systems

Principles of Stationary Machines

Air Conditioning

Industrial Prime Movers

Industrial Safety

Surveying--Route, land, and topographic

SAN BERNARDINO VALLEY COLLEGE

Mechanical drawing

Electrical drawing

Aircraft drawing

Aeronautical drawing

Topographical drawing

Electricity

Industrial electronics

Surveying field work

SAN BERNARDINO VALLEY COLLEGE (Continued)

Estimating

A number of basic Civil Engineering subjects

Refrigeration

Air Conditioning

SAN FRANCISCO CITY COLLEGE

Engineering drafting

Map drafting

Estimating

Surveying--Route, land, topographic

Elementary Strength of Materials

Elementary Fluid Mechanics

Electricity

Piping and electrical drafting

Air Conditioning and Refrigeration

SAN JOSE JUNIOR COLLEGE

Electricity

Technical drawing

SAN LUIS OBISPO JUNIOR COLLEGE

None

SAN MATEO JUNIOR COLLEGE

Electricity

Electronics

Geometrical and Engineering drawing

Manufacturing Processes

SAN MATEO JUNIOR COLLEGE (Continued)

General Hydraulics

General Thermodynamics

Elementary Mechanisms

Plane Surveying

Advanced Surveying

Materials of Construction

Elements of Structural design

SANTA ANA COLLEGE

Electrical drafting and design

SANTA MARIA JUNIOR COLLEGE

Electricity fundamentals

SANTA MONICA CITY COLLEGE

Drafting

Electricity

Electronic Technology

Technical drafting

Electronic drafting

Advanced detail and assembly drawing

(specifications, computations, design)

Properties of Materials

Manufacturing Processes

SANTA ROSA JUNIOR COLLEGE

None

SEQUOIAS, COLLEGE OF THE

Mechanical drawing

Trade drawing (metal)

Commercial electric wiring

SHASTA COLLEGE

Mechanical drawing

SIERRA COLLEGE

Land surveying

Electrical circuits and machines

STOCKTON COLLEGE

Technical drafting

Machine drafting

Aircraft drafting

Civil Engineering drafting

Descriptive Geometry

Drafting for trades and industry

Quantity Survey (estimating)

Industrial electricity

TAFT JUNIOR COLLEGE

Mechanical drawing

Drafting for the trades

Map drafting

VALLEJO COLLEGE

Plane Surveying

Electronics

VENTURA COLLEGE

Mechanical drawing

Industrial drafting

Shop Metallurgy

WEST CONTRA COSTA JUNIOR COLLEGE

Practical Metallurgy

Electricity

Petroleum Refining Instrumentation

YUBA COLLEGE

Mechanical drawing

Technical drawing