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**UNIVERSITY of MINNESOTA**

Institute of Technology  
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Curricula



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AERONAUTICAL, AGRICULTURAL, CIVIL, ELECTRICAL, GEOLOGICAL,  
MECHANICAL, METALLURGICAL, MINING, AND PETROLEUM  
ENGINEERING, ARCHITECTURE, AND PREBUSINESS

FRESHMAN YEARS

(For students entering with chemistry, higher algebra, and solid geometry and who pass their English tests.)

*First Quarter*

| Course No.    | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|---------------|--|---------|-------|-------|-------|
| M.&M. 11      | College Algebra .....                  | 5       | 5     | ..... | ..... |
| Inorg.Chem. 4 | General Inorganic Chemistry .....      | 4       | 1     | 3     | 3     |
| Engl. 4       | Written and Spoken Communication ..... | 3       | 3     | ..... | ..... |
| Draw. 1       | Engineering Drawing .....              | 3       | ..... | ..... | 8     |
| M.E. 1*       | Metal Working (for Prebusiness) .....  | 2       | ..... | 2     | 3     |
| G.E. 21       | Orientation .....                      | 1       | ..... | 1     | ..... |

*Second Quarter*

|               |  |   |       |       |       |
|---------------|--|---|-------|-------|-------|
| M.&M. 12      | Trigonometry .....                     | 5 | 5     | ..... | ..... |
| Inorg.Chem. 5 | General Inorganic Chemistry .....      | 4 | 1     | 3     | 3     |
| Engl. 5       | Written and Spoken Communication ..... | 3 | 3     | ..... | ..... |
| Draw. 2       | Engineering Drawing .....              | 3 | ..... | ..... | 8     |
| M.E. 12*      | Materials and Processing II .....      | 2 | ..... | 2     | 3     |

*Third Quarter*

|                |  |   |       |       |       |
|----------------|--|---|-------|-------|-------|
| M.&M. 13       | Analytic Geometry .....                  | 5 | 5     | ..... | ..... |
| Inorg.Chem. 11 | Semimicro Qualitative Analysis .....     | 4 | ..... | 3     | 4     |
| Engl. 6        | Written and Spoken Communication .....   | 3 | 3     | ..... | ..... |
| Draw. 3‡       | Descriptive Geometry .....               | 3 | ..... | ..... | 8     |
| M.E. 4*        | General Woodwork (for Prebusiness) ..... | 2 | ..... | 2     | 3     |
| P.H. 3         | Personal Health .....                    | 2 | ..... | 2     | ..... |

AERONAUTICAL ENGINEERING

Five-year course (four-year for veterans or those registering prior to fall quarter, 1946) leading to the degree of bachelor of aeronautical engineering, B.Aero.E.

In addition to the prescribed courses, sufficient electives must be taken to complete a total of at least 255 credits for graduation (207 for the four-year course).

The course in Aeronautical Engineering is intended to provide instruction and training for students who wish to enter this field of engineering as a profession. With the rapid development of aviation in recent years, aeronautical engineering has assumed a prominent and important position among the engineering professions. The production, development, and use of airplanes in the United States is increasing at a rapid rate. Attention is given to lighter-than-air craft and high altitude flight problems. Aeronautical engineers are required in all stages of the process, from the research work preliminary to improvements in design to the actual construction, testing, operation, and maintenance. Students trained in aerodynamics and the designing of light structures have been in demand in recent years in many industries.

The aeronautical engineering course is similar to other professional engineering courses. The first three quarters of the course are the same as those of agricultural, civil, electrical, geological, mechanical, metallurgical, mining, and petroleum engineering. The fundamental studies are the same. As a result, the graduates in aeronautical engineering

\* Freshmen in Engineering Prebusiness are required to take Shop Practice, M.E. 1, 4, and 12, 2 credits per quarter; not required of the others.

‡ See statement on page 15.

¶ Not required of students in Prebusiness Engineering.

should be prepared to enter various branches of the engineering field if, for any reason, they should prefer to do so.

As in other technical courses, so in aeronautical engineering, mathematics plays an important part. No student should enter this course who feels poorly prepared in mathematics.

It should be understood that this is a professional engineering course and not a training course for airplane pilots. It deals with the preparation of students for research, design, construction, operation, management, and maintenance of aircraft from the standpoint of the engineer or manager. However, practical flight training is important for aeronautical engineers, and students are urged to take advantage of their opportunities to obtain it through the University of Minnesota Flying Club, Army Air Corps, National Guard, Naval Reserve, or private organizations.

A limited number of students may take the five-year combined course in Aeronautical Engineering and Business Administration.

For freshman year, see page 16.

### FIVE-YEAR COURSE SECOND YEAR

#### *First Quarter*

| Course No.  | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Draw. 28    | Drafting .....                            | 2       | ..... | ..... | 6     |
| M.E. 18     | Materials and Processing .....            | 3       | ..... | 2     | 6     |
| Nat.Sci. 7* | General Biology .....                     | 3       | ..... | 2     | 2     |

#### *Second Quarter*

|             |                                    |   |       |       |       |
|-------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25    | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Aero.E. 1   | Aeronautics .....                  | 3 | 3     | ..... | ..... |
| Nat.Sci. 8* | General Biology .....              | 3 | ..... | 2     | 2     |
|             | Elective .....                     |   |       |       |       |

#### *Third Quarter*

|              |  |   |       |       |       |
|--------------|--|---|-------|-------|-------|
| M.&M. 26     | Technical Mechanics: Statics .....     | 5 | 5     | ..... | ..... |
| M.&M. 151    | Differential Equations .....           | 3 | 3     | ..... | ..... |
| Phys. 9      | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Nat.Sci. 9** | General Biology .....                  | 3 | ..... | 2     | 2     |
|              | Elective .....                         |   |       |       |       |

### THIRD YEAR

#### *First Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 86    | Fluid Mechanics .....                | 3 | 3     | ..... | ..... |
| Aero.E. 142 | Aircraft Installation I .....        | 2 | ..... | 1     | 3     |
| M.E. 26     | Mechanism and Kinematics .....       | 3 | 3     | ..... | ..... |
| Soc.Sci. 1* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
|             | Elective .....                       |   |       |       |       |

#### *Second Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 127   | Technical Mechanics: Dynamics .....  | 5 | 5     | ..... | ..... |
| Aero.E. 158 | Physics of the Atmosphere .....      | 2 | 1     | 2     | ..... |
| Phys. 73    | Intermediate Thermodynamics .....    | 3 | 3     | ..... | ..... |
| Soc.Sci. 2* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
|             | Elective .....                       |   |       |       |       |

#### *Third Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 128   | Strength of Materials .....          | 5 | 5     | ..... | ..... |
| Aero.E. 140 | Aeronautical Laboratory .....        | 4 | ..... | 3     | 3     |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
|             | Elective .....                       |   |       |       |       |

\* See pages 74 and 75 for alternate sequences which may be substituted as a unit.

## FOURTH YEAR

*First Quarter*

| Course No.  | Title   | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 167   | Mathematics of Modern Engineering .....                       | 3       | 3     | ..... | ..... |
| Aero.E. 83  | Stresses in Simple Structures .....                           | 4       | ..... | 3     | 2     |
| Aero.E. 100 | Aerodynamics .....  | 3       | 3     | ..... | ..... |
| E.E. 46     | Electrical Engineering Survey and<br>Aeronautical Radio ..... | 3       | 2     | ..... | 2     |
| Hum. 1*     | Humanities of the Modern World I .....                        | 5       | ..... | 5     | ..... |
| or          |   |         |       |       |       |
| Hum. 11*    | The Greek Heritage .....                                      | 5       | ..... | 5     | ..... |
| or          |   |         |       |       |       |
| Hum. 21*    | Humanities in the United States .....                         | 3       | ..... | 3     | ..... |
|             | Elective  |         |       |       |       |

*Second Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| Aero.E. 101 | Aerodynamics .....  | 3 | 3     | ..... | ..... |
| Aero.E. 115 | Airplane Stresses .....                                       | 3 | 2     | ..... | 2     |
| E.E. 47     | Electrical Engineering Survey and<br>Aeronautical Radio ..... | 3 | 2     | ..... | 2     |
| M.E. 150A   | Internal Combustion Engines .....                             | 4 | 4     | ..... | ..... |
| Hum. 2*     | Humanities in the Modern World II .....                       | 5 | ..... | 5     | ..... |
| or          |   |   |       |       |       |
| Hum. 12*    | The Roman and the Medieval Heritage .....                     | 5 | ..... | 5     | ..... |
| or          |   |   |       |       |       |
| Hum. 22*    | Humanities in the United States .....                         | 3 | ..... | 3     | ..... |
|             | Elective  |   |       |       |       |

*Third Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| Aero.E. 102 | Aerodynamics .....                         | 3 | 3     | ..... | ..... |
| Aero.E. 110 | Vibration and Flutter .....                | 3 | ..... | 3     | ..... |
| Aero.E. 141 | Aerodynamics Laboratory .....              | 2 | ..... | ..... | 6     |
| M.E. 151A   | Advanced Internal Combustion Engines ..... | 2 | 2     | ..... | ..... |
| M.E. 154A   | Design of Airplane Engines .....           | 2 | ..... | ..... | 6     |
| Hum. 3*     | Humanities in the Modern World III .....   | 5 | ..... | 5     | ..... |
| or          |  |   |       |       |       |
| Hum. 13*    | The Renaissance Heritage .....             | 5 | ..... | 5     | ..... |
| or          |  |   |       |       |       |
| Hum. 23*    | Humanities in the United States .....      | 3 | ..... | 3     | ..... |
|             | Elective                                   |   |       |       |       |

## FIFTH YEAR

*First Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| Aero.E. 120 | Airplane Design .....                  | 2 | ..... | 2     | ..... |
| Aero.E. 130 | Aerodynamic Design .....               | 2 | ..... | ..... | 6     |
| Aero.E. 143 | Aircraft Installation II .....         | 3 | ..... | 1     | 6     |
| Engl. 85    | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| M.E. 158    | Aero Engine Testing .....              | 2 | ..... | ..... | 6     |
|             | Electives                              |   |       |       |       |

*Second Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| Aero.E. 106 | Advanced Aerodynamics .....            | 3 | ..... | 3     | ..... |
| Aero.E. 121 | Airplane Design .....                  | 2 | ..... | 2     | ..... |
| Aero.E. 131 | Airplane Design Laboratory .....       | 2 | ..... | ..... | 6     |
| Aero.E. 190 | Seminar .....                          | 1 | 1     | ..... | ..... |
| Engl. 86    | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| G.E. 103    | Professional Problems .....            | 1 | ..... | 1     | ..... |
|             | Elective                               |   |       |       |       |

\* See page 74 for alternate sequences which may be substituted as a unit.

*Third Quarter*

| Course No.   | Title  | Credits | Rec.  | Lect. | Lab.  |
|--------------|--|---------|-------|-------|-------|
| Aero.E. 122  | Airplane Design .....                            | 4       | ..... | 1     | 6     |
| Aero.E. 135  | Airplane Static Test. ....                       | 2       | ..... | 1     | 3     |
| Aero.E. 155  | Aeronautical Calculations .....                  | 2       | 2     | ..... | ..... |
| Aero.E. 159* | Inspection Trip (Spring Vacation) .....          | 1       | ..... | ..... | ..... |
| Aero.E. 191  | Seminar .....                                    | 1       | 1     | ..... | ..... |
| M.E. 157     | Gas Turbine and Jet Propulsion Power Plants..... | 3       | ..... | 3     | ..... |
|              | Elective   |         |       |       |       |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

SOPHOMORE YEAR

*First Quarter*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| M.&M. 24  | Calculus I: Differential .....            | 5 | 5     | ..... | ..... |
| Phys. 7   | General Physics: Mechanics and Heat ..... | 5 | 1     | 4     | 2     |
| Aero.E. 2 | Aircraft and Auto Engines .....           | 3 | 1     | 2     | 2     |
| Draw. 28  | Drafting .....                            | 2 | ..... | ..... | 6     |
|           | Electives                                 |   |       |       |       |

*Second Quarter*

|           |                                    |   |       |       |       |
|-----------|------------------------------------|---|-------|-------|-------|
| M.&M. 25  | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8   | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Aero.E. 1 | Aeronautics .....                  | 3 | 3     | ..... | ..... |
| M.E. 6    | Machine Shop .....                 | 2 | ..... | 2     | 3     |
|           | Electives                          |   |       |       |       |

*Third Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| M.&M. 26    | Technical Mechanics: Statics .....     | 5 | 5     | ..... | ..... |
| M.&M. 151   | Differential Equations .....           | 3 | 3     | ..... | ..... |
| Phys. 9     | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Aero.E. 142 | Aircraft Installations .....           | 2 | ..... | 1     | 3     |
|             | Electives                              |   |       |       |       |

JUNIOR YEAR

*First Quarter*

|             |   |   |   |       |       |
|-------------|---|---|---|-------|-------|
| M.&M. 86    | Fluid Mechanics .....                                     | 3 | 3 | ..... | ..... |
| Aero.E. 100 | Aerodynamics .....  | 3 | 3 | ..... | ..... |
| E.E. 46     | Electrical Engineering Survey and Aeronautical Radio..... | 3 | 2 | ..... | 2     |
| M.E. 26     | Mechanism and Kinematics .....                            | 3 | 3 | ..... | ..... |
|             | Electives   |   |   |       |       |

*Second Quarter*

|             |   |   |   |       |       |
|-------------|---|---|---|-------|-------|
| M.&M. 128   | Strength of Materials .....                               | 5 | 5 | ..... | ..... |
| Aero.E. 101 | Aerodynamics .....  | 3 | 3 | ..... | ..... |
| Aero.E. 158 | Physics of the Atmosphere .....                           | 2 | 1 | 2     | ..... |
| E.E. 47     | Electrical Engineering Survey and Aeronautical Radio..... | 3 | 2 | ..... | 2     |
| Phys. 73    | Intermediate Thermodynamics .....                         | 3 | 3 | ..... | ..... |
|             | Electives   |   |   |       |       |

*Third Quarter*

|             |                                     |   |       |       |       |
|-------------|-------------------------------------|---|-------|-------|-------|
| M.&M. 127   | Technical Mechanics: Dynamics ..... | 5 | 5     | ..... | ..... |
| Aero.E. 83  | Stresses in Simple Structures ..... | 4 | ..... | 3     | 2     |
| Aero.E. 102 | Aerodynamics .....                  | 3 | 3     | ..... | ..... |
| Aero.E. 140 | Aeronautical Laboratory .....       | 4 | ..... | 3     | 3     |
|             | Electives                           |   |       |       |       |

SENIOR YEAR

*First Quarter*

|             |                                     |   |       |       |       |
|-------------|-------------------------------------|---|-------|-------|-------|
| Aero.E. 106 | Advanced Aerodynamics .....         | 3 | ..... | 3     | ..... |
| Aero.E. 115 | Airplane Stresses .....             | 3 | 2     | ..... | 2     |
| Aero.E. 120 | Airplane Design .....               | 2 | ..... | 2     | ..... |
| Aero.E. 130 | Aerodynamic Design Laboratory ..... | 2 | ..... | ..... | 6     |
| M.E. 150A   | Internal Combustion Engines .....   | 4 | 4     | ..... | ..... |

\* Subject to cancellation.

## Second Quarter

| Course No.  | Title                                      | Credits | Rec.  | Lect. | Lab   |
|-------------|--|---------|-------|-------|-------|
| M.&M. 167   | Mathematics of Modern Engineering .....    | 3       | 3     | ..... | ..... |
| Aero.E. 110 | Vibration and Flutter .....                | 3       | ..... | 3     | ..... |
| Aero.E. 121 | Airplane Design .....                      | 2       | ..... | 2     | ..... |
| Aero.E. 131 | Airplane Design Laboratory .....           | 2       | ..... | ..... | 6     |
| Aero.E. 190 | Seminar .....                              | 1       | 1     | ..... | ..... |
| G.E. 103    | Professional Problems .....                | 1       | ..... | 1     | ..... |
| M.E. 151A   | Advanced Internal Combustion Engines ..... | 2       | 2     | ..... | ..... |
| M.E. 154A   | Design of Airplane Engines .....           | 2       | ..... | ..... | 6     |

## Third Quarter

|             |                                  |   |       |       |       |
|-------------|----------------------------------|---|-------|-------|-------|
| Aero.E. 122 | Airplane Design .....            | 2 | ..... | 2     | ..... |
| Aero.E. 132 | Airplane Design Laboratory ..... | 2 | ..... | ..... | 6     |
| Aero.E. 135 | Airplane Static Test .....       | 2 | ..... | 1     | 3     |
| Aero.E. 141 | Aerodynamic Laboratory .....     | 2 | ..... | ..... | 6     |
| Aero.E. 155 | Aeronautical Calculation .....   | 2 | 2     | ..... | ..... |
| Aero.E. 191 | Seminar .....                    | 1 | 1     | ..... | ..... |
| M.E. 158    | Aero Engine Testing .....        | 2 | ..... | ..... | 6     |
|             | Elective                         |   |       |       |       |

## AGRICULTURAL ENGINEERING

Five-year course (four-year course for veterans or those registering prior to fall quarter, 1946) leading to the degree of bachelor of agricultural engineering, B.Ag.E., in co-operation with the College of Agriculture, Forestry, and Home Economics.

Requirements for graduation include all prescribed courses with sufficient approved electives to make a total of at least 255 credits (207 for the four-year course).

Agricultural engineering activities are usually grouped under the heads of *farm power and machinery*, *rural electrification*, *farm structures*, and *soil moisture relations*. There is also need for service in the entire field necessitating general preparation in all four lines.

The farm machinery field covers the selection and management of machinery and equipment best suited to produce good results locally on any given type of farm, the design and construction of such machinery or equipment where it does not yet exist, the improvement of such design to meet special needs, and the adaptation of available types of power to local farm conditions. Rural electrification includes studies of electric circuits, electrical machinery, and applications of electricity to agricultural tasks and processes. The farm structures field covers arrangement of the structures on the farmstead for economy, convenience, and comfort; the design and construction of farm buildings and related structures; and the adaptation of available types of structural materials to local farm conditions. The soil moisture relations field covers development of virgin lands suited to agriculture and the improvement of lands already under cultivation through soil conditioning by means of effective design and proper installation of drainage, and irrigation works and control of soil erosion.

The field, as yet comparatively new and uncrowded, offers many opportunities among which the following are prominent: with manufacturers of farm machinery, equipment, and building materials; as executives, research engineers, publicity and sales managers, and technical field experts; as managers of large farms requiring extensive machinery or equipment; as engineers with the local, state, and federal government, and with development companies; as agricultural advisers with power companies in development of rural service; as engineering specialists in soil erosion control, farm drainage, and irrigation; as agricultural engineering editors for farm papers and trade journals; as rural architects and builders; as teachers, investigators, and extension specialists in state agricultural colleges, experiment stations, and in the United States Department of Agriculture; as consulting agricultural engineers in general practice.

Students taking the combined five-year course in agricultural engineering and busi-

*Third Quarter*

| Course No. | Title                     | Credits | Rec.  | Lect. | Lab.  |
|------------|---------------------------|---------|-------|-------|-------|
| Ag.E. 37   | Rural Sanitation .....    | 3       | ..... | 3     | ..... |
| Ag.E. 72   | Applied Electricity ..... | 3       | ..... | 2     | 4     |
| Rhet. 22   | Public Speaking .....     | 3       | 3     | ..... | ..... |
|            | Electives .....           | 8       | ..... | ..... | ..... |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

SOPHOMORE YEAR

*First Quarter*

|          |                                  |   |       |       |       |
|----------|----------------------------------|---|-------|-------|-------|
| M.&M. 24 | Calculus I: Differential .....   | 5 | 5     | ..... | ..... |
| Phys. 7  | General Physics .....            | 5 | 1     | 4     | 2     |
| Ag.E. 5  | Farm Structures Laboratory ..... | 3 | ..... | 2     | 4     |
| Econ. 8  | General Economics .....          | 3 | 3     | ..... | ..... |

*Second Quarter*

|          |                             |   |   |       |       |
|----------|-----------------------------|---|---|-------|-------|
| M.&M. 25 | Calculus II: Integral ..... | 5 | 5 | ..... | ..... |
| Phys. 8  | General Physics .....       | 5 | 1 | 4     | 2     |
| Soils 4  | Soils .....                 | 3 | 3 | ..... | ..... |
| Econ. 9  | General Economics .....     | 3 | 3 | ..... | ..... |

*Third Quarter*

|          |                                    |   |       |       |       |
|----------|------------------------------------|---|-------|-------|-------|
| M.&M. 26 | Technical Mechanics: Statics ..... | 5 | 5     | ..... | ..... |
| Phys. 9  | General Physics .....              | 5 | 1     | 4     | 2     |
| Ag.E. 21 | Elements of Surveying .....        | 5 | ..... | 1     | 12    |
| Ag.E. 43 | Mechanical Laboratory .....        | 3 | ..... | 1     | 5     |

JUNIOR YEAR

*First Quarter*

|           |                                     |   |       |       |       |
|-----------|-------------------------------------|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics ..... | 5 | 5     | ..... | ..... |
| M.&M. 129 | Hydraulics .....                    | 4 | 3     | 1     | ..... |
| M.&M. 143 | Hydraulics Laboratory .....         | 1 | ..... | ..... | 2     |
| Ag.E. 52  | Elements of Farm Machinery .....    | 3 | 1     | 1     | 3     |
| Geol. 5   | Engineering Geology .....           | 3 | ..... | 3     | ..... |
| M.E. 131  | Thermodynamics .....                | 3 | 3     | ..... | 2     |

*Second Quarter*

|              |                                     |   |       |       |       |
|--------------|-------------------------------------|---|-------|-------|-------|
| M.&M. 128    | Strength of Materials .....         | 5 | 5     | ..... | ..... |
| Ag.Econ. 102 | Farm Management: Organization ..... | 3 | 3     | ..... | ..... |
| Soils 108    | Physical Properties of Soils .....  | 3 | ..... | 1     | 6     |
| M.E. 26      | Mechanism and Kinematics .....      | 3 | 3     | ..... | ..... |
| Rhet. 22     | Public Speaking .....               | 3 | 3     | ..... | ..... |

*Third Quarter*

|          |                                      |   |       |       |       |
|----------|--------------------------------------|---|-------|-------|-------|
| Agron. 1 | General Farm Crops .....             | 3 | 3     | ..... | ..... |
| Ag.E. 18 | Agricultural Automotives .....       | 4 | ..... | 2     | 6     |
| Ag.E. 37 | Rural Sanitation .....               | 3 | ..... | 3     | ..... |
| Ag.E. 53 | Farm Structures .....                | 3 | ..... | 2     | 4     |
| Ag.E. 73 | Steam Boilers and Heat Engines ..... | 3 | 1     | 1     | 4     |
| M.E. 27  | Machine Design .....                 | 3 | ..... | 2     | 3     |

## INSTITUTE OF TECHNOLOGY

## SENIOR YEAR

*First Quarter*

| Course No. | Title                                   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| Ag.E. 67   | Advanced Farm Structures Design .....   | 3       | 1     | 1     | 4     |
| Ag.E. 71   | Design of Agricultural Machinery .....  | 3       | ..... | 1     | 4     |
| C.E. 37    | Elementary Structural Engineering ..... | 3       | ..... | 1     | 3     |
| Dy.Husb. 1 | Elements of Dairying .....              | 3       | ..... | 3     | ..... |
|            | Electives to complete program.          |         |       |       |       |

*Second Quarter*

|            |                                    |   |       |   |       |
|------------|------------------------------------|---|-------|---|-------|
| Ag.E. 51   | Soil Moisture Relations .....      | 5 | 1     | 4 | ..... |
| G.E. 101   | Contracts and Specifications ..... | 3 | ..... | 3 | ..... |
| An.Husb. 1 | Livestock Production .....         | 4 | ..... | 3 | 2     |
|            | Electives to complete program.     |   |       |   |       |

*Third Quarter*

|          |                                       |   |       |   |       |
|----------|---------------------------------------|---|-------|---|-------|
| Ag.E. 72 | Applied Electricity .....             | 3 | ..... | 2 | 4     |
| C.E. 146 | Concrete and Concrete Materials ..... | 3 | ..... | 2 | 4     |
| G.E. 103 | Professional Problems .....           | 1 | ..... | 1 | ..... |
|          | Electives to complete program.        |   |       |   |       |

## RECOMMENDED ELECTIVES§

The following courses are suggested for the guidance of students who wish to elect work along the general lines indicated.

*Farm Structures*

| Course No.        | Title  | Credits |
|-------------------|--|---------|
| Ag.E. 111,112,113 | Farm Building Problems, per quarter .....                  | 2-6     |
| Arch. 57          | Building Materials and Methods, Part I .....               | 4       |
| Arch. 58-59       | Building Materials and Methods, Part II, per quarter ..... | 4       |
| C.E. 33           | Design in Timber .....                                     | 3       |
| For. 10           | Farm Forestry .....  | 3       |
| Hort. 24          | Principles of Landscape Design .....                       | 3       |

*Farm Power and Machinery*

|                   |  |     |
|-------------------|--|-----|
| M.E. 6            | Machine Shop Practice .....                          | 2   |
| M.E. 121          | Machine Design .....                                 | 2   |
| M.E. 150          | Internal Combustion Engines .....                    | 3   |
| Met. 156          | Metallography .....                                  | 4   |
| Ag.E. 121,122,123 | Farm Power and Machinery Problems, per quarter ..... | 2-6 |
| Ag.E. 126         | Selection of Farm Equipment .....                    | 3   |
| Soils 5           | Soils Management .....                               | 3   |

*Rural Electrification*

|               |  |   |
|---------------|--|---|
| Ag.Econ. 144  | Co-operative Organization .....                  | 3 |
| Ag.E. 125     | Topics in Agricultural Physics .....             | 3 |
| E.E. 36-37-38 | Electrical Engineering Survey, per quarter ..... | 3 |
| E.E. 151      | Illuminating Engineering .....                   | 3 |

§ Students taking the combined five-year course in agricultural engineering and business administration see statement on pages 20 and 21.



*Soil Moisture Relations*

|                   |  |     |
|-------------------|--|-----|
| Ag.E. 101-102-103 | Advanced Drainage Problems, per quarter .....          | 2-6 |
| Ag.E. 105         | Advanced Soil and Water Conservation .....             | 3   |
| C.E. 161          | Hydrology .....  | 3   |
| C.E. 183          | Open Channel Flow .....                                | 3   |
| C.E. 190          | Mechanics of Similitude and Dimensional Analysis ..... | 3   |
| Soils 103         | Principles of Soil Erosion .....                       | 3   |
| Soils 104         | Soils Mapping .....                                    | 3   |

*General*

|                |  |    |
|----------------|--|----|
| Ag.Econ. 191   | Advanced Agricultural Statistics ..... | 3  |
| Ag.Econ. 103   | Farm Operation .....                   | 3  |
| Hort. 6        | Fruit Growing .....                    | 3  |
| Nat.Sci. 7-8-9 | General Biology .....                  | 10 |

ARCHITECTURE

The work in Architecture offered by the School of Architecture includes courses dealing with the history, theory, and practice of architecture and the allied arts of design. It is organized into general and professional courses as follows:

GENERAL COURSE

Four-year course leading to the degree of bachelor of arts (B.A.) with a major in architecture, in the College of Science, Literature, and the Arts.

The general course is intended for students who wish to combine with their academic training, whether for cultural or vocational reasons, some study of architecture. It offers an advantageous approach to the professional courses in architecture described below, or to further training at other schools in the special fields of city and regional planning, landscape architecture, or decorative, industrial, and interior design. For further information see the Bulletin of the College of Science, Literature, and the Arts and the Combined Class Schedule, or consult Professor Rhodes Robertson of the School of Architecture, major adviser.

PROFESSIONAL COURSES

Five-year course leading to the degree of bachelor of architecture (B.Arch.) in the Institute of Technology.

Six-year course leading to the degree of bachelor of arts (B.A.) with a major in architecture, in the College of Science, Literature, and the Arts and the degree of bachelor of architecture (B.Arch.) in the Institute of Technology.

**SPECIAL NOTE**—For returning veterans, the time required to complete these courses can be reduced by credit allowed for military study and experience and by accelerated programs which include summer work.

The professional courses are intended primarily for students who expect to enter the professional practice of architecture in any of its many recognized phases. It is assumed that the students taking them have a definite interest in architecture and a natural aptitude for the actual processes of designing buildings. They provide training which, when supplemented by practical experience in architects' offices, places the student in line for recognition as a practicing architect according to the registration laws of the various states. They also serve as advantageous approaches to various fields in government and industry where architectural skill and knowledge are valuable.

The work in architecture included in these courses falls into three general divisions. One is theory, presenting the technical, analytical, and historical knowledge on which architecture is based. The second is practice in drawing and modeling as a means of

expression. The third and principal division is continued practice in all phases of architectural design, including both composition and construction.

As high school preparation for the professional courses, higher algebra and solid geometry are essential; physics, chemistry, history, and foreign language are strongly recommended; instrumental and freehand drawing are advantageous.

Whether the student elects the five- or the six-year course will depend on the time and means at his disposal. He will find it highly desirable to supplement and broaden his technical training by as much general academic work of college grade as he finds possible. College work taken at institutions other than Minnesota can be readily adjusted to each professional course. In any such work college algebra, trigonometry, and analytic geometry should be included as essential prerequisites to certain courses in structural design. Selections from language, history, economics, political science, sociology, physics, and chemistry are recommended. Prospective students should note that it normally takes four years to complete the required technical work, regardless of how much other college work they may have to their credit, and should calculate their time accordingly.

For further information concerning the professional courses, see the following pages, or consult Professor Roy Jones, head, School of Architecture.

#### FIVE-YEAR COURSE

This course is intended to provide a basic professional training in architectural theory and practice. In addition, a certain amount of specialization is possible in general design, city planning, interior design, or building construction and equipment (sometimes called "architectural engineering"). This specialization is accomplished by (1) a choice of electives and (2) a choice of problems in architectural design.

In addition to the prescribed courses, sufficient approved electives must be taken to make a minimum total of 225 credits. The first year consists of pre-architectural college work, which may be taken at Minnesota or elsewhere, and whose satisfactory completion is a prerequisite for the student's admission to the second year's work as a candidate for the B.Arch. degree.

The specific requirements are listed in the following program. This program is typical for students who have completed high school with acceptable credits in higher algebra, solid geometry, and preparatory English, who enter college in the fall, and who maintain a normal rate of progress in their architectural and other work. For other students, the sequence of courses and the time required to complete them are subject to modification.

#### *First Year*

The first year's work may be taken according to any of the following plans:

1. One year at the University of Minnesota in the common first year course offered by the Institute of Technology. See page 16.
2. One year at the University of Minnesota in the College of Science, Literature, and the Arts. See Bulletin of the College of Science, Literature, and the Arts.
3. One year of college work at an accredited institution other than the University of Minnesota.

For students not entering the Institute of Technology the following courses offered by the Institute of Technology at the University of Minnesota, or their equivalents if taken elsewhere, are required for the bachelor of architecture degree, and should normally be included in the first year's work:

|  | Credits |
|--|---------|
| M.&M. 11f-12w-13s, College Algebra, Trigonometry,<br>and Analytic Geometry ..... | 15      |
| Eng. 4f-5w-6s, Written and Spoken Communication .....                            | 9       |

Additional courses which may include selections from the following approved electives:

|   |    |
|---|----|
| Inorganic chemistry (must be included if not taken in high school), and selections from foreign language, history, economics, political science, descriptive geometry, freehand or mechanical drawing, etc., totaling approximately ..... | 21 |
| Normal total .....  | 45 |

SPECIAL NOTE—Students transferring from other institutions should note that the credits listed are quarter credits. To translate semester credits to quarter credits multiply by 1½.

To become a candidate for the B.Arch. degree, and to enroll in the architectural courses scheduled for the second or subsequent years, the student must have substantially completed a year of college work as described above, and must have secured the approval of the School of Architecture. Such approval must be applied for in the manner prescribed, and will be based on a consideration of (1) the student's scholastic standing in previous high school and college work; (2) his maturity and experience; (3) his professional aptitude and objective; and (4) the work space and instructional facilities available in the school.

NOTE—For recommended general and technical electives, see the *Combined Class Schedule*, the description of courses in architecture and other technical fields in this bulletin, and supplementary lists issued periodically by the School of Architecture.

SECOND YEAR

*First Quarter*

| Course No. | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|------------|--|---------|-------|-------|-------|
| Arch. 40   | Graphic Representation .....           | 5       | ..... | 3     | 12    |
| Arch. DP-I | Drawing and Painting, Grade I .....    | 2       | ..... | ..... | 4     |
| M.&M. 91   | Calculus for Architects .....          | 4       | 4     | ..... | ..... |
| Phys. 1    | Introduction to Physical Science ..... | 3       | ..... | 3     | ..... |
|            | Approved Elective .....                |         |       |       |       |

*Second Quarter*

|            |  |   |       |       |       |
|------------|--|---|-------|-------|-------|
| Arch. AD-I | Architectural Design, Grade I .....    | 5 | ..... | ..... | 15    |
| Arch. DP-I | Drawing and Painting, Grade I .....    | 2 | ..... | ..... | 4     |
| M.&M. 92   | Mechanics for Architects .....         | 4 | 4     | ..... | ..... |
| Phys. 2    | Introduction to Physical Science ..... | 3 | ..... | 3     | ..... |
|            | Approved Elective .....                |   |       |       |       |

*Third Quarter*

|            |  |   |       |       |       |
|------------|--|---|-------|-------|-------|
| Arch. AD-I | Architectural Design, Grade I .....        | 5 | ..... | ..... | 15    |
| Arch. DP-I | Drawing and Painting, Grade I .....        | 2 | ..... | ..... | 4     |
| M.&M. 93   | Strength of Materials for Architects ..... | 4 | 4     | ..... | ..... |
| Phys. 3    | Introduction to Physical Science .....     | 3 | ..... | 3     | ..... |
|            | Approved Elective .....                    |   |       |       |       |

THIRD YEAR

*First Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| Arch. 51    | History of Architecture .....                | 3 | ..... | 4     | ..... |
| Arch. 57    | Building Materials and Methods, Part I ..... | 4 | 4     | ..... | ..... |
| Arch. AD-II | Architectural Design, Grade II .....         | 5 | ..... | ..... | 15    |
| Arch. DP-II | Drawing and Painting, Grade II .....         | 2 | ..... | ..... | 4     |
| C.E. 38     | Elementary Structural Design (Steel) .....   | 3 | ..... | 3     | ..... |

*Second Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| Arch. 52    | History of Architecture .....                         | 3 | ..... | 4     | ..... |
| Arch. 58    | Building Materials and Methods, Part II .....         | 4 | 4     | ..... | ..... |
| Arch. AD-II | Architectural Design, Grade II .....                  | 5 | ..... | ..... | 15    |
| Arch. DP-II | Drawing and Painting, Grade II .....                  | 2 | ..... | ..... | 4     |
| C.E. 39     | Elementary Structural Design (Steel and Timber) ..... | 3 | ..... | 3     | ..... |

## INSTITUTE OF TECHNOLOGY

*Third Quarter*

| Course No.  | Title  | Credits | Rec.  | Lect. | Lab.  |
|-------------|--|---------|-------|-------|-------|
| Arch. 53    | History of Architecture .....                          | 3       | ..... | 4     | ..... |
| Arch. 59    | Building Materials and Methods .....                   | 4       | 4     | ..... | ..... |
| Arch. AD-II | Architectural Design, Grade II .....                   | 5       | ..... | ..... | 15    |
| Arch. DP-II | Drawing and Painting, Grade II .....                   | 2       | ..... | ..... | 4     |
| C.E. 41     | Elementary Structural Design (Steel and Concrete)..... | 3       | ..... | 3     | ..... |

## FOURTH YEAR

*First Quarter*

|               |                                       |   |       |       |       |
|---------------|---------------------------------------|---|-------|-------|-------|
| Arch. 71      | Building Equipment .....              | 2 | ..... | 2     | ..... |
| Arch. 104     | City Planning .....                   | 3 | ..... | 3     | ..... |
| Arch. AD-IIIB | Architectural Design, Grade IIIB..... | 7 | ..... | ..... | 21    |
| Arch. DP-III  | Drawing and Painting, Grade III.....  | 2 | ..... | ..... | 4     |
|               | Approved Electives                    |   |       |       |       |

*Second Quarter*

|               |  |   |       |       |       |
|---------------|--|---|-------|-------|-------|
| Arch. 72      | Building Equipment .....               | 2 | ..... | 2     | ..... |
| Arch. AD-IIIB | Architectural Design, Grade III-B..... | 7 | ..... | ..... | 21    |
| Arch. DP-III  | Drawing and Painting, Grade III.....   | 2 | ..... | ..... | 4     |
|               | Approved Electives                     |   |       |       |       |

*Third Quarter*

|               |  |   |       |       |       |
|---------------|--|---|-------|-------|-------|
| Arch. 73      | Building Equipment .....               | 2 | ..... | 2     | ..... |
| Arch. AD-IIIB | Architectural Design, Grade IIIB ..... | 7 | ..... | ..... | 21    |
| Arch. DP-III  | Drawing and Painting, Grade III.....   | 2 | ..... | ..... | 4     |
|               | Approved Electives                     |   |       |       |       |

## FIFTH YEAR

*First Quarter*

|               |  |    |       |       |    |
|---------------|--|----|-------|-------|----|
| Arch. AD-IIIA | Architectural Design, Grade IIIA ..... | 12 | ..... | ..... | 36 |
|               | Approved Electives                     |    |       |       |    |

*Second Quarter*

|               |  |    |       |       |       |
|---------------|--|----|-------|-------|-------|
| Arch. AD-IIIA | Architectural Design, Grade IIIA ..... | 12 | ..... | ..... | 36    |
| Arch. 105     | Professional Relations .....           | 2  | 2     | ..... | ..... |
|               | Approved Electives                     |    |       |       |       |

*Third Quarter*

|             |              |    |       |       |    |
|-------------|--------------|----|-------|-------|----|
| Arch. AD-IV | Thesis ..... | 15 | ..... | ..... | 45 |
|-------------|--------------|----|-------|-------|----|

## SIX-YEAR COURSE IN ARTS AND ARCHITECTURE

In this course the student normally is registered for the first four years in the College of Science, Literature, and the Arts and for the last two years in the School of Architecture of the Institute of Technology.

While registered in the College of Science, Literature, and the Arts he follows the plan of study prescribed for a bachelor of arts degree with a major in architecture. See Junior and Senior College requirements as given in the *Bulletin of the College of Science, Literature, and the Arts*; and Architecture, in the *Combined Class Schedule*.

The following courses should be completed during this period:  
 Required for the major sequence

| Course No.     | Title  | Credits |
|----------------|--|---------|
| Arch. 40       | Graphic Representation .....                 | 5       |
| Arch. 51-52-53 | History of Architecture .....                | 9       |
| Arch. 57       | Building Materials and Methods, Part I ..... | 4       |
| Arch. DP-I, II | Drawing and Painting, Grades I and II .....  | 12      |
| Arch. AD-I, II | Architectural Design, Grades I and II .....  | 25      |

Additional Special Requirements:

|   |  |    |
|---|--|----|
| Math. 7-6-30  | College Algebra, Trigonometry, Analytic Geometry ..... | 15 |
| M.&M. 91-92-93  | Calculus, Mechanics, Strength of Materials .....       | 12 |
| C.E. 38-39-41   | Structural Design .....                                | 9  |
| Junior and Senior College courses to make a total for the bachelor of arts degree of 189 credits. |  |    |

NOTE—Of the courses listed above, Civil Engineering 38-39-41 (9 credits) is not a part of the work required (normally 180 credits) for the bachelor of arts degree. It is an extra requirement which should be taken as a prerequisite for the work of the last two years of this six-year course in Arts and Architecture.

Upon completion of the requirements for the bachelor of arts degree, and subject to the approval by the School of Architecture, the student is registered in the Institute of Technology to complete the requirements for a bachelor of architecture degree, as prescribed in this bulletin. These requirements include the following courses, to make a minimum total of 270 credits for the two degrees.

| Course No.     | Title   | Credits |
|----------------|---|---------|
| Arch. 57-58    | Building Materials and Methods, Part II ..... | 8       |
| Arch. 71-72-73 | Building Equipment .....                      | 6       |
| Arch. 104      | City Planning .....                           | 3       |
| Arch. 105      | Professional Relations .....                  | 2       |
| Arch. DP-III   | Drawing and Painting, Grade III .....         | 6       |
| Arch. AD-III   | Architectural Design, Grade III .....         | 45      |
| Arch. AD-IV    | Thesis .....                                  | 15      |

CHEMISTRY AND CHEMICAL ENGINEERING

FOUR- OR FIVE-YEAR COURSE

FRESHMAN YEAR

First Quarter

| Course No.    | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|---------------|--|---------|-------|-------|-------|
| M.&M. 11      | College Algebra .....                  | 5       | 5     | ..... | ..... |
| Inorg.Chem. 9 | General Inorganic Chemistry .....      | 5       | 1     | 3     | 5     |
| Engl. 4       | Written and Spoken Communication ..... | 3       | 3     | ..... | ..... |
| Draw. 7       | Engineering Drawing .....              | 3       | ..... | ..... | 8     |

Second Quarter

|                |  |   |       |       |       |
|----------------|--|---|-------|-------|-------|
| M.&M. 12       | Trigonometry .....                     | 5 | 5     | ..... | ..... |
| Inorg.Chem. 10 | General Inorganic Chemistry .....      | 5 | 1     | 3     | 5     |
| Engl. 5        | Written and Spoken Communication ..... | 3 | 3     | ..... | ..... |
| Draw. 7        | Engineering Drawing .....              | 3 | ..... | ..... | 8     |
| or             |  |   |       |       |       |
| Draw. 8        | Descriptive Geometry .....             | 3 | ..... | ..... | 8     |

Third Quarter

|                |  |   |       |       |       |
|----------------|--|---|-------|-------|-------|
| M.&M. 13       | Analytic Geometry .....                | 5 | 5     | ..... | ..... |
| Inorg.Chem. 12 | Semimicro Qualitative Analysis .....   | 5 | 2     | 1     | 6     |
| Engl. 6        | Written and Spoken Communication ..... | 3 | 3     | ..... | ..... |
| Draw. 8        | Descriptive Geometry .....             | 3 | ..... | ..... | 8     |
| P.H. 3         | Personal Health .....                  | 2 | ..... | 2     | ..... |
| Chem.E. 20*    | Chemical Engineering Orientation ..... | 1 | ..... | 1     | ..... |

\* Required of chemical engineers only.

## CHEMISTRY

Five-year course leading to the degree of bachelor of chemistry, B.Chem. A four-year course, open only to veterans, is also offered.

In addition to the prescribed courses, sufficient approved electives must be taken to complete a total of at least 255 credits (207 in the four-year course).

This professional course in Chemistry is designed to provide thoro training in the fundamentals of chemistry and related subjects. It serves as a basis for further specialization and a foundation for graduate work. Its graduates secure positions in practical chemistry, research, and teaching, in chemical industries, the government service, in colleges and laboratories, etc.

For freshman year, see page 29.

## SECOND YEAR

*First Quarter*

| Course No.     | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|----------------|---|---------|-------|-------|-------|
| M.&M. 24       | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Inorg.Chem. 13 | Semimicro Qualitative Analysis .....      | 5       | 1     | 2     | 8     |
| Phys. 7        | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Nat.Sci. 7*    | General Biology .....                     | 3       | ..... | 2     | 2     |

*Second Quarter*

|              |                                    |   |       |       |       |
|--------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25     | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Anal.Chem. 1 | Quantitative Analysis .....        | 5 | 1     | 1     | 10    |
| Phys. 8      | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Nat.Sci. 8*  | General Biology .....              | 3 | ..... | 2     | 2     |

*Third Quarter*

|              |  |   |       |       |       |
|--------------|--|---|-------|-------|-------|
| M.&M. 84     | Technical Mechanics .....              | 5 | 5     | ..... | ..... |
| Anal.Chem. 2 | Quantitative Analysis .....            | 5 | 1     | 1     | 10    |
| Phys. 9      | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Nat.Sci. 9*  | General Biology .....                  | 3 | ..... | 2     | 2     |

## THIRD YEAR

*First Quarter*

|                  |                                      |   |       |       |       |
|------------------|--------------------------------------|---|-------|-------|-------|
| Org.Chem. 61     | Elementary Organic Chemistry .....   | 4 | 2     | 3     | 4     |
| Phys.Chem. 101   | Physical Chemistry .....             | 3 | 1     | 3     | ..... |
| Phys.Chem. 104   | Physical Chemistry Laboratory .....  | 2 | 1     | ..... | 5     |
| German 24 or 27† | Chemical German .....                | 3 | 3     | ..... | ..... |
| Soc.Sci. 1*      | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Second Quarter*

|                  |                                      |   |       |       |       |
|------------------|--------------------------------------|---|-------|-------|-------|
| Org.Chem. 62     | Elementary Organic Chemistry .....   | 4 | 2     | 3     | 4     |
| Phys.Chem. 102   | Physical Chemistry .....             | 3 | 1     | 3     | ..... |
| Phys.Chem. 105   | Physical Chemistry Laboratory .....  | 2 | 1     | ..... | 5     |
| German 25 or 28† | Chemical German .....                | 3 | 3     | ..... | ..... |
| Soc.Sci. 2*      | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Third Quarter*

|                  |   |   |       |       |       |
|------------------|---|---|-------|-------|-------|
| Org.Chem. 63     | Elementary Organic Chemistry .....            | 3 | 1     | 3     | ..... |
| Org.Chem. 64     | Elementary Organic Chemistry Laboratory ..... | 3 | ..... | 1     | 6     |
| Phys.Chem. 103   | Physical Chemistry .....                      | 3 | 1     | 3     | ..... |
| Phys.Chem. 106   | Physical Chemistry Laboratory .....           | 2 | 1     | ..... | 5     |
| German 26 or 29† | Chemical German .....                         | 3 | 3     | ..... | ..... |
| Soc.Sci. 3*      | Introduction to Social Science .....          | 4 | ..... | 4     | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

† German 24-25-26 is for those who have had no high school or college German, German 27-28-29 is for those who have had two years of high school German or one year of college German.

*Second Quarter*

| Course No.      | Title   | Credits | Rec.  | Lect. | Lab.  |
|-----------------|---|---------|-------|-------|-------|
| Inorg.Chem. 104 | Advanced Inorganic Chemistry .....              | 3       | ..... | 3     | ..... |
| Anal.Chem. 132† | Electrometric Measurements and Titrations ..... | 3       | ..... | 2     | 5     |
| Phys.Chem.§     | Advanced Physical Chemistry .....               | 3       | ..... | ..... | ..... |
| German 42       | Chemical German .....                           | 2       | 2     | ..... | ..... |
|                 | Electives                                       |         |       |       |       |

*Third Quarter*

| Course No.      | Title                              | Credits | Rec.  | Lect. | Lab.  |
|-----------------|------------------------------------|---------|-------|-------|-------|
| Inorg.Chem. 105 | Advanced Inorganic Chemistry ..... | 3       | ..... | 3     | ..... |
| German 43       | Chemical German .....              | 2       | 2     | ..... | ..... |
|                 | Electives                          |         |       |       |       |

NOTE—Near the close of the fourth or junior year, each student will choose a major adviser from the list below. In consultation with the adviser he will plan a program of work for the entire senior year, based normally upon concentration of electives around a chosen field of chemistry.

## LIST OF ADVISERS FOR SENIORS

Inorganic Chemistry: Professors Sneed, Barber, Heisig, Pervier, Maynard.

Analytical Chemistry: Professors Kolthoff, Sandell.

Organic Chemistry: Professors Smith, Lauer, Koelsch, Arnold, Parham.

Physical Chemistry: Professors MacDougall, Reyerson, Livingston.

Chemical Engineering: Professors Mann, Ceaglske, Stoppel, Piret.

## SPECIALIZATION IN BACTERIOLOGY, BIOCHEMISTRY, AND GEOLOGY

For the benefit of students in chemistry who may desire to specialize in related fields, minor groups of electives have been arranged in bacteriology, biochemistry, and geology which may be taken in the last two years in addition to the required courses of the regular chemistry curriculum shown above. The completion of one of these groups will qualify the chemistry graduate to enter upon graduate work towards the Ph.D. degree in that department, thus providing an exceptionally strong foundation in chemistry for specialization in the chosen field.

## MINOR IN BACTERIOLOGY

## JUNIOR YEAR

Four credits of botany or zoology are prerequisite to Bacteriology 53. Botany 1, 4 credits, or Zoology 14-15, 6 credits, should be taken in the junior year to satisfy this requirement. By special arrangement it may be possible to take Bacteriology 53, 5 credits, in the winter or spring quarter of the junior year, if desired.

## SENIOR YEAR

*First Quarter*

| Course No. | Title                        | Credits | Rec.  | Lect. | Lab.  |
|------------|------------------------------|---------|-------|-------|-------|
| Bact. 53   | General Bacteriology .....   | 5       | ..... | 3     | 6     |
| Bact. 121  | Physiology of Bacteria ..... | 3       | ..... | 3     | ..... |

*Second Quarter*

|           |                              |   |       |   |       |
|-----------|------------------------------|---|-------|---|-------|
| Bact. 122 | Physiology of Bacteria ..... | 3 | ..... | 3 | ..... |
|-----------|------------------------------|---|-------|---|-------|

† For permissible substitute, see page 75.

§ Three credits per quarter in physical chemistry courses to which Phys.Chem. 103 is a prerequisite.

*Third Quarter*

| Course No. | Title                      | Credits | Rec.  | Lect. | Lab.  |
|------------|----------------------------|---------|-------|-------|-------|
| Bact. 123  | Applied Bacteriology ..... | 3       | ..... | 3     | ..... |

## MINOR IN BIOCHEMISTRY

## JUNIOR YEAR

*First Quarter*

|           |                       |   |       |   |   |
|-----------|-----------------------|---|-------|---|---|
| Zool. 14† | General Zoology ..... | 3 | ..... | 2 | 4 |
|-----------|-----------------------|---|-------|---|---|

*Second Quarter*

|           |                       |   |       |   |   |
|-----------|-----------------------|---|-------|---|---|
| Zool. 15† | General Zoology ..... | 3 | ..... | 2 | 4 |
|-----------|-----------------------|---|-------|---|---|

## SENIOR YEAR

*First Quarter*

|                 |                                      |   |       |       |       |
|-----------------|--------------------------------------|---|-------|-------|-------|
| Ag.Biochem. 113 | Biochemical Laboratory Methods ..... | 2 | ..... | ..... | 6     |
| Ag.Biochem. 119 | Colloids .....                       | 3 | ..... | 3     | ..... |
| Bact. 53        | General Bacteriology .....           | 5 | ..... | 3     | 6     |

*Second Quarter*

|                 |                                      |   |       |       |   |
|-----------------|--------------------------------------|---|-------|-------|---|
| Ag.Biochem. 114 | Biochemical Laboratory Methods ..... | 2 | ..... | ..... | 6 |
|-----------------|--------------------------------------|---|-------|-------|---|

*Third Quarter*

|                 |                                      |   |       |       |       |
|-----------------|--------------------------------------|---|-------|-------|-------|
| Ag.Biochem. 115 | Biochemical Laboratory Methods ..... | 2 | ..... | ..... | 6     |
| Ag.Biochem. 123 | Enzymes .....                        | 3 | ..... | 3     | ..... |

## MINOR IN GEOLOGY

## JUNIOR YEAR

*First Quarter*

|          |                              |   |   |   |   |
|----------|------------------------------|---|---|---|---|
| Geol. 23 | Elements of Mineralogy ..... | 4 | 1 | 2 | 4 |
|----------|------------------------------|---|---|---|---|

*Third Quarter*

|          |                              |   |   |   |   |
|----------|------------------------------|---|---|---|---|
| Geol. 24 | Elements of Mineralogy ..... | 4 | 1 | 2 | 4 |
|----------|------------------------------|---|---|---|---|

## SENIOR YEAR

*First Quarter*

|           |                                  |   |       |       |       |
|-----------|----------------------------------|---|-------|-------|-------|
| Geol. 1   | General Geology .....            | 3 | ..... | 3     | ..... |
| Geol. A   | General Geology Laboratory ..... | 2 | ..... | ..... | 4     |
| Geol. 121 | Crystallography .....            | 3 | ..... | 3     | 2     |

*Third Quarter*

|         |                                  |   |       |       |       |
|---------|----------------------------------|---|-------|-------|-------|
| Geol. 2 | General Geology .....            | 3 | ..... | 3     | ..... |
| Geol. B | General Geology Laboratory ..... | 2 | ..... | ..... | 4     |

## CHEMICAL ENGINEERING

Five-year course leading to the degree of bachelor of chemical engineering, B.Ch.E. A four-year course is also offered which is open only to veterans or those who entered prior to the fall quarter, 1946.

In addition to the prescribed courses, sufficient approved electives must be taken to complete a total of 270 credits (218 for four-year course).\*

Chemical engineering deals with the unit operations, such as crushing, grinding, sifting, mixing, fluid flow and heat flow, filtration, evaporation, drying, distillation, extrac-

\* Students who are planning to take graduate work are urged to take French or other approved foreign language as one of the electives in the senior year.

† Nine credits in Botany may be substituted for Zoology 14-15.



tion, absorption, crystallization, and the organic processes that are so vital in making any industry based on a chemical transformation of matter a commercial success. The chemist uses these operations in the laboratory, but in order to apply them to large-scale industrial processes he must have a thoro understanding of the fundamental physicochemical, chemical, and engineering principles on which they are based. The study of such principles constitutes that branch of engineering known as chemical engineering. For this purpose the chemical engineer must be thoroly trained in the various branches of chemistry, physics, and mathematics and have a good training in the fundamentals of mechanical, electrical, and chemical engineering so that he can design, construct, and successfully operate a plant using these unit operations.

The chemical engineer is primarily a producer. It is his province to develop a process from the laboratory stage through semi-works equipment to the production stage which uses engineering materials for the manufacture of unit process equipment in accordance with fundamental chemical engineering principles.

As many industries are based on some chemical process, the chemical engineer is much in demand. He may be engaged in the manufacture of inorganic products—the mineral acids, alkalis, ammonia, paint pigments, fertilizers; in the organic industries—dyes, explosives, textiles, fibers, rubber, soap, lacquers, solvents, plastics, medicinals; in the manufacture of gases—coal gas, carbureted blue gas, hydrogen, acetylene, helium; in the electrochemical industries such as the manufacture of graphite, calcium carbide, carborundum and other abrasives, wet and dry batteries, electroplating; in the metallurgical industries; and even in the food industries such as the manufacture of sugar, flour, salt, starch, and refrigeration, dehydration, and canning. There are many others such as leather, paper, petroleum, glass, and cement.

In these industries the chemical engineer does investigational work, development work, design of equipment, and plant operation. Some enter the field of sales engineering and technical writing.

Students taking the five-year combined course in chemical engineering and business administration may substitute business courses for M.&M. 86.

For freshman year, see page 29.

FIVE-YEAR COURSE

SECOND YEAR

*First Quarter*

| Course No.   | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|--------------|---|---------|-------|-------|-------|
| M.&M. 24     | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7      | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Anal.Chem. 1 | Quantitative Analysis .....               | 5       | 1     | 1     | 10    |
| Nat.Sci. 7*  | General Biology .....                     | 3       | ..... | 2     | 2     |

*Second Quarter*

|              |                                    |   |       |       |       |
|--------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25     | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8      | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Anal.Chem. 2 | Quantitative Analysis .....        | 5 | 1     | 1     | 10    |
| Nat.Sci. 8*  | General Biology .....              | 3 | ..... | 2     | 2     |

*Third Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| M.&M. 84    | Technical Mechanics .....              | 5 | 5     | ..... | ..... |
| Phys. 9     | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Chem.E. 80  | Chemical Engineering Materials .....   | 1 | ..... | 2     | ..... |
| Chem.E. 105 | Fuels and Combustion .....             | 4 | 2     | 2     | 4     |
| Nat.Sci. 9* | General Biology .....                  | 3 | ..... | 2     | 2     |

\* See page 73 for alternate sequences which may be substituted as a unit.

## INSTITUTE OF TECHNOLOGY

## THIRD YEAR

*First Quarter*

| Course No.     | Title                                | Credits | Rec.  | Lect. | Lab.  |
|----------------|--------------------------------------|---------|-------|-------|-------|
| Chem.E. 101    | Unit Operations .....                | 3       | 2     | 2     | ..... |
| M.&M. 151      | Differential Equations .....         | 3       | 3     | ..... | ..... |
| Org.Chem. 61   | Elementary Organic Chemistry .....   | 4       | 2     | 3     | 4     |
| Phys.Chem. 101 | Physical Chemistry .....             | 3       | 1     | 3     | ..... |
| Soc.Sci. 1*    | Introduction to Social Science ..... | 4       | ..... | 4     | ..... |

*Second Quarter*

|                |                                      |   |       |       |       |
|----------------|--------------------------------------|---|-------|-------|-------|
| Chem.E. 102    | Unit Operations .....                | 5 | 3     | 3     | ..... |
| Org.Chem. 62   | Elementary Organic Chemistry .....   | 4 | 2     | 3     | 4     |
| M.E. 38        | Heat Engine .....                    | 3 | 3     | ..... | ..... |
| M.E. 39        | Heat Engine Laboratory .....         | 1 | ..... | ..... | 3     |
| Phys.Chem. 102 | Physical Chemistry .....             | 3 | 1     | 3     | ..... |
| Soc.Sci. 2*    | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Third Quarter*

|                |   |   |       |   |       |
|----------------|---|---|-------|---|-------|
| Chem.E. 103    | Unit Operations .....                         | 5 | 3     | 3 | ..... |
| Org.Chem. 63   | Elementary Organic Chemistry .....            | 3 | 1     | 3 | ..... |
| Org.Chem. 64   | Elementary Organic Chemistry Laboratory ..... | 3 | ..... | 1 | 6     |
| Phys.Chem. 103 | Physical Chemistry .....                      | 3 | 1     | 3 | ..... |
| Soc.Sci. 3*    | Introduction to Social Science .....          | 4 | ..... | 4 | ..... |

## FOURTH YEAR

*First Quarter*

|                |                                       |   |       |       |       |
|----------------|---------------------------------------|---|-------|-------|-------|
| Chem.E. 111    | Unit Operations Laboratory .....      | 1 | ..... | ..... | 4     |
| E.E. 43        | Electrical Engineering Survey .....   | 3 | ..... | 2     | 2     |
| Mct. 160       | Metallography .....                   | 3 | ..... | 2     | 3     |
| Phys.Chem. 104 | Physical Chemistry Laboratory .....   | 2 | 1     | ..... | 5     |
| Hum. 1*        | Humanities in the Modern World .....  | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 11*       | The Greek Heritage .....              | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 21*       | Humanities in the United States ..... | 3 | ..... | 3     | ..... |
|                | Elective                              |   |       |       |       |

*Second Quarter*

|                |   |   |       |       |       |
|----------------|---|---|-------|-------|-------|
| Chem.E. 112    | Unit Operations Laboratory .....                  | 1 | ..... | ..... | 4     |
| E.E. 44        | Electrical Engineering Survey .....               | 3 | ..... | 2     | 2     |
| Chem.E. 131    | Inorganic Technology .....                        | 4 | 1     | 4     | ..... |
| Phys.Chem. 105 | Physical Chemistry Laboratory .....               | 2 | 1     | ..... | 5     |
| Hum. 2*        | Humanities in the Modern World .....              | 5 | ..... | 5     | ..... |
| or             |   |   |       |       |       |
| Hum. 12*       | The Roman and the Medieval Heritage .....         | 5 | ..... | 5     | ..... |
| or             |   |   |       |       |       |
| Hum. 22*       | Humanities in the United States .....             | 3 | ..... | 3     | ..... |
| Chem.E. 187    | Chemical Engineering Trip (spring vacation) ..... | 2 | ..... | ..... | ..... |
|                | Elective  |   |       |       |       |

*Third Quarter*

|                |                                       |   |       |       |       |
|----------------|---------------------------------------|---|-------|-------|-------|
| Chem.E. 113    | Unit Operations Laboratory .....      | 1 | ..... | ..... | 4     |
| Chem.E. 132    | Organic Technology .....              | 4 | 1     | 4     | ..... |
| E.E. 45        | Electrical Engineering Survey .....   | 3 | ..... | 2     | 2     |
| Phys.Chem. 106 | Physical Chemistry Laboratory .....   | 2 | 1     | ..... | 5     |
| Hum. 3*        | Humanities in the Modern World .....  | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 13*       | The Renaissance Heritage .....        | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 23*       | Humanities in the United States ..... | 3 | ..... | 3     | ..... |
|                | Electives                             |   |       |       |       |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

FIFTH YEAR

*First Quarter*

| Course No.  | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|-------------|--|---------|-------|-------|-------|
| M.&M. 85    | Strength of Materials .....            | 3       | 3     | ..... | ..... |
| M.&M. 87    | Materials Laboratory .....             | 1       | ..... | ..... | 2     |
| M.&M. 143   | Hydraulic Laboratory .....             | 1       | ..... | ..... | 2     |
| Chem.E. 121 | Chemical Engineering Economics .....   | 3       | ..... | 3     | ..... |
| Chem.E. 201 | Seminar .....                          | 1       | 1     | ..... | ..... |
| Engl. 85    | Advanced Technical Communication ..... | 3       | 3     | ..... | ..... |
| German 24   | Chemical German .....                  | 3       | 3     | ..... | ..... |
|             | Elective                               |         |       |       |       |

*Second Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| Chem.E. 117 | Chemical Engineering Equipment Design ..... | 3 | 2     | 1     | 4     |
| Chem.E. 119 | Chemical Engineering Thermodynamics .....   | 3 | 3     | ..... | ..... |
| Chem.E. 202 | Seminar .....                               | 1 | 1     | ..... | ..... |
| Engl. 86    | Advanced Technical Communication .....      | 3 | 3     | ..... | ..... |
| German 25   | Chemical German .....                       | 3 | 3     | ..... | ..... |
| G.E. 103    | Professional Problems .....                 | 1 | ..... | 1     | ..... |
|             | Elective                                    |   |       |       |       |

*Third Quarter*

|             |   |   |   |       |       |
|-------------|---|---|---|-------|-------|
| Chem.E. 118 | Chemical Engineering Equipment Design ..... | 3 | 2 | 1     | 4     |
| Chem.E. 120 | Chemical Engineering Thermodynamics .....   | 3 | 3 | ..... | ..... |
| Chem.E. 203 | Seminar .....                               | 1 | 1 | ..... | ..... |
| German 26   | Chemical German .....                       | 3 | 3 | ..... | ..... |
|             | Elective                                    |   |   |       |       |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

SOPHOMORE YEAR

*First Quarter*

| Course No.     | Title                                | Credits | Rec. | Lect. | Lab.  |
|----------------|--------------------------------------|---------|------|-------|-------|
| M.&M. 24       | Calculus I: Differential .....       | 5       | 5    | ..... | ..... |
| Inorg.Chem. 13 | Semimicro Qualitative Analysis ..... | 5       | 1    | 2     | 8     |
| Phys. 7        | General Physics .....                | 5       | 1    | 4     | 2     |
| German 24*     | Chemical German .....                | 3       | 3    | ..... | ..... |

*Second Quarter*

|              |                             |   |   |       |       |
|--------------|-----------------------------|---|---|-------|-------|
| M.&M. 25     | Calculus II: Integral ..... | 5 | 5 | ..... | ..... |
| Anal.Chem. 1 | Quantitative Analysis ..... | 5 | 1 | 1     | 10    |
| Phys. 8      | General Physics .....       | 5 | 1 | 4     | 2     |
| German 25*   | Chemical German .....       | 3 | 3 | ..... | ..... |

*Third Quarter*

|              |                                      |   |       |       |       |
|--------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 84     | Technical Mechanics .....            | 5 | 5     | ..... | ..... |
| Anal.Chem. 2 | Quantitative Analysis .....          | 5 | 1     | 1     | 10    |
| Phys. 9      | General Physics .....                | 5 | 1     | 4     | 2     |
| German 26*   | Chemical German .....                | 3 | 3     | ..... | ..... |
| Chem.E. 80   | Chemical Engineering Materials ..... | 1 | ..... | 2     | ..... |

\* Students who have had two years of high school German or one year of college German take course 27-28-29.

## INSTITUTE OF TECHNOLOGY

## JUNIOR YEAR

*First Quarter*

| Course No.     | Title                              | Credits | Rec.  | Lect. | Lab.  |
|----------------|------------------------------------|---------|-------|-------|-------|
| Chem.E. 101    | Unit Operations .....              | 3       | 2     | 2     | ..... |
| Chem.E. 105    | Fuels and Combustion .....         | 4       | 2     | 2     | 4     |
| Org.Chem. 61   | Elementary Organic Chemistry ..... | 4       | 2     | 3     | 4     |
| M.&M. 86†      | Hydraulics .....                   | 3       | 3     | ..... | ..... |
| M.&M. 143      | Hydraulics Laboratory .....        | 1       | ..... | ..... | 2     |
| Phys.Chem. 101 | Physical Chemistry .....           | 3       | 1     | 3     | ..... |

*Second Quarter*

|                |                                    |   |       |       |       |
|----------------|------------------------------------|---|-------|-------|-------|
| Chem.E. 102    | Unit Operations .....              | 5 | 3     | 2     | ..... |
| Org.Chem. 62   | Elementary Organic Chemistry ..... | 4 | 2     | 3     | 4     |
| Phys.Chem. 102 | Physical Chemistry .....           | 3 | 1     | 3     | ..... |
| M.E. 38        | Heat Engines .....                 | 3 | 1     | 2     | ..... |
| M.E. 39        | Heat Engines Laboratory .....      | 1 | ..... | ..... | 3     |

*Third Quarter*

|                |   |   |       |   |       |
|----------------|---|---|-------|---|-------|
| Chem.E. 103    | Unit Operations .....                         | 5 | 3     | 2 | ..... |
| Org.Chem. 63   | Elementary Organic Chemistry .....            | 3 | 1     | 3 | ..... |
| Org.Chem. 64   | Elementary Organic Chemistry Laboratory ..... | 2 | ..... | 1 | 6     |
| Phys.Chem. 103 | Physical Chemistry .....                      | 3 | 1     | 3 | ..... |
| Chem.E. 131    | Inorganic Technology .....                    | 4 | 1     | 4 | ..... |

*Summer Session*

Summer practice consisting of Chem.E. 151-152, **Chemical Manufacture**, 6 cred. will be taken by students in Chemical Engineering in the regular Summer Session between their junior and senior years. It is required for the degree of bachelor of chemical engineering.

## SENIOR YEAR

*First Quarter*

|                |                                      |   |       |       |       |
|----------------|--------------------------------------|---|-------|-------|-------|
| Phys.Chem. 104 | Physical Chemistry Laboratory .....  | 2 | 1     | ..... | 5     |
| E.E. 43        | Electrical Engineering Survey .....  | 3 | ..... | 2     | 2     |
| Chem.E. 121    | Chemical Engineering Economics ..... | 3 | ..... | 3     | ..... |
| Chem.E. 132    | Organic Technology .....             | 3 | 1     | 4     | ..... |
| M.&M. 85†      | Strength of Materials .....          | 3 | 3     | ..... | ..... |
| M.&M. 87†      | Materials Laboratory .....           | 1 | ..... | ..... | 2     |
| Met. 160§      | Metallography .....                  | 3 | ..... | 2     | 3     |
|                | Electives                            |   |       |       |       |

*Second Quarter*

|                |   |   |       |       |   |
|----------------|---|---|-------|-------|---|
| Phys.Chem. 105 | Physical Chemistry Laboratory .....         | 2 | 1     | ..... | 5 |
| E.E. 44        | Electrical Engineering Survey .....         | 3 | ..... | 2     | 2 |
| Chem.E. 117    | Chemical Engineering Equipment Design ..... | 3 | 2     | 1     | 4 |
| Met. 160§      | Metallography .....                         | 3 | ..... | 2     | 3 |
|                | Electives                                   |   |       |       |   |

*Third Quarter*

|                |   |   |       |       |       |
|----------------|---|---|-------|-------|-------|
| Phys.Chem. 106 | Physical Chemistry Laboratory .....               | 2 | 1     | ..... | 5     |
| E.E. 45        | Electrical Engineering Survey .....               | 3 | ..... | 2     | 2     |
| Chem.E. 118    | Chemical Engineering Equipment Design .....       | 3 | 2     | 1     | 4     |
| Chem.E. 187    | Chemical Engineering Trip (spring vacation) ..... | 2 | ..... | ..... | ..... |
|                | Electives   |   |       |       |       |

## CIVIL ENGINEERING

Two five-year courses are offered: Civil Engineering and Sanitary Engineering Option.

Veterans and others registered prior to fall quarter, 1946 may take the four-year course.

† For permissible substitute, see page 75.

§ Met. 160 may be taken first or second quarter.

In addition to the prescribed courses, sufficient electives must be taken to complete a total of at least 255 credits for graduation. This is an average of about 17 credits per quarter.

The principal aim of the curriculum in civil engineering is to present to the student an opportunity to become familiar with the methods of science, so that in his attack upon any professional problem he may employ his abilities with economy and secure dependable conclusions. A secondary but important object of the course is to train the student in technique, so that at graduation he may be an economic asset to his employer.

The technique of surveying and platting, drawing, and certain laboratory procedures is taught throughout the course. Typical problems of railroad, highway, hydraulic, structural, and sanitary engineering occupy the greater part of the last three years. In the fifth year, there is a course of lectures and conferences on the relations of engineering projects to business and to public affairs. Elective courses are available in each of the two upper years; these offer a wide range of choice to the student who desires to extend his range of interests to those fields of knowledge and action related to civil engineering, but not strictly included therein.

For freshman year, see page 16.

FIVE-YEAR COURSE

SECOND YEAR

*First Quarter*

| Course No.  | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| C.E. 11     | Surveying .....                           | 3       | 1     | ..... | 7     |
| Draw. 21    | Drafting .....                            | 2       | ..... | ..... | 6     |
| Nat.Sci. 7* | General Biology .....                     | 3       | ..... | 2     | 2     |

*Second Quarter*

|             |                                    |   |       |       |       |
|-------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25    | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| C.E. 12     | Surveying .....                    | 3 | 1     | ..... | 7     |
| Draw. 22    | Structural Detailing .....         | 2 | ..... | ..... | 6     |
| Nat.Sci. 8* | General Biology .....              | 3 | ..... | 2     | 2     |

*Third Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| M.&M. 26    | Technical Mechanics: Statics .....     | 5 | 5     | ..... | ..... |
| Phys. 9     | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| C.E. 13     | Surveying .....                        | 3 | 1     | ..... | 7     |
| Draw. 23    | Structural Detailing .....             | 2 | ..... | ..... | 6     |
| Nat.Sci. 9* | General Biology .....                  | 3 | ..... | 2     | 2     |

THIRD YEAR

*First Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 128   | Strength of Materials .....          | 5 | 5     | ..... | ..... |
| M.&M. 141   | Materials Laboratory .....           | 1 | ..... | ..... | 2     |
| C.E. 14     | Surveying .....                      | 3 | ..... | 1     | 7     |
| C.E. 31     | Stresses in Structures .....         | 3 | ..... | 3     | 3     |
| Soc.Sci. 1* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Second Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 129   | Hydraulics .....                     | 4 | 4     | ..... | ..... |
| M.&M. 143   | Hydraulic Laboratory .....           | 1 | ..... | ..... | 2     |
| C.E. 15     | Surveying .....                      | 2 | ..... | 1     | 3     |
| C.E. 21     | Route Surveying .....                | 2 | ..... | 1     | 4     |
| C.E. 32     | Design in Steel .....                | 3 | ..... | 3     | 3     |
| Soc.Sci. 2* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

|             |                                      | <i>Third Quarter</i> |       |       |       |
|-------------|--------------------------------------|----------------------|-------|-------|-------|
| Course No.  | Title                                | Credits              | Rec.  | Lect. | Lab.  |
| M.&M. 127   | Technical Mechanics: Dynamics .....  | 5                    | 5     | ..... | ..... |
| C.E. 16     | Surveying .....                      | 2                    | ..... | 1     | 4     |
| C.E. 22     | Railway Engineering .....            | 2                    | ..... | 1     | 4     |
| C.E. 33     | Design in Timber .....               | 3                    | ..... | 3     | 3     |
| C.E. 160    | Applied Hydraulics .....             | 3                    | 3     | ..... | ..... |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4                    | ..... | 4     | ..... |

*Summer Camp*

|   |   |   |  |  |  |
|---|---|---|--|--|--|
| C.E. 23                                   | Summer camp is held in the vacation preceding the fourth year for 6 weeks beginning the last of August. Required of all students taking the course in Civil Engineering ..... | 9 |  |  |  |
| Fee, \$25.80 and Health Service fee, \$1. |   |   |  |  |  |

## FOURTH YEAR

*First Quarter*

|          |   |   |       |   |       |
|----------|---|---|-------|---|-------|
| C.E. 51  | Highways and Pavements .....              | 3 | ..... | 2 | 3     |
| C.E. 130 | Statically Indeterminate Structures ..... | 3 | ..... | 2 | 2     |
| C.E. 161 | Hydrology .....                           | 3 | ..... | 2 | 4     |
| Geol. 5  | Engineering Geology .....                 | 3 | ..... | 3 | ..... |
| Hum. 1*  | Humanities in the Modern World I .....    | 5 | ..... | 5 | ..... |
| or       |   |   |       |   |       |
| Hum. 11* | The Greek Heritage .....                  | 5 | ..... | 5 | ..... |
| or       |   |   |       |   |       |
| Hum. 21* | Humanities in the United States .....     | 3 | ..... | 3 | ..... |
|          | Electives .....                           | 3 |       |   |       |

*Second Quarter*

|          |   |   |       |   |       |
|----------|---|---|-------|---|-------|
| C.E. 52  | Highways and Pavements .....              | 3 | ..... | 2 | 4     |
| C.E. 131 | Structural Analysis .....                 | 2 | ..... | 1 | 3     |
| C.E. 162 | Water Supply .....                        | 3 | ..... | 2 | 4     |
| Geol. 6  | Engineering Geology .....                 | 3 | ..... | 3 | ..... |
| Hum. 2*  | Humanities in the Modern World II .....   | 5 | ..... | 5 | ..... |
| or       |   |   |       |   |       |
| Hum. 12* | The Roman and the Medieval Heritage ..... | 5 | ..... | 5 | ..... |
| or       |   |   |       |   |       |
| Hum. 22* | Humanities in the United States .....     | 3 | ..... | 3 | ..... |
|          | Electives .....                           | 3 |       |   |       |

*Third Quarter*

|          |  |   |       |   |       |
|----------|--|---|-------|---|-------|
| C.E. 53  | Elements of Soil Mechanics .....         | 3 | ..... | 2 | ..... |
| C.E. 132 | Structural Design .....                  | 2 | ..... | 1 | 3     |
| C.E. 163 | Sewerage and Sewage Treatment .....      | 3 | ..... | 2 | 4     |
| M.E. 42  | Power .....                              | 4 | 2     | 2 | ..... |
| Hum. 3*  | Humanities in the Modern World III ..... | 5 | ..... | 5 | ..... |
| or       |  |   |       |   |       |
| Hum. 13* | The Renaissance Heritage .....           | 5 | ..... | 5 | ..... |
| or       |  |   |       |   |       |
| Hum. 23* | Humanities in the United States .....    | 3 | ..... | 3 | ..... |
|          | Electives .....                          | 2 |       |   |       |

## FIFTH YEAR

*First Quarter*

|          |  |   |       |       |       |
|----------|--|---|-------|-------|-------|
| C.E. 121 | Railway Engineering .....              | 3 | ..... | 1     | 6     |
| C.E. 141 | Reinforced Concrete .....              | 3 | ..... | 2     | 2     |
| C.E. 146 | Concrete and Concrete Materials .....  | 3 | ..... | 2     | 4     |
| Engl. 85 | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
|          | Electives .....                        | 6 |       |       |       |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

*Second Quarter*

| Course No. | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|------------|--|---------|-------|-------|-------|
| C.E. 142   | Reinforced Concrete Design .....       | 3       | ..... | 2     | 2     |
| C.E. 147   | Foundations .....                      | 2       | ..... | 2     | ..... |
| Engl. 86   | Advanced Technical Communication ..... | 3       | 3     | ..... | ..... |
| G.E. 101   | Contracts and Specifications .....     | 3       | ..... | 3     | ..... |
|            | Electives .....                        | 6       |       |       |       |

*Third Quarter*

|          |                                     |   |       |       |       |
|----------|-------------------------------------|---|-------|-------|-------|
| C.E. 137 | Structural Laboratory .....         | 2 | ..... | 1     | 3     |
| C.E. 166 | Water Power .....                   | 3 | ..... | 2     | 3     |
| E.E. 42  | Electrical Engineering Survey ..... | 3 | 3     | ..... | ..... |
| G.E. 103 | Professional Problems .....         | 1 | ..... | 1     | ..... |
|          | Electives .....                     | 9 |       |       |       |

SANITARY ENGINEERING OPTION (FIVE-YEAR CURRICULUM)

The option in Sanitary Engineering is designed to allow a student to complete four years of the regular Civil Engineering course before selecting the Sanitary option, at the beginning of his fifth year. However, for those students making this selection before or during the fourth year, upon approval, starred courses from the recommended elective list may be substituted for any or all of the following courses:

| Course No. |   | Credits |
|------------|---|---------|
| C.E. 15    | Surveying .....                           | 2       |
| C.E. 16    | Surveying .....                           | 2       |
| C.E. 21    | Route Surveying .....                     | 2       |
| C.E. 22    | Railway Engineering .....                 | 2       |
| C.E. 52    | Highways and Pavements .....              | 3       |
| C.E. 121   | Railway Engineering .....                 | 3       |
| C.E. 130   | Statically Indeterminate Structures ..... | 3       |
| C.E. 131   | Structural Analysis .....                 | 2       |
| C.E. 132   | Structural Design .....                   | 2       |

SANITARY ENGINEERING OPTION

FIFTH YEAR

*First Quarter*

|          |   |   |
|----------|---|---|
| P.H. 52  | Elements of Preventive Medicine and Public Health ..... | 5 |
| C.E. 141 | Reinforced Concrete .....                               | 3 |
| C.E. 173 | Sanitary Engineering Problems (Water) .....             | 3 |
| C.E. 179 | Sanitary Laboratory .....                               | 3 |
|          | Electives (from list of recommended electives)          |   |

*Second Quarter*

|          |  |     |
|----------|--|-----|
| P.H. 102 | Environmental Sanitation .....                                     | 3   |
| G.E. 101 | Contracts and Specifications .....                                 | 3   |
| C.E. 174 | Sanitary Engineering Problems (Sewage and Industrial Wastes) ..... | 3   |
| Engl. 85 | Advanced Technical Communication .....                             | 3   |
|          | Electives (from list of recommended electives) .....               | 6-7 |

*Third Quarter*

|          |  |     |
|----------|--|-----|
| C.E. 165 | Public Health Engineering .....                      | 3   |
| C.E. 146 | Concrete and Concrete Materials .....                | 3   |
| Engl. 86 | Advanced Technical Communication .....               | 3   |
| E.E. 42  | Electrical Engineering Survey .....                  | 3   |
| G.E. 103 | Professional Problems .....                          | 1   |
|          | Electives (from list of recommended electives) ..... | 6-7 |

## LIST OF RECOMMENDED ELECTIVES FOR SANITARY ENGINEERING

| Course No.    |  | Credits |
|---------------|--|---------|
| Org.Chem. 1*  | Elementary Organic Chemistry .....                     | 4       |
| Org.Chem. 2*  | Elementary Organic Chemistry .....                     | 4       |
| Anal.Chem. 2* | Quantitative Analysis .....                            | 3       |
| Bact. 53*     | General Bacteriology .....                             | 5       |
| C.E. 135      | Structural Problems in Sanitary Engineering .....      | 2       |
| C.E. 142      | Reinforced Concrete .....                              | 3       |
| C.E. 147*     | Foundations .....                                      | 2       |
| C.E. 164      | Water Conservation .....                               | 3       |
| C.E. 166*     | Water Power .....                                      | 3       |
| C.E. 168      | Irrigation and Drainage .....                          | 3       |
| C.E. 172      | City Planning .....                                    | 3       |
| C.E. 176      | Public Works Engineering .....                         | 3       |
| C.E. 183*     | Open Channel Flow .....                                | 3       |
| C.E. 190*     | Mechanics of Similitude and Dimensional Analysis ..... | 3       |
| C.E. 191*     | Hydraulic Motors and Pumps .....                       | 3       |
| C.E. 192*     | Natural and Artificial Waterways .....                 | 3       |
| C.E. 193*     | Hydraulic Measurements .....                           | 3       |
| P.H. 104      | Epidemiology .....                                     | 3       |
| P.H. 106      | Public Health Administration .....                     | 3       |
| P.H. 117      | Sanitary Biology .....                                 | 3       |

## FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

## SOPHOMORE YEAR

*First Quarter*

| Course No. | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| M.&M. 24   | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7    | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Draw. 21   | Drafting .....                            | 2       | ..... | ..... | 6     |
| C.E. 11    | Surveying .....                           | 3       | 1     | ..... | 7     |
| Geol. 5    | Engineering Geology .....                 | 3       | ..... | 3     | ..... |

*Second Quarter*

|          |                             |   |       |       |       |
|----------|-----------------------------|---|-------|-------|-------|
| M.&M. 25 | Calculus II: Integral ..... | 5 | 5     | ..... | ..... |
| Phys. 8  | General Physics .....       | 5 | 1     | 4     | 2     |
| Draw. 22 | Structural Detailing .....  | 2 | ..... | ..... | 6     |
| C.E. 12  | Surveying .....             | 3 | 1     | ..... | 7     |
| Geol. 6  | Engineering Geology .....   | 3 | ..... | 3     | ..... |

*Third Quarter*

|          |                                    |   |       |       |       |
|----------|------------------------------------|---|-------|-------|-------|
| M.&M. 26 | Technical Mechanics: Statics ..... | 5 | 5     | ..... | ..... |
| Phys. 9  | General Physics .....              | 5 | 1     | 4     | 2     |
| Draw. 23 | Structural Detailing .....         | 2 | ..... | ..... | 6     |
| C.E. 13  | Surveying .....                    | 3 | 1     | ..... | 7     |
|          | Electives                          |   |       |       |       |

## JUNIOR YEAR

*First Quarter*

|           |                              |   |       |       |       |
|-----------|------------------------------|---|-------|-------|-------|
| M.&M. 128 | Strength of Materials .....  | 5 | 5     | ..... | ..... |
| M.&M. 141 | Materials Laboratory .....   | 2 | ..... | 1     | 2     |
| C.E. 14   | Surveying .....              | 3 | ..... | ..... | 7     |
| C.E. 31   | Stresses in Structures ..... | 3 | ..... | 3     | 3     |
| C.E. 51   | Highways and Pavements ..... | 3 | ..... | 2     | 3     |
|           | Electives                    |   |       |       |       |

\* See statement on page 41 under Sanitary Engineering Option.



*Second Quarter*

| Course No. | Title                        | Credits | Rec.  | Lect. | Lab.  |
|------------|------------------------------|---------|-------|-------|-------|
| M.&M. 129  | Hydraulics .....             | 4       | 4     | ..... | ..... |
| M.&M. 143  | Hydraulics Laboratory .....  | 1       | ..... | ..... | 2     |
| C.E. 15    | Surveying .....              | 2       | ..... | 1     | 3     |
| C.E. 21    | Route Surveying .....        | 2       | ..... | 1     | 4     |
| C.E. 32    | Design in Steel .....        | 3       | ..... | 3     | 3     |
| C.E. 52    | Highways and Pavements ..... | 3       | 1     | 1     | 4     |
|            | Electives                    |         |       |       |       |

*Third Quarter*

|           |                                     |   |       |       |       |
|-----------|-------------------------------------|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics ..... | 5 | 5     | ..... | ..... |
| C.E. 16   | Surveying .....                     | 2 | ..... | 1     | 4     |
| C.E. 22   | Railway Engineering .....           | 2 | 1     | ..... | 4     |
| C.E. 33   | Design in Timber .....              | 3 | ..... | 3     | 3     |
| C.E. 53   | Elements of Soil Mechanics .....    | 3 | ..... | 2     | 3     |
|           | Electives                           |   |       |       |       |

*Summer Camp*

|         |  |   |  |  |  |
|---------|--|---|--|--|--|
| C.E. 23 | Summer camp is held in the vacation preceding the senior year for 6 weeks beginning the last of August. Required of all students taking the courses in Civil Engineering ..... | 9 |  |  |  |
|         | Fee, \$25.80 and Health Service fee, \$1.  |   |  |  |  |

SENIOR YEAR

*First Quarter*

|          |   |   |       |   |       |
|----------|---|---|-------|---|-------|
| C.E. 121 | Railway Engineering .....                 | 3 | ..... | 1 | 6     |
| C.E. 130 | Statically Indeterminate Structures ..... | 3 | ..... | 2 | 2     |
| C.E. 141 | Reinforced Concrete .....                 | 3 | ..... | 2 | 2     |
| C.E. 161 | Hydrology .....                           | 3 | ..... | 2 | 4     |
| C.E. 146 | Concrete and Concrete Materials .....     | 3 | ..... | 2 | 4     |
| or       |   |   |       |   |       |
| G.E. 101 | Contracts and Specifications .....        | 3 | ..... | 3 | ..... |
|          | Electives                                 |   |       |   |       |

*Second Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| C.E. 131  | Structural Analysis .....                  | 2 | ..... | 1     | 3     |
| C.E. 142  | Reinforced Concrete Design .....           | 3 | ..... | 2     | 2     |
| C.E. 162  | Water Supply .....                         | 3 | ..... | 2     | 4     |
| C.E. 109  | Cadastral Surveying .....                  | 2 | ..... | 2     | ..... |
| or        |  |   |       |       |       |
| C.E. 124  | Transportation .....                       | 3 | 3     | ..... | ..... |
| or        |  |   |       |       |       |
| C.E. 147  | Foundations .....                          | 2 | ..... | 2     | ..... |
| or        |  |   |       |       |       |
| C.E. 156  | Traffic Engineering .....                  | 2 | ..... | 2     | ..... |
| or        |  |   |       |       |       |
| C.E. 173  | Sanitary Engineering Problems (Water)..... | 3 | 3     | ..... | ..... |
| C.E. 137† | Structural Laboratory .....                | 2 | ..... | 1     | 3     |
| or        |  |   |       |       |       |
| G.E. 101  | Contracts and Specifications .....         | 3 | ..... | 3     | ..... |
| M.E. 42   | Power .....                                | 4 | 2     | 2     | ..... |
|           | Electives                                  |   |       |       |       |

*Third Quarter*

|           |                                       |   |       |       |       |
|-----------|---------------------------------------|---|-------|-------|-------|
| C.E. 132  | Structural Design .....               | 2 | ..... | 1     | 3     |
| C.E. 163  | Sewerage and Sewage Treatment .....   | 3 | ..... | 2     | 4     |
| C.E. 146  | Concrete and Concrete Materials ..... | 3 | ..... | 2     | 4     |
| or        |                                       |   |       |       |       |
| C.E. 137† | Structural Laboratory .....           | 2 | ..... | 1     | 3     |
| E.E. 42   | Electrical Engineering Survey .....   | 3 | 3     | ..... | ..... |
| G.E. 103  | Professional Problems .....           | 1 | ..... | 1     | ..... |
|           | Electives                             |   |       |       |       |

† C.E. 137 limited to 20 students.

## ELECTRICAL ENGINEERING

## FIVE-YEAR COURSE

Starting with the fall quarter of 1946 a five-year curriculum is offered which leads normally to the degree of bachelor of electrical engineering, B.E.E. This course is designed to fit the student for a position of responsibility in the electrical field by providing studies of two kinds. (1) Fundamental technical studies in mathematics, physics, and engineering, and (2) broad liberalizing studies to provide a background for an understanding of the world in which we live and its social relationships. In addition to the courses prescribed in the five-year curriculum, sufficient electives must be taken to complete a total of 255 credits for graduation.

Students who maintain an honor point average of 1.80 or better throughout the first four years of the course may elect, upon petitioning therefor, to receive a bachelor of science degree (without departmental designation) at the end of the fourth year. This will permit honor students who so desire to register in the Graduate School in the fifth year and pursue work toward a Master's degree with a major in electrical engineering. Alternatively they may pursue the regular work of the electrical engineering curriculum leading to the degree of B.E.E. at the end of the fifth year.

Several optional courses are offered in the fifth year in the specialized fields of communications, electronics, power, physics,† mathematics,‡ or chemistry.†

## FOUR-YEAR CURRICULUM (FOR VETERANS ONLY)

In consideration of greater maturity, experience, and national service a four-year curriculum leading to the degree of bachelor of electrical engineering is offered to veterans only.

## FIVE-YEAR COURSE COMBINED WITH BUSINESS ADMINISTRATION

This curriculum may be elected by students who have completed their freshman year with a high honor point average. Entrance to this course is by petition and individual action.

Students taking the five-year combined course may substitute business courses for Nat. Sci. 7-8-9 General Biology, Soc. Sci. 1-2-3 Introduction to Social Science, the three quarters in Humanities, Engl. 85-86 Advanced Technical Communication, M.E. 8 Machine Shop, M.E. 26 Mechanism and Kinematics, M.&M. 151 Differential Equations and E.E. 127-128-129 Transient Analysis.

For freshman year see page 16.

## FIVE-YEAR COURSE

## SECOND YEAR

*First Quarter*

| Course No.  | Title   | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....                      | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat .....           | 5       | 1     | 4     | 2     |
| E.E. 11     | Elements of Electrical Engineering .....            | 3       | 2     | 1     | ..... |
| E.E. 12     | Elements of Electrical Engineering Laboratory ..... | 1       | ..... | ..... | 2     |
| Nat.Sci. 7* | General Biology .....                               | 3       | ..... | 2     | 2     |

*Second Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 25    | Calculus II: Integral .....                         | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity .....                  | 5 | 1     | 4     | 2     |
| E.E. 13     | Elements of Electrical Engineering .....            | 3 | 2     | 1     | ..... |
| E.E. 14     | Elements of Electrical Engineering Laboratory ..... | 1 | ..... | ..... | 2     |
| Nat.Sci. 8* | General Biology .....                               | 3 | ..... | 2     | 2     |

\* See page 73 for alternate sequences which may be substituted as a unit.

† Eighteen credits of approved electives required. Consult your adviser.

*Third Quarter*

| Course No.  | Title  | Credits | Rec.  | Lect. | Lab.  |
|-------------|--|---------|-------|-------|-------|
| M.&M. 26    | Technical Mechanics: Statics .....                 | 5       | 5     | ..... | ..... |
| Phys. 9     | General Physics: Sound and Light .....             | 5       | 1     | 4     | 2     |
| E.E. 15     | Elements of Electrical Engineering .....           | 3       | 2     | 1     | ..... |
| E.E. 16     | Elements of Electrical Engineering Laboratory..... | 2       | ..... | ..... | 4     |
| Nat.Sci. 9* | General Biology .....                              | 3       | ..... | 2     | 2     |

## THIRD YEAR

*First Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 86    | Hydraulics .....                        | 3 | 3     | ..... | ..... |
| M.&M. 151   | Differential Equations .....            | 3 | 3     | ..... | ..... |
| E.E. 111    | Electrical Engineering .....            | 5 | 5     | ..... | ..... |
| E.E. 112    | Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 4     |
| Soc.Sci. 1* | Introduction to Social Science .....    | 4 | ..... | 4     | ..... |

*Second Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 127   | Technical Mechanics: Dynamics .....     | 5 | 5     | ..... | ..... |
| E.E. 113    | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 114    | Electrical Engineering Laboratory ..... | 1 | ..... | ..... | 2     |
| E.E. 117    | Engineering Electronics .....           | 3 | 3     | ..... | ..... |
| E.E. 118    | Electronics Laboratory .....            | 1 | ..... | ..... | 2     |
| Soc.Sci. 2* | Introduction to Social Science .....    | 4 | ..... | 4     | ..... |

*Third Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 85    | Strength of Materials .....             | 3 | 3     | ..... | ..... |
| M.&M. 87    | Materials Laboratory .....              | 1 | ..... | ..... | 2     |
| E.E. 115    | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 116    | Electrical Engineering Laboratory ..... | 1 | ..... | ..... | 2     |
| E.E. 119    | Engineering Electronics .....           | 3 | 3     | ..... | ..... |
| E.E. 120    | Electronics Laboratory .....            | 1 | ..... | ..... | 2     |
| Soc.Sci. 3* | Introduction to Social Science .....    | 4 | ..... | 4     | ..... |

## FOURTH YEAR

*First Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| E.E. 121 | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 122 | Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 4     |
| E.E. 161 | Electric Communication .....            | 4 | 3     | ..... | 2     |
| M.E. 26  | Mechanism and Kinematics .....          | 3 | 3     | ..... | ..... |
| Hum. 1*  | Humanities in the Modern World I.....   | 5 | ..... | 5     | ..... |
| or       |   |   |       |       |       |
| Hum. 11* | The Greek Heritage .....                | 5 | ..... | 5     | ..... |
| or       |   |   |       |       |       |
| Hum. 21* | Humanities in the United States .....   | 3 | ..... | 3     | ..... |
|          | Electives                               |   |       |       |       |

*Second Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| E.E. 123 | Electrical Engineering .....              | 3 | 3     | ..... | ..... |
| E.E. 124 | Electrical Engineering Laboratory .....   | 2 | ..... | ..... | 4     |
| E.E. 162 | Electric Communication .....              | 4 | 3     | ..... | 2     |
| M.E. 8   | Machine Shop .....                        | 2 | ..... | 2     | 3     |
| Hum. 2*  | Humanities in the Modern World II .....   | 5 | ..... | 5     | ..... |
| or       |   |   |       |       |       |
| Hum. 12* | The Roman and the Medieval Heritage ..... | 5 | ..... | 5     | ..... |
| or       |   |   |       |       |       |
| Hum. 22* | Humanities in the United States .....     | 3 | ..... | 3     | ..... |
|          | Electives                                 |   |       |       |       |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

*Third Quarter*

| Course No. | Title                                   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| E.E. 125   | Electrical Engineering .....            | 3       | 3     | ..... | ..... |
| E.E. 126   | Electrical Engineering Laboratory ..... | 2       | ..... | ..... | 4     |
| E.E. 163   | Electric Communication .....            | 4       | 3     | ..... | 2     |
| Hum. 3†    | Humanities in the Modern World III..... | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 13†   | The Renaissance Heritage .....          | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 23†   | Humanities in the United States .....   | 3       | ..... | 3     | ..... |
|            | Electives                               |         |       |       |       |

**FIFTH YEAR***First Quarter*

|          |  |   |   |       |       |
|----------|--|---|---|-------|-------|
|          | E.E. Option .....                      | 6 |   |       |       |
| E.E. 127 | Transient Analysis .....               | 3 | 2 | ..... | 2     |
| Engl. 85 | Advanced Technical Communication ..... | 3 | 3 | ..... | ..... |
| M.E. 40  | Heat Engines .....                     | 3 | 2 | ..... | 3     |
|          | Electives                              |   |   |       |       |

*Second Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
|           | E. E. Option .....                     | 6 |       |       |       |
| E.E. 128  | Transient Analysis .....               | 3 | 2     | ..... | 2     |
| Engl. 86  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| M.E. 41   | Heat Engines .....                     | 3 | 2     | ..... | 3     |
| E.E. 100§ | Inspection Trip .....                  | 2 | ..... | ..... | ..... |
|           | Electives                              |   |       |       |       |

*Third Quarter*

|          |                                   |   |       |       |       |
|----------|-----------------------------------|---|-------|-------|-------|
|          | E.E. Option .....                 | 6 |       |       |       |
| E.E. 129 | Transient Analysis .....          | 3 | 2     | ..... | 2     |
| G.E. 103 | Professional Problems .....       | 1 | ..... | 1     | ..... |
| M.E. 55  | Internal Combustion Engines ..... | 3 | 2     | ..... | 3     |
|          | Electives                         |   |       |       |       |

**ELECTRICAL ENGINEERING OPTIONS**

|                                |                   |                              | Credits |   |   |           |       |
|--------------------------------|-------------------|------------------------------|---------|---|---|-----------|-------|
|                                |                   |                              | F       | W | S | Rec. Lab. |       |
| Communication Option           | E.E. 164-165-166  | Communication Circuits ..... | 3       | 3 | 3 | 2         | 2     |
|                                | E.E. 167-168-169  | Radio .....                  | 3       | 3 | 3 | 2         | 2     |
| Electronics Option             | E.E. 131-133-135  | Electronic Design .....      | 3       | 3 | 3 | 3         | ..... |
|                                | E.E. 157-158-159  | Industrial Electronics ..... | 3       | 3 | 3 | 2         | 2     |
| Power Option                   | E.E. 132-134-136  | Electric Design .....        | 3       | 3 | 3 | 3         | ..... |
|                                | E.E. 138-139-140  | Power Systems .....          | 3       | 3 | 3 | 3         | ..... |
|                                | E.E. 141-142-143  | Central Stations .....       | 3       | 3 | 3 | 3         | ..... |
|                                | E.E. 151-152-153  | Illumination .....           | 3       | 3 | 3 | 3         | ..... |
|                                | E.E. 157-158-159  | Industrial Electronics ..... | 3       | 3 | 3 | 2         | 2     |
| Physics and Mathematics Option | Ph. 101-103-105   | Theoretical Physics .....    | 5       | 5 | 5 | 5         | ..... |
|                                | M.&M. 150-152-153 | Advanced Calculus .....      | 3       | 3 | 3 | 3         | ..... |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

**SECOND YEAR***First Quarter*

| Course No. | Title   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| M.&M. 24   | Calculus I: Differential .....                      | 5       | 5     | ..... | ..... |
| Phys. 7    | General Physics: Mechanics and Heat .....           | 5       | 1     | 4     | 2     |
| E.E. 11    | Elements of Electrical Engineering .....            | 3       | 2     | 1     | ..... |
| E.E. 12    | Elements of Electrical Engineering Laboratory ..... | 1       | ..... | ..... | 2     |
|            | Electives   |         |       |       |       |

† See pages 73 and 74 for alternate sequences which may be substituted as a unit.

§ Between winter and spring quarters.

*Second Quarter*

| Course No. | Title   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| M.&M. 25   | Calculus II: Integral .....                         | 5       | 5     | ..... | ..... |
| Phys. 8    | General Physics: Electricity .....                  | 5       | 1     | 4     | 2     |
| M.E. 8     | Machine Shop .....                                  | 2       | ..... | ..... | 4     |
| E.E. 13    | Elements of Electrical Engineering .....            | 3       | 2     | 1     | ..... |
| E.E. 14    | Elements of Electrical Engineering Laboratory ..... | 1       | ..... | ..... | 2     |
|            | Electives   |         |       |       |       |

*Third Quarter*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| M.&M. 26  | Technical Mechanics: Statics .....                  | 5 | 5     | ..... | ..... |
| M.&M. 151 | Differential Equations .....                        | 3 | 3     | ..... | ..... |
| Phys. 9   | General Physics: Sound and Light .....              | 5 | 1     | 4     | 2     |
| E.E. 15   | Elements of Electrical Engineering .....            | 3 | 2     | 1     | ..... |
| E.E. 16   | Elements of Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 2     |

## THIRD YEAR

*First Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| M.&M. 86 | Hydraulics .....                        | 3 | 3     | ..... | ..... |
| E.E. 111 | Electrical Engineering .....            | 5 | 5     | ..... | ..... |
| E.E. 112 | Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 4     |
| M.E. 26  | Mechanisms and Kinematics .....         | 3 | 3     | ..... | ..... |
| M.E. 40  | Heat Engines .....                      | 3 | 2     | ..... | 3     |
|          | Electives                               |   |       |       |       |

*Second Quarter*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics .....     | 5 | 5     | ..... | ..... |
| E.E. 113  | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 114  | Electrical Engineering Laboratory ..... | 1 | ..... | ..... | 2     |
| E.E. 117  | Engineering Electronics .....           | 3 | 3     | ..... | ..... |
| E.E. 118  | Electronics Laboratory .....            | 1 | ..... | ..... | 2     |
| M.E. 41   | Heat Engines .....                      | 3 | 2     | ..... | 3     |
|           | Electives                               |   |       |       |       |

*Third Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| M.&M. 85 | Strength of Materials .....             | 3 | 3     | ..... | ..... |
| M.&M. 87 | Materials Laboratory .....              | 1 | ..... | 1     | 2     |
| E.E. 115 | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 116 | Electrical Engineering Laboratory ..... | 1 | ..... | ..... | 2     |
| E.E. 119 | Engineering Electronics .....           | 3 | 3     | ..... | ..... |
| E.E. 120 | Electronics Laboratory .....            | 1 | ..... | ..... | 2     |
| M.E. 55  | Internal Combustion Engines .....       | 3 | 2     | ..... | 3     |
|          | Electives                               |   |       |       |       |

## FOURTH YEAR

*First Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| E.E. 121 | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 122 | Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 4     |
| E.E. 161 | Electric Communication .....            | 4 | 3     | ..... | 2     |
|          | E.E. Option* .....                      | 6 | ..... | ..... | ..... |
|          | Electives                               |   |       |       |       |

*Second Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| E.E. 123 | Electrical Engineering .....            | 3 | 3     | ..... | ..... |
| E.E. 124 | Electrical Engineering Laboratory ..... | 2 | ..... | ..... | 4     |
| E.E. 162 | Electric Communication .....            | 4 | 3     | ..... | 2     |
| G.E. 103 | Professional Problems .....             | 1 | ..... | 1     | ..... |
|          | E.E. Option* .....                      | 6 | ..... | ..... | ..... |
|          | Electives                               |   |       |       |       |

\* For Electrical Engineering Options consult adviser.

## Third Quarter

| Course No. | Title                                   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| E.E. 100†  | Inspection Trip (Spring vacation) ..... | 2       | ..... | ..... | ..... |
| E.E. 125   | Electrical Engineering .....            | 3       | 3     | ..... | ..... |
| E.E. 126   | Electrical Engineering Laboratory ..... | 2       | ..... | ..... | 4     |
| E.E. 163   | Electric Communication .....            | 4       | 3     | ..... | 2     |
|            | E.E. Option* .....                      | 6       |       |       |       |
|            | Electives                               |         |       |       |       |

## ENGINEERING AND BUSINESS ADMINISTRATION

For many years engineers have recognized the importance of a knowledge of the principles of economics in connection with their profession. Engineering students are encouraged to elect courses of various kinds in the fields of economics and administration when it is possible for them to find time to do so. This is true in all of the branches of engineering.

With the vast expansion which has taken place in the manufacturing industries in the United States, there has arisen a need for engineers having more training in economics and administration than is usually possible in the four-year engineering courses. To meet this need special groups of elective courses have been arranged.

The *Engineering Prebusiness course* described on page 50 provides a four-year combined curriculum in business administration with a background of the fundamental mathematics, chemistry, English, physics, and drawing, of the engineering courses.

As a further step to provide adequate training in engineering or chemistry, combined with business administration, a plan of *five-year courses leading to two degrees* has been arranged for the capable student who wishes to enter upon a comprehensive professional training in this combined field.

## FIVE-YEAR COMBINED COURSES WITH BUSINESS ADMINISTRATION

The plan of five-year combined courses in Engineering, Architecture (six years), or Chemistry with Business Administration enables the student to complete the requirements for the Bachelor's degrees in both fields, as, for example, bachelor of electrical engineering and bachelor of business administration. Five years will usually be necessary for the completion of the combined course, but a longer time may be required if suitable programs cannot be arranged for the five-year period. This will depend upon the particular curriculum with which the combination with business administration is made.

For this purpose the School of Business Administration will accept the 74 credits in business subjects shown in the following list in conjunction with one of the regular curricula in engineering, architecture, or chemistry, as satisfying the requirements for the degree of bachelor of business administration. The student receives his engineering degree upon the completion of his regular course, altho this may not be until the end of the fifth year. He is not eligible for the degree in business administration on this 74-credit basis unless *the work is taken in conjunction with one of the regular curricula in this college*. Students in these programs will be required to have at the time of entrance and to maintain a minimum honor point average of 1.5 in each field, that is engineering and business, throughout the course. The number enrolled at any time will be limited to 160. Selection will be based upon academic standing.

Application for admission to the five-year combinations must be made by petition to the combined engineering-business committee within the first ten days of the third quarter of the freshman year. The honor point ratio must be maintained at the completion of the 74 credits, otherwise the business administration degree will be given only upon the completion of the regular School of Business Administration requirements.

\* For Electrical Engineering Option, consult adviser.

† Between winter and spring quarters.

The business courses are intended to be spread over four years, beginning the business sequence in the sophomore year by taking economics and business law, 3 credits per quarter, as electives, in addition to the usual engineering program.

Normally, some of the required technical work of the senior year will be postponed to the fifth year to make room for business courses, in order to secure a desirable distribution of the latter rather than to concentrate them in the fifth year. Not more than 28 credits of business should be left for the fifth year.

In certain curricula, special concessions are made to students taking this five-year combined course by permitting them to omit certain required courses or to substitute business courses for them.

Under this plan the student will be registered in the Institute of Technology and in the School of Business Administration for the entire combined program. His registration for each quarter beginning with the school year is subject to *approval by the adviser representing the School of Business Administration* as well as by the regular classifier.

No student is considered officially registered in the five-year business engineering combination unless he has the approval of the Five-Year Student Work Committee.

The following order and distribution by years are suggested. With the approval of the adviser in the School of Business Administration both may be varied, however, so as to accommodate individual programs.

|                       |  | SECOND YEAR |       |       |
|-----------------------|--|-------------|-------|-------|
| Course No.            | Title  | Credits     |       |       |
|                       |  | F           | W     | S     |
| Econ. 8-9             | General Economics .....                              | 3           | 3     | ..... |
| Econ. 28              | Business Law (8, 9) .....                            | .....       | ..... | 3     |
|                       |  | THIRD YEAR  |       |       |
| B.A. 54-55*           | Elementary Accounting: Combined Course .....         | 4           | 4     | ..... |
| B.A. 77               | Survey in Marketing (8, 9) .....                     | .....       | ..... | 3     |
|                       |  | FOURTH YEAR |       |       |
| B.A. 58               | Elements of Public Finance (8, 9) .....              | .....       | 3     | ..... |
| B.A. 70               | Statistics Survey (8, 9) .....                       | 3           | ..... | ..... |
| B.A. 71               | Transportation: Services and Charges I (8, 9) .....  | .....       | ..... | 3     |
| B.A. 89§              | Production Management (8, 9) .....                   | .....       | ..... | 3     |
| B.A. 112              | Business Statistics (70) .....                       | .....       | 3     | ..... |
| B.A. 130              | Cost Accounting Survey (26, 29 or 55) .....          | .....       | ..... | 3     |
| B.A. 142              | Advanced Money and Banking (8, 9) .....              | 3           | ..... | ..... |
| B.A. 167              | Introduction to Industrial Relations (161) .....     | .....       | 3     | ..... |
| Econ. 161             | Labor Problems and Trade Unionism (8, 9) .....       | 3           | ..... | ..... |
|                       |  | FIFTH YEAR  |       |       |
| Econ. 155             | Corporation Finance (8, 9) .....                     | 3           | ..... | ..... |
| B.A. 101-102          | Advanced General Economics (8, 9) .....              | 3           | 3     | ..... |
| B.A. 180-181-182G     | Senior Topics: Production Management (89, 130) ..... | 3           | 3     | 3     |
| Econ. 149             | Business Cycles (142) .....                          | .....       | 3     | ..... |
| Econ. 175             | Government Regulation of Business (8, 9) .....       | .....       | ..... | 3     |
| One of the following: |  |             |       |       |
| B.A. 133              | Standard Costs (130) .....                           | .....       | ..... | 3     |
| B.A. 139              | Advanced General Accounting (26) .....               | .....       | ..... | 3     |
| B.A. 170-171          | Production Standards .....                           | .....       | 3     | 3     |
| B.A. 180-181C         | Senior Topics: Marketing .....                       | 3           | 3     | ..... |
| B.A. 180-181-182D     | Senior Topics: Industrial Relations .....            | 3           | 3     | 3     |
| Psy. 130              | Vocational and Occupational Psychology (1, 2) .....  | .....       | 3     | ..... |
| Total credits .....   |  | 74          |       |       |

\* If Econ. 54-55 cannot be scheduled, Econ. 20, 25, and 26 may be substituted.

§ Mechanical engineering students substitute M.E. 171 for B.A. 89 and replace the latter with an approved business course, preferably B.A. 180C. Credit will not be given for both M.E. 171 and B.A. 89.

Any engineering graduate who has taken the courses in Group A as an undergraduate, or who will satisfy the requirements in these undergraduate Core Group Courses of the School of Business Administration after graduation, may be accepted as a candidate for the degree of master of business administration after the completion of the courses included under Group B, or with approved substitutions.

The requirements of the Graduate School must be met in the Group B courses. He must maintain a B average in these courses and must take both written and oral examinations in the Core Group and in his field of specialization.

## GROUP A

|            |  |
|------------|--|
| Econ. 8-9  | General Economics for Engineers        |
| Econ. 28   | Business Law for Engineers             |
| B.A. 54-55 | Elementary Accounting—Combined Course  |
| B.A. 58    | Elements of Public Finance             |
| B.A. 70    | Statistics Survey                      |
| B.A. 71    | Transportation: Services and Charges I |
| B.A. 77    | Survey in Marketing                    |
| B.A. 89    | Production Management                  |

## GROUP B

|                   |  |
|-------------------|--|
| Econ. 155         | Corporation Finance                    |
| Econ. 161         | Labor Problems and Trade Unionism      |
| Econ. 175         | Government Regulation of Business      |
| B.A. 101-102      | Advanced General Economics             |
| B.A. 112          | Business Statistics                    |
| B.A. 130          | Cost Accounting Survey                 |
| B.A. 133          | Standard Costs                         |
| B.A. 142          | Advanced Money and Banking             |
| B.A. 167          | Introduction to Industrial Relations   |
| B.A. 180-181-182G | Senior Topics: Industrial Relations    |
| B.A. 184          | Scientific Management in Industry      |
| Psy. 130          | Vocational and Occupational Psychology |
| M.E. 174          | Motion and Time Study Laboratory       |

## ENGINEERING PREBUSINESS

(Four-year course in Engineering and Business Administration)

This course has been arranged for students who wish to prepare for positions in industry for which basic technical training is necessary, with instruction in business administration. Such positions are found in fields of purchasing, sales and sales promotion, cost accounting, employment and rate setting, and production control.

Upon the completion of two years of prescribed work in the Institute of Technology the student transfers to the School of Business Administration, where the third and fourth years are taken. Students in this program *must* transfer their enrolment to the School of Business Administration at the *beginning* of their junior year. The combined course leads to the degree of bachelor of business administration.

For freshman year, see page 16.

## SOPHOMORE YEAR

| Course No. | Title                                     | <i>First Quarter</i> |       |       |       |
|------------|---|----------------------|-------|-------|-------|
|            |   | Credits              | Rec.  | Lect. | Lab.  |
| M.&M. 91†  | Calculus .....                            | 4                    | 4     | ..... | ..... |
| Phys. 7    | General Physics: Mechanics and Heat ..... | 5                    | 1     | 4     | 2     |
| Econ. 8    | General Economics .....                   | 3                    | ..... | 3     | ..... |
| M.E. 8     | Machine Shop Practice .....               | 2                    | ..... | 2     | 3     |
| M.E. 70    | Mechanical Technology .....               | 1                    | ..... | 2     | ..... |
|            | Electives                                 |                      |       |       |       |

† For permissible substitute, see page 75.



## Second Quarter

| Course No. | Title                               | Credits | Rec. | Lect. | Lab.  |
|------------|-------------------------------------|---------|------|-------|-------|
| Econ. 3    | Elements of Money and Banking ..... | 5       | 3    | 2     | ..... |
| Econ. 9    | General Economics .....             | 3       | 3    | ..... | ..... |
| Econ. 20†  | Elements of Accounting .....        | 3       | 3    | ..... | ..... |
| Phys. 8    | General Physics: Electricity .....  | 5       | 1    | 4     | 2     |
|            | Electives                           |         |      |       |       |

## Third Quarter

|           |  |   |   |       |       |
|-----------|--|---|---|-------|-------|
| M.&M. 84† | Technical Mechanics .....              | 5 | 5 | ..... | ..... |
| Phys. 9   | General Physics: Sound and Light ..... | 5 | 1 | 4     | 2     |
| Econ. 5   | Elements of Statistics .....           | 5 | 5 | ..... | ..... |
| Econ. 25  | Principles of Accounting .....         | 3 | 3 | ..... | ..... |

## JUNIOR YEAR‡

(In the School of Business Administration)

|  | Credits |
|--|---------|
| Strength of Materials (M.&M. 85)† .....                    | 3       |
| Materials Testing Laboratory (M.&M. 87)† .....             | 1       |
| Principles of Accounting (Econ. 26) .....                  | 3       |
| Business Law (Bus.Adm. 51-52-53) .....                     | 9       |
| Business Statistics (Bus.Adm. 112) .....                   | 3       |
| Corporation Finance (Econ. 155) .....                      | 3       |
| Advanced Money and Banking (Bus.Adm. 142) .....            | 3       |
| Transportation: Services and Charges I (Bus.Adm. 71) ..... | 3       |
| Survey in Marketing (Bus.Adm. 77) .....                    | 3       |
| Production Management (Bus.Adm. 89) .....                  | 3       |
| Advanced General Accounting (Bus.Adm. 139) .....           | 3       |
| Tabulating Equipment Laboratory (Bus.Adm. 91) .....        | 1       |
| Electives (See below) .....                                | 4       |

## SENIOR YEAR‡

(In the School of Business Administration)

|  |    |
|--|----|
| Transportation: Services and Charges II (Bus.Adm. 72) .....        | 3  |
| Cost Accounting Survey (Bus.Adm. 130) .....                        | 3  |
| Advanced General Economics (Bus.Adm. 101-102) .....                | 6  |
| Business Cycles (Econ. 149) .....                                  | 3  |
| Labor Problems and Trade Unionism (Econ. 161) .....                | 3  |
| Introduction to Industrial Relations (Bus.Adm. 167) .....          | 3  |
| Elements of Public Finance (Bus.Adm. 58) .....                     | 3  |
| Government Regulation of Business (Econ. 175) .....                | 3  |
| Senior Topics: Production Management (Bus.Adm. 180-181-182G) ..... | 9  |
| Electives (See below) .....  | 12 |

## RECOMMENDED ELECTIVES

|   | Hours |
|---|-------|
| Economic History (Hist. 80-81-82) .....                       | 9     |
| Finance Management (Bus.Adm. 156) .....                       | 3     |
| Theory of Statistics (Econ. 121-122-123) .....                | 9     |
| Geography of Commercial Production (Geog. 41) .....           | 5     |
| Fire and Marine Insurance (Bus.Adm. 60) .....                 | 3     |
| Casualty Insurance (Bus.Adm. 61) .....                        | 3     |
| Senior Topics: Marketing (Bus.Adm. 180C) .....                | 3     |
| Contracts and Specifications (G.E. 101) .....                 | 3     |
| General Psychology (Psy. 1-2) .....                           | 6     |
| Vocational Psychology (Psy. 130) .....                        | 3     |
| Senior Topics: Industrial Relations (B.A. 180-181-182D) ..... | 9     |

† For permissible substitute, see page 75.

‡ In addition to the required courses in the junior and senior years, the student must earn approximately 10 credits per year.

§ Students who have had a high school course or experience in bookkeeping may be exempt from this course and admitted to Econ. 25 by passing a placement test.

## GEOPHYSICS

The institute has established a curriculum in physics for those who wish to enter specialized training in other schools or with commercial companies.

It is suggested that any student who desires to enter such a curriculum arrange his programs to include the following courses :

|  |   |
|--|---|
| English                                    | Physics   |
| Drawing                                    | General Physics 7-8-9   |
| Chemistry                                  | Theoretical Physics 101-103-105                                       |
| Mathematics                                | Modern Experimental Physics 110-112                                   |
| Algebra, Trigonometry, and Analytics       | Experimental Optics 134   |
| Differential and Integral Calculus         | Electricity Measurements 144  |
| Differential Equations                     | It would be highly desirable to add Mathematical Physics 191-193-195. |
| Advanced Calculus                          |   |
| Technical Mechanics (Statics and Dynamics) | Elective  |
| Geology                                    | Elements of Paleontology 51   |
| General and Historical 1-2, A-B            | Economic Geology 110  |
| Mineralogy 23-24                           | Ore Deposits 111  |
| Sedimentation 101-102                      | Stratigraphy 151-152-153  |
| Rock Study 105                             | Field Work 85   |
| Geology of Petroleum 112                   | Mining  |
| Structural Geology 125                     | Mining 131  |
| Map Interpretation 144-145                 | Civil Engineering   |
| Field Work 85                              | Surveying 11-12-13  |
| Elective topics in Mathematical Analysis   |   |
| 144-145-146                                |   |

The proposed program should include as a minimum at least the number of credits required for the degree of bachelor of physics.

## MECHANICAL ENGINEERING

A five-year course leading to the degree of bachelor of mechanical engineering. A four-year course leading to the same degree is open only to veterans of World War II. Both courses have the same technical requirements, but the five-year course includes additional work in the humanistic-social subjects. A reasonable degree of selection of this non-technical material is available to the students. Veterans as well as non-veterans are urged to take the five-year course which has as its objectives not only a technical education but also an understanding of the influence of science and engineering upon our social organization.

The mechanical engineering profession includes the following major divisions: design of machinery and apparatus for all purposes; production and manufacturing methods; operation of industrial plants; steam power generation; internal combustion engines; heating, ventilating and air conditioning; refrigeration; mechanical research and development; sales engineering; and the general field of management.

In addition to the prescribed courses, sufficient electives must be taken to complete a total of at least 255 credits for graduation in the five-year course and 207 in the four-year course.

For freshman year see page 16.

## FIVE-YEAR COURSE

## SECOND YEAR

*First Quarter*

| Course No.         | Title  | Credits | Rec.  | Lect. | Lab.  |
|--------------------|--|---------|-------|-------|-------|
| M.&M. 24           | Calculus I: Differential .....               | 5       | 5     | ..... | ..... |
| Phys. 7            | General Physics: Mechanics and Heat .....    | 5       | 1     | 4     | 2     |
| M.E. 11            | Materials and Processing I .....             | 2       | ..... | 2     | ..... |
| M.E. 12, 13 or 14† | Materials and Processing II, III, or IV..... | 2       | ..... | 2     | 3     |
| Nat.Sci. 7*        | General Biology .....                        | 3       | ..... | 2     | 2     |
|                    | Electives                                    |         |       |       |       |

*Second Quarter*

|                    |  |   |       |       |       |
|--------------------|--|---|-------|-------|-------|
| M.&M. 25           | Calculus II: Integral .....                  | 5 | 5     | ..... | ..... |
| Phys. 8            | General Physics: Electricity .....           | 5 | 1     | 4     | 2     |
| M.E. 12, 13 or 14† | Materials and Processing II, III, or IV..... | 2 | ..... | 2     | 3     |
| M.E. 20            | Elementary Machine Design .....              | 2 | ..... | ..... | 6     |
| Nat.Sci. 8*        | General Biology .....                        | 3 | ..... | 2     | 2     |
|                    | Electives                                    |   |       |       |       |

*Third Quarter*

|                    |  |   |       |       |       |
|--------------------|--|---|-------|-------|-------|
| M.&M. 26           | Technical Mechanics: Statics .....           | 5 | 5     | ..... | ..... |
| Phys. 9            | General Physics: Sound and Light .....       | 5 | 1     | 4     | 2     |
| M.E. 12, 13 or 14† | Materials and Processing II, III, or IV..... | 2 | ..... | 2     | 3     |
| M.E. 21            | Kinematics .....                             | 2 | ..... | ..... | 6     |
| Nat.Sci. 9*        | General Biology .....                        | 3 | ..... | 2     | 2     |

## THIRD YEAR

*First Quarter*

|                    |  |   |       |       |       |
|--------------------|--|---|-------|-------|-------|
| M.&M. 127          | Technical Mechanics: Dynamics .....          | 5 | 5     | ..... | ..... |
| M.E. 15, 16 or 17† | Materials and Processing V, VI, or VII ..... | 2 | ..... | 2     | 3     |
| M.E. 22            | Mechanism .....                              | 3 | 3     | ..... | ..... |
| M.E. 70            | Mechanical Technology .....                  | 1 | ..... | 2     | ..... |
| M.E. 131           | Thermodynamics .....                         | 3 | 3     | ..... | 2     |
| Soc.Sci. 1*        | Introduction to Social Science .....         | 4 | ..... | 4     | ..... |

*Second Quarter*

|                    |  |   |       |       |       |
|--------------------|--|---|-------|-------|-------|
| M.&M. 128          | Strength of Materials .....                  | 5 | 5     | ..... | ..... |
| M.&M. 141          | Materials Laboratory .....                   | 1 | ..... | ..... | 2     |
| M.E. 15, 16 or 17† | Materials and Processing V, VI, or VII ..... | 2 | ..... | 2     | 3     |
| M.E. 33            | Mechanical Laboratory I .....                | 2 | ..... | 1     | 3     |
| M.E. 132           | Thermodynamics .....                         | 3 | 3     | ..... | ..... |
| Soc.Sci. 2*        | Introduction to Social Science .....         | 4 | ..... | 4     | ..... |
|                    | Electives                                    |   |       |       |       |

*Third Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 130   | Fluid Mechanics .....                | 5 | 5     | ..... | ..... |
| M.&M. 143   | Fluid Mechanics Laboratory .....     | 1 | ..... | ..... | 2     |
| M.E. 23     | Dynamics of Machine Design .....     | 3 | ..... | 1     | 3     |
| M.E. 34     | Mechanical Laboratory II .....       | 2 | ..... | 1     | 3     |
| M.E. 141    | Heat Power Engineering .....         | 3 | 3     | ..... | ..... |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

† M.E. 12, 13, 14, 15, 16, and 17 must all be completed before the fifth year.

## FOURTH YEAR

*First Quarter*

| Course No.        | Title                                 | Credits | Rec.  | Lect. | Lab.  |
|-------------------|---------------------------------------|---------|-------|-------|-------|
| Chem.E. 31        | Chemistry of Engineering Materials    | 2       | ..... | 3     | ..... |
| M.E. 15, 16 or 17 | Materials and Processing V, VI or VII | 2       | ..... | 2     | 3     |
| M.E. 24           | Elementary Machine Design             | 3       | 2     | ..... | 3     |
| M.E. 35           | Mechanical Laboratory III             | 2       | ..... | 1     | 3     |
| M.E. 150§         | Internal Combustion Engines           | 4       | 4     | ..... | ..... |
| M.E. 160§         | Heating and Ventilating               | 3       | 3     | ..... | ..... |
| M.E. 171§         | Production Control                    | 3       | 3     | ..... | ..... |
| M.E. 180§         | Refrigeration                         | 3       | 3     | ..... | ..... |
| Hum. 1*           | Humanities in the Modern World I      | 5       | ..... | 5     | ..... |
| or                |                                       |         |       |       |       |
| Hum. 11*          | The Greek Heritage                    | 5       | ..... | 5     | ..... |
| or                |                                       |         |       |       |       |
| Hum. 21*          | Humanities in the United States       | 3       | ..... | 3     | ..... |

*Second Quarter*

|           |                                     |        |       |       |       |
|-----------|-------------------------------------|--------|-------|-------|-------|
| M.&M. 151 | Differential Equations              | 0 or 3 | 3     | ..... | ..... |
| M.E. 121  | General Engineering Design          | 2      | ..... | ..... | 6     |
| M.E. 150§ | Internal Combustion Engines         | 4      | 4     | ..... | ..... |
| M.E. 160§ | Heating and Ventilating             | 3      | 2     | 1     | ..... |
| M.E. 171§ | Production Control                  | 3      | 3     | ..... | ..... |
| M.E. 180§ | Refrigeration                       | 3      | 3     | ..... | ..... |
| Hum. 2*   | Humanities in the Modern World II   | 5      | ..... | 5     | ..... |
| or        |                                     |        |       |       |       |
| Hum. 12*  | The Roman and the Medieval Heritage | 5      | ..... | 5     | ..... |
| or        |                                     |        |       |       |       |
| Hum. 22*  | Humanities in the United States     | 3      | ..... | 3     | ..... |
|           | Elective                            |        |       |       |       |

*Third Quarter*

|           |                                    |        |       |       |       |
|-----------|------------------------------------|--------|-------|-------|-------|
| M.&M. 151 | Differential Equations             | 0 or 3 | 3     | ..... | ..... |
| M.E.      | Engineering Design¶                | 0 to 2 | ..... | ..... | ..... |
| M.E. 150§ | Internal Combustion Engines        | 4      | 4     | ..... | ..... |
| M.E. 160§ | Heating and Ventilating            | 3      | 2     | 1     | ..... |
| M.E. 171§ | Production Control                 | 3      | 3     | ..... | ..... |
| M.E. 180§ | Refrigeration                      | 3      | 3     | ..... | ..... |
| Hum. 3*   | Humanities in the Modern World III | 5      | ..... | 5     | ..... |
| or        |                                    |        |       |       |       |
| Hum. 13*  | The Renaissance Heritage           | 5      | ..... | 5     | ..... |
| or        |                                    |        |       |       |       |
| Hum. 23*  | Humanities in the United States    | 3      | ..... | ..... | 2     |
|           | Elective                           |        |       |       |       |

## FIFTH YEAR

*First Quarter*

|          |                                     |        |       |       |        |
|----------|-------------------------------------|--------|-------|-------|--------|
| E.E. 36  | Electrical Engineering Survey       | 3      | 2     | ..... | 2      |
| M.E. 190 | Seminar                             | 1      | 1     | ..... | .....  |
| M.E.     | Mechanical Engineering Senior Lab.† | 2      | ..... | ..... | 4 or 6 |
| Engl. 85 | Advanced Technical Communication    | 3      | 3     | ..... | .....  |
| M.E.     | Engineering Design¶                 | 0 or 2 | ..... | ..... | .....  |
|          | Electives                           |        |       |       |        |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

† Three of the five laboratory courses M.E. 149, 159, 169, 174, 189 must be taken in the three quarters and not more than two in any one quarter.

‡ The entire four courses must be completed during the year.

¶ A minimum of 4 credits of engineering design must be completed in addition to M.E. 121. The following courses are accepted for this requirement: M.E. 122-123, Mechanical Engineering Design; M.E. 147, Design of Steam Machinery; M.E. 148, Design of Power Plant Units; M.E. 154-155, Design of Internal Combustion Engines; M.E. 161, 162, Heating and Ventilation Design; M.E. 170, Tool Design and Construction; M.E. 172, Industrial Plant Design; C.E. 37, Structural Engineering; M.E. 182, Refrigeration Design.

## Second Quarter

| Course No. | Title                                     | Credits | Rec.  | Lect. | Lab.   |
|------------|---|---------|-------|-------|--------|
| E.E. 37    | Electrical Engineering Survey .....       | 3       | 2     | ..... | 2      |
| M.E. 191   | Seminar .....                             | 1       | 1     | ..... | .....  |
| M.E.       | Mechanical Engineering Senior Lab.† ..... | 2       | ..... | ..... | 4 or 6 |
| Engl. 86   | Advanced Technical Communication .....    | 3       | 3     | ..... | .....  |
| M.E.       | Engineering Design‡ .....                 | 0 or 2  | ..... | ..... | .....  |
|            | Electives                                 |         |       |       |        |

## Third Quarter

|          |   |        |       |       |        |
|----------|---|--------|-------|-------|--------|
| E.E. 38  | Electrical Engineering Survey .....       | 3      | 2     | ..... | 2      |
| G.E. 103 | Professional Problems .....               | 1      | ..... | 1     | .....  |
| M.E. 192 | Seminar .....                             | 1      | 1     | ..... | .....  |
| M.E.     | Mechanical Engineering Senior Lab.† ..... | 2      | ..... | ..... | 4 or 6 |
| M.E.     | Engineering Design‡ .....                 | 0 or 2 | ..... | ..... | .....  |
| M.E. 195 | Inspection Trip .....                     | 1      | ..... | ..... | .....  |
|          | Electives                                 |        |       |       |        |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

## SOPHOMORE YEAR

## First Quarter

|                   |   |   |       |       |       |
|-------------------|---|---|-------|-------|-------|
| M.&M. 24          | Calculus I: Differential .....                | 5 | 5     | ..... | ..... |
| Phys. 7           | General Physics: Mechanics and Heat .....     | 5 | 1     | 4     | 2     |
| M.E. 11           | Materials and Processing I .....              | 2 | ..... | 2     | ..... |
| M.E. 12, 13 or 14 | Materials and Processing II, III, or IV ..... | 2 | ..... | 2     | 3     |
| Engl. 9           | Technical Discussion .....                    | 3 | 3     | ..... | ..... |
| or                |   |   |       |       |       |
| Chem.E. 31        | Chemistry of Engineering Materials .....      | 2 | ..... | 3     | ..... |
|                   | Electives                                     |   |       |       |       |

## Second Quarter

|                    |   |   |       |       |       |
|--------------------|---|---|-------|-------|-------|
| M.&M. 25           | Calculus II: Integral .....                   | 5 | 5     | ..... | ..... |
| Phys. 8            | General Physics: Electricity .....            | 5 | 1     | 4     | 2     |
| M.E. 12, 13, or 14 | Materials and Processing II, III, or IV ..... | 2 | ..... | 2     | 3     |
| M.E. 20            | Elementary Machine Design .....               | 2 | ..... | ..... | 6     |
| Engl. 9            | Technical Discussion .....                    | 3 | 3     | ..... | ..... |
|                    | Chemistry of Engineering Materials .....      | 2 | ..... | 3     | ..... |

## Third Quarter

|                   |   |   |       |       |       |
|-------------------|---|---|-------|-------|-------|
| M.&M. 26          | Technical Mechanics: Statics .....            | 5 | 5     | ..... | ..... |
| Phys. 9           | General Physics: Sound and Light .....        | 5 | 1     | 4     | 2     |
| M.E. 12, 13 or 14 | Materials and Processing II, III, or IV ..... | 2 | ..... | 2     | 3     |
| M.E. 21           | Kinematics .....                              | 2 | ..... | ..... | 6     |
| Engl. 9           | Technical Discussion .....                    | 3 | 3     | ..... | ..... |
| or                |   |   |       |       |       |
| Chem.E. 31        | Chemistry of Engineering Materials .....      | 2 | ..... | 3     | ..... |
|                   | Electives                                     |   |       |       |       |

† Three of the five laboratory courses M.E. 149, 159, 169, 174, 189 must be taken in the three quarters and not more than two in any one quarter.

‡ A minimum of 4 credits of engineering design must be completed in addition to M.E. 121. The following courses are accepted for this requirement: M.E. 122-123, Mechanical Engineering Design; M.E. 147, Design of Steam Machinery; M.E. 148, Design of Power Plant Units; M.E. 154, 155, Design of Internal Combustion Engines; M.E. 161, 162, Heating and Ventilation Design; M.E. 170, Tool Design and Construction; M.E. 172, Industrial Plant Design; C.E. 37, Structural Engineering; M.E. 182, Refrigeration Design.

## INSTITUTE OF TECHNOLOGY

## JUNIOR YEAR

*First Quarter*

| Course No.        | Title  | Credits | Rec.  | Lect. | Lab.  |
|-------------------|--|---------|-------|-------|-------|
| M.&M. 127         | Technical Mechanics: Dynamics .....          | 5       | 5     | ..... | ..... |
| M.E. 15, 16 or 17 | Materials and Processing V, VI, or VII ..... | 2       | ..... | 2     | 3     |
| M.E. 22           | Mechanics .....                              | 3       | 3     | ..... | ..... |
| M.E. 33           | Mechanical Laboratory I .....                | 2       | ..... | 1     | 3     |
| M.E. 70           | Mechanical Technology .....                  | 1       | ..... | 2     | ..... |
| M.E. 131          | Thermodynamics .....                         | 3       | 3     | ..... | 2     |
|                   | Electives                                    |         |       |       |       |

*Second Quarter*

|                   |  |   |       |       |       |
|-------------------|--|---|-------|-------|-------|
| M.&M. 128         | Strength of Materials .....                  | 5 | 5     | ..... | ..... |
| M.&M. 141         | Materials Laboratory .....                   | 1 | ..... | ..... | 2     |
| M.E. 15, 16 or 17 | Materials and Processing V, VI, or VII ..... | 2 | ..... | 2     | 3     |
| M.E. 23           | Dynamics of Machine Design .....             | 3 | ..... | 1     | 6     |
| M.E. 34           | Mechanical Laboratory II .....               | 2 | ..... | 1     | 3     |
| M.E. 132          | Thermodynamics .....                         | 3 | 3     | ..... | ..... |
|                   | Electives                                    |   |       |       |       |

*Third Quarter*

|                   |                                  |   |       |       |       |
|-------------------|----------------------------------|---|-------|-------|-------|
| M.&M. 130         | Fluid Mechanics .....            | 5 | 5     | ..... | ..... |
| M.&M. 143         | Fluid Mechanics Laboratory ..... | 1 | ..... | ..... | 2     |
| M.E. 15, 16 or 17 | Materials and Processing .....   | 2 | ..... | 2     | 3     |
| M.E. 24           | Elements of Machine Design ..... | 3 | 2     | ..... | 3     |
| M.E. 35           | Mechanical Laboratory III .....  | 2 | ..... | 1     | 3     |
| M.E. 141          | Heat-Power Engineering .....     | 3 | 3     | ..... | ..... |
|                   | Electives                        |   |       |       |       |

## SENIOR YEAR

*First Quarter*

|           |                                     |   |       |       |        |
|-----------|-------------------------------------|---|-------|-------|--------|
| E.E. 36   | Electrical Engineering Survey ..... | 3 | 2     | ..... | 2      |
| M.E. 121  | General Engineering Design .....    | 2 | ..... | ..... | 6      |
| M.E. 150* | Internal Combustion Engines .....   | 4 | 4     | ..... | .....  |
| M.E. 160* | Heating and Ventilation .....       | 3 | 2     | 1     | .....  |
| M.E. 171* | Production Control .....            | 3 | 3     | ..... | .....  |
| M.E. 180* | Refrigeration .....                 | 3 | 3     | ..... | .....  |
| M.E. 190  | Seminar .....                       | 1 | 1     | ..... | .....  |
| M.E.      | Senior Laboratory† .....            | 2 | ..... | ..... | 4 or 6 |
|           | Electives                           |   |       |       |        |

*Second Quarter*

|            |                                     |   |       |       |        |
|------------|-------------------------------------|---|-------|-------|--------|
| E.E. 37    | Electrical Engineering Survey ..... | 3 | 2     | ..... | .....  |
| M.E. 150*  | Internal Combustion Engines .....   | 4 | 4     | ..... | .....  |
| M.E. 160*  | Heating and Ventilation .....       | 3 | 2     | 1     | .....  |
| M.E. 171*  | Production Control .....            | 3 | 3     | ..... | .....  |
| M.E. 180*  | Refrigeration .....                 | 3 | 3     | ..... | .....  |
| M.E. 191   | Seminar .....                       | 1 | 1     | ..... | .....  |
| M.E.       | Senior Laboratory† .....            | 2 | ..... | ..... | 4 or 6 |
| M.E.       | Senior Design‡ .....                | 2 | ..... | ..... | 6      |
| G.E. 103   | Professional Problems .....         | 1 | ..... | 1     | .....  |
| M.&M. 151¶ | Differential Equations .....        | 3 | 3     | ..... | .....  |
|            | Electives                           |   |       |       |        |

\* The entire four courses must be completed during the first two quarters.

† Three of the five laboratory courses M.E. 149, 159, 169, 174, 189 must be taken in the three quarters and not more than two in any one quarter.

‡ A minimum of 4 credits of engineering design must be completed in addition to M.E. 121. The following courses are accepted for this requirement: M.E. 122-123, Mechanical Engineering Design; M.E. 147, Design of Steam Machinery; M.E. 148, Design of Power Plant Units; M.E. 154, 155, Design of Internal Combustion Engines; M.E. 161, 162, Heating and Ventilation Design; M.E. 170, Tool Design and Construction; M.E. 172, Industrial Plant Design; C.E. 37, Structural Engineering; M.E. 182, Refrigeration Design.

¶ M.&M. 151 may be taken either during the second or third quarter.

*Third Quarter*

| Course No. | Title                               | Credits | Rec.  | Lect. | Lab.   |
|------------|-------------------------------------|---------|-------|-------|--------|
| E.E. 38    | Electrical Engineering Survey ..... | 3       | 2     | ..... | 2      |
| M.E. 192   | Seminar .....                       | 1       | 1     | ..... | .....  |
| M.E.       | Senior Laboratory† .....            | 2       | ..... | ..... | 4 or 6 |
| M.E.       | Senior Design‡ .....                | 2       | ..... | ..... | 6      |
| M.E. 195   | Inspection Trip .....               | 1       | ..... | ..... | .....  |
| M.&M. 151¶ | Differential Equations .....        | 3       | 3     | ..... | .....  |
|            | Electives                           |         |       |       |        |

## GEOLOGICAL, MINING, AND PETROLEUM ENGINEERING

Five-year courses leading to the degree of bachelor of geological engineering, B.Geol.E., or bachelor of mining engineering, B.Min.E., or bachelor of petroleum engineering, B.Pet.E. are required of all students, except veterans, beginning with freshmen who enter in the fall quarter of 1946. Students taking the five-year curricula are required to take all prescribed courses, including summer field trips and electives. Exclusive of summer field trips, a total of 255 credits are required for graduation. The equivalent of approximately one year's work in the Arts College is distributed over a five-year program to provide a more general education for all except veterans who are more mature and anxious to begin their professional career without further delay.

A four-year course leading to the above degrees is open only to veterans and those who entered prior to the fall of 1946. Exclusive of summer field trips 217, 213, and 208 respective credits are required for graduation with degrees of bachelor of geological engineering, bachelor of mining engineering, and bachelor of petroleum engineering.

## GEOLOGICAL ENGINEERING

The course in Geological Engineering is designed to prepare students for responsible positions in geological departments of exploration, oil, or mining companies, or to engage in consulting geological practice.

Many ore deposits are economically of no particular value at the present time, either because the cost of mining is excessive or because there is no known method of separating the minerals in the ore at a profit. In addition to thoro courses in geology, the mining geologist must be familiar with the various methods of mining and know something of the possibilities of ore dressing to recover the valuable minerals. A knowledge of the fundamental principles of the smelting and refining of metals is a decided asset in his work.

The Department of Geology is well supplied with working collections of minerals, crystal models, rocks, thin sections, ores and economic minerals, fossils, and other illustrative material used in connection with the courses in paleontology, stratigraphy, and historical geology. Large, well-lighted, and fully equipped laboratories are available for the basic courses of mineralogy, rock study, and petrology. Special equipment is available for studies in sedimentation, rock analysis, and X-ray studies of minerals.

Students taking the five-year combined course with business administration may substitute business courses for Nat. Sci. 7, 8, 9; Soc. Sci. 1, 2, 3; Hum. 1, 2, 3, or 11, 12, 13 or 21-22-23; Geol. 101, 132, 166, 61, 140; Engl. 85, 86; Mining 141, 143; Met. 106, 107, and Science, Literature, and the Arts electives.

For freshman year see page 16.

For second year see page 59.

† Three of the five laboratory courses M.E. 149, 159, 169, 174, 189 must be taken in the three quarters and not more than two in any one quarter.

‡ A minimum of 4 credits in engineering design must be completed in addition to M.E. 121. The following courses are accepted for this requirement: M.E. 122-123, Mechanical Engineering Design; M.E. 147, Design of Steam Machinery; M.E. 148, Design of Power Plant Units; M.E. 154, 155, Design of Internal Combustion Engines, M.E. 161, 162, Heating and Ventilation Design; M.E. 170, Tool Design and Construction; M.E. 172, Industrial Plant Design; C.E. 37, Structural Engineering; M.E. 182, Refrigeration Design.

¶ M.&M. 151 may be taken either during the second or third quarter.

## MINING ENGINEERING

The course in Mining is designed to prepare the student for responsible positions in the field of mining. In such positions a mining engineer, in addition to meeting the technical problems involved in the development and operation of a mine, must be able to pass upon proposals and specifications for structures and for mechanical and electrical equipment. In addition he must be familiar with the fundamental principles of mineral dressing and be able to determine whether separation of the minerals in the ore may be made at a profit. The basic training must, therefore, include thoro courses in mathematics, drafting, chemistry, physics, and geology including the identification of minerals and rocks. It must also include plane and mine surveying, mapping, assaying, mineral dressing, and ore testing.

The Department of Mining is well-supplied with samples of the smaller mine equipment, models, drawings, photographs, lantern slides, and mine maps. The lectures treat of prospecting, development, support of excavations, mining methods, mine administration, mining law, safety and safety regulations, and the necessary allied subjects.

Students taking the five-year combined course with business administration may substitute business courses for Nat. Sci. 7-8-9; Soc. Sci. 1-2-3; Hum. 1-2-3 or 11-12-13 or 21-22-23; Mining 127, 141, 144; Geology 125; Met. 121, 156; M.E. 138; E.E. 41 and electives.

For freshman year see page 16.

For second year see page 59.

## PETROLEUM ENGINEERING

The course in Petroleum Engineering is designed to prepare the student for responsible positions in the field of petroleum production. In such a position the petroleum engineer must be familiar with geology and in particular with oil geology. This involves a knowledge of the various geological ages during which oil was formed, of the geological conditions under which the oil was collected in pools, and the methods of interpreting geological data to determine whether or not a given locality may contain such pools. He must know the principles of pumping, with both gas lift and mechanical pumps, and the methods of gasoline recovery to be used in connection with these methods.

The basic training must, therefore, include thoro courses in mathematics, drafting, chemistry, physics, and geology, including in particular, a thoro knowledge of sedimentary deposits. It must also include surveying and mapping.

The department is well supplied with samples of the smaller oil field equipment, well logs, drill cores, models, maps, photographs, lantern slides, and samples of petroleum products. The lectures treat of location, prospecting, development, production, refining methods, distribution, administration, leasing, mineral laws, safety work and safety regulations, and allied subjects affecting oil and gas production. Laboratory work includes special problems in oil and gas production.

Students taking the five-year combined course with business administration may substitute business courses for Biol. 7, 8, 9; Soc. Sci. 1, 2, 3; Met. 156; Hum. 1, 2, 3 or 11, 12, 13 or 21, 22, 23; Geol. 101, 125, 131; E.E. 41; Min. 141; Pet. 134, 144, and Institute of Technology and Science, Literature, and the Arts electives.

For freshman year see page 16.

For second year see page 59.

## GEOLOGICAL, MINING, AND PETROLEUM ENGINEERING

Candidates for either of these degrees need not choose the field of specialization until the beginning of the junior year.



## FIVE-YEAR COURSE

## SECOND YEAR

*First Quarter*

| Course No.  | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Geol. 11    | General and Historical Geology .....      | 5       | ..... | 5     | 1     |
| Nat.Sci. 7* | General Biology .....                     | 3       | ..... | 2     | 2     |

*Second Quarter*

|             |                                    |   |       |       |       |
|-------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25    | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Geol. 23    | Mineralogy .....                   | 5 | 1     | 3     | 4     |
| Nat.Sci. 8* | General Biology .....              | 3 | ..... | 2     | 2     |

*Third Quarter*

|             |  |   |       |   |   |
|-------------|--|---|-------|---|---|
| Phys. 9     | General Physics: Sound and Light ..... | 5 | 1     | 4 | 2 |
| Geol. 24    | Mineralogy .....                       | 5 | 1     | 3 | 4 |
| Met. 1      | Assaying .....                         | 3 | ..... | 3 | 4 |
| Nat.Sci. 9* | General Biology .....                  | 3 | ..... | 2 | 2 |

## GEOLOGICAL ENGINEERING

## FIVE-YEAR COURSE

## THIRD YEAR

*First Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| Geol. 105   | Rock Study .....                     | 2 | ..... | 2     | 2     |
| Geol. 125   | Structural Geology .....             | 3 | ..... | 3     | ..... |
| Met. 110    | Mineral Dressing .....               | 3 | ..... | 2     | 3     |
| Min. 11     | Surveying .....                      | 3 | 1     | 3     | ..... |
| Soc.Sci. 1* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
| Electives   | Science, Literature and Arts .....   | 3 | ..... | ..... | ..... |

*Second Quarter*

|              |                                      |   |       |       |       |
|--------------|--------------------------------------|---|-------|-------|-------|
| Anal.Chem. 9 | Quantitative Analysis .....          | 3 | 1     | 1     | 6     |
| Geol. 106    | Petrography .....                    | 2 | ..... | 2     | 2     |
| Met. 111     | Mineral Dressing .....               | 3 | ..... | 2     | 3     |
| Min. 12      | Surveying .....                      | 3 | 1     | 3     | ..... |
| Soc.Sci. 2*  | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
| Electives    | Science, Literature and Arts .....   | 3 | ..... | ..... | ..... |

*Third Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 26    | Technical Mechanics: Statics .....   | 5 | 5     | ..... | ..... |
| Min. 13     | Mine Surveying .....                 | 2 | 1     | 2     | ..... |
| Min. 14     | Surveying Field Work .....           | 5 | ..... | ..... | 20    |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Summer Field Trips*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| Min. 15   | Field work in surveying on the iron ranges of Minnesota | 8 | ..... | ..... | ..... |
| Geol. 100 | Field work in geology on the iron ranges of Minnesota   | 3 | ..... | ..... | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

## INSTITUTE OF TECHNOLOGY

## FOURTH YEAR

*First Quarter*

| Course No. | Title                                   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| Geol. 91   | Invertebrate Paleontology .....         | 3       | ..... | ..... | 6     |
| Geol. 131  | Advanced Petrology .....                | 4       | 1     | 3     | 4     |
| Geol. 144  | Interpretation of Geological Maps ..... | 3       | ..... | ..... | 6     |
| Min. 111   | Exploration .....                       | 4       | ..... | 5     | ..... |
| Hum. 1*    | Humanities in the Modern World I .....  | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 11*   | The Greek Heritage .....                | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 21*   | Humanities in the United States .....   | 3       | ..... | 3     | ..... |

*Second Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Geol. 92  | Invertebrate Paleontology .....                    | 3 | ..... | ..... | 6     |
| Geol. 132 | Advanced Petrology .....                           | 4 | 1     | 3     | 4     |
| Geol. 145 | Use and Interpretation of Aerial Photographs ..... | 3 | ..... | ..... | 6     |
| Min. 112  | Exploration and Development .....                  | 4 | ..... | 5     | ..... |
| Hum. 2*   | Humanities in the Modern World II .....            | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 12*  | The Roman and the Medieval Heritage .....          | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 22*  | Humanities in the United States .....              | 3 | ..... | 3     | ..... |

*Third Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics .....      | 5 | 5     | ..... | ..... |
| Geol. 93  | Invertebrate Paleontology .....          | 3 | ..... | ..... | 6     |
| Geol. 124 | Metamorphic Geology .....                | 3 | ..... | 3     | ..... |
| Min. 113  | Development and Exploitation .....       | 4 | ..... | 5     | ..... |
| Hum. 3*   | Humanities in the Modern World III ..... | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 13*  | The Renaissance Heritage .....           | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 23*  | Humanities in the United States .....    | 3 | ..... | 3     | ..... |

*Summer Field Trip*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Geol. 150 | Field Geology. Detailed systematic work conforming with standards of official surveys. Preparation of geologic maps, structure sections, reports; paragenesis of ores and their relations to geologic structures. Field, Black Hills, South Dakota ..... | 6 | ..... | ..... | ..... |
|-----------|--|---|-------|-------|-------|

## FIFTH YEAR

*First Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Geol. 101 | Sedimentation .....                    | 3 | ..... | 3     | ..... |
| Geol. 110 | Economic Geology .....                 | 3 | ..... | 3     | ..... |
| Geol. 151 | Stratigraphy .....                     | 3 | ..... | 3     | ..... |
| Engl. 85  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| Met. 106  | Nonferrous Metallurgy .....            | 3 | ..... | 3     | ..... |
| Min. 141  | Reports and Administration .....       | 4 | ..... | 5     | ..... |

*Second Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Geol. 111 | Economic Geology .....                 | 3 | ..... | 3     | ..... |
| Geol. 152 | Stratigraphy .....                     | 3 | ..... | 3     | ..... |
| Geol. 166 | Mineralography .....                   | 3 | ..... | ..... | 6     |
| Engl. 86  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| Met. 107  | Nonferrous Metallurgy .....            | 3 | ..... | 3     | ..... |

\* See page 74 for alternate sequences which may be substituted as a unit.

*Third Quarter*

| Course No. | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|------------|--|---------|-------|-------|-------|
| Geol. 61   | Blowpipe Analysis .....                | 3       | ..... | 2     | 4     |
| Geol. 112  | Economic Geology .....                 | 3       | ..... | 3     | ..... |
| Geol. 140  | Applied Petrography .....              | 3       | ..... | 1     | 4     |
| Geol. 153  | Stratigraphy .....                     | 3       | ..... | 3     | ..... |
| Min. 143   | Mining Law, Quarries and Placers ..... | 4       | ..... | 5     | ..... |

## MINING ENGINEERING

## FIVE-YEAR COURSE

## THIRD YEAR

*First Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| Geol. 105   | Rock Study .....                     | 2 | ..... | 2     | 2     |
| Met. 11     | Metallurgy of Pig Iron .....         | 3 | 1     | 3     | ..... |
| Met. 110    | Mineral Dressing .....               | 3 | ..... | 2     | 3     |
| Min. 11     | Surveying .....                      | 3 | 1     | 3     | ..... |
| Soc.Sci. 1* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |
| Electives   | Science, Literature, and Arts .....  | 3 | ..... | ..... | ..... |

*Second Quarter*

|              |                                      |   |       |   |       |
|--------------|--------------------------------------|---|-------|---|-------|
| Anal.Chem. 9 | Quantitative Analysis .....          | 3 | 1     | 1 | 6     |
| Geol. 106    | Petrography .....                    | 2 | ..... | 2 | 2     |
| Met. 111     | Mineral Dressing .....               | 3 | ..... | 2 | 3     |
| Min. 12      | Surveying .....                      | 3 | 1     | 3 | ..... |
| Soc.Sci. 2*  | Introduction to Social Science ..... | 4 | ..... | 4 | ..... |

*Third Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 26    | Technical Mechanics: Statics .....   | 5 | 5     | ..... | ..... |
| Met. 112    | Mineral Dressing .....               | 3 | ..... | 2     | 3     |
| Min. 13     | Mine Surveying .....                 | 2 | 1     | 2     | ..... |
| Min. 14     | Surveying Field Work .....           | 5 | ..... | ..... | 20    |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

*Summer Field Trips*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Min. 15   | Field Work in Surveying on the iron ranges<br>of Minnesota ..... | 8 | ..... | ..... | ..... |
| Geol. 100 | Field work in geology on the iron ranges<br>of Minnesota .....   | 3 | ..... | ..... | ..... |

## FOURTH YEAR

*First Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| M.&M. 128 | Strength of Materials .....            | 5 | 5     | ..... | ..... |
| Geol. 110 | Economic Geology .....                 | 3 | ..... | 3     | ..... |
| Met. 106  | Nonferrous Metallurgy .....            | 3 | ..... | 3     | ..... |
| Min. 111  | Exploration .....                      | 4 | ..... | 5     | ..... |
| Hum. 1*   | Humanities in the Modern World I ..... | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 11*  | The Greek Heritage .....               | 5 | ..... | 5     | ..... |
| or        |  |   |       |       |       |
| Hum. 21*  | Humanities in the United States .....  | 3 | ..... | 3     | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

## INSTITUTE OF TECHNOLOGY

## Second Quarter

| Course No. | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| M.&M. 129  | Hydraulics .....                          | 4       | 4     | ..... | ..... |
| Geol. 111  | Economic Geology .....                    | 3       | ..... | 3     | ..... |
| Met. 107   | Nonferrous Metallurgy .....               | 3       | ..... | 3     | ..... |
| Min. 106   | Mine Mapping .....                        | 2       | ..... | ..... | 8     |
| Min. 112   | Exploration and Development .....         | 4       | ..... | 5     | ..... |
| Hum. 2*    | Humanities in the Modern World .....      | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 12*   | The Roman and the Medieval Heritage ..... | 5       | ..... | 5     | ..... |
| or         |   |         |       |       |       |
| Hum. 22*   | Humanities in the United States .....     | 3       | ..... | 3     | ..... |

## Third Quarter

|           |                                       |   |       |       |       |
|-----------|---------------------------------------|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics .....   | 5 | 5     | ..... | ..... |
| Geol. 112 | Economic Geology .....                | 3 | ..... | 3     | ..... |
| Min. 113  | Development and Exploitation .....    | 4 | ..... | 5     | ..... |
| Hum. 3*   | Humanities in the Modern World .....  | 5 | ..... | 5     | ..... |
| or        |                                       |   |       |       |       |
| Hum. 13*  | The Renaissance Heritage .....        | 5 | ..... | 5     | ..... |
| or        |                                       |   |       |       |       |
| Hum. 23*  | Humanities in the United States ..... | 3 | ..... | 3     | ..... |

## Summer Field Trip

|          |   |   |  |  |  |
|----------|---|---|--|--|--|
| Min. 139 | Study of mining operations, mine plants, and metallurgical plants in one or more western mining camps ..... | 6 |  |  |  |
|----------|---|---|--|--|--|

## FIFTH YEAR

## First Quarter

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Engr. 85  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| Geol. 125 | Structural Geology .....               | 3 | ..... | 3     | ..... |
| Met. 121  | Ore Testing .....                      | 2 | ..... | 1     | 3     |
| Met. 156  | Metallography .....                    | 3 | ..... | 2     | 3     |
| Min. 126  | Engineering Construction .....         | 3 | ..... | ..... | 8     |
| Min. 141  | Reports and Administration .....       | 4 | ..... | 5     | ..... |

## Second Quarter

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Engr. 86  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| M.E. 138  | General Laboratory .....               | 2 | ..... | ..... | 4     |
| Min. 127  | Engineering Construction .....         | 3 | ..... | ..... | 8     |
| Min. 142  | Coal Mining .....                      | 4 | ..... | 5     | ..... |
| Min. 144  | Advanced Mining .....                  | 3 | ..... | ..... | 8     |
| Electives | Science, Literature, and Arts .....    | 3 | ..... | ..... | ..... |

## FIFTH YEAR

## Third Quarter

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| E.E. 41   | Electrical Engineering Survey .....    | 3 | ..... | 2     | 3     |
| Min. 143  | Mining Law, Quarries and Placers ..... | 4 | ..... | 5     | ..... |
| Min. 145  | Advanced Mining .....                  | 4 | ..... | ..... | 8     |
| Electives | Science, Literature, and Arts .....    | 3 | ..... | ..... | ..... |

## PETROLEUM ENGINEERING

## FIVE-YEAR COURSE

## THIRD YEAR

## First Quarter

|             |                                      |   |       |   |       |
|-------------|--------------------------------------|---|-------|---|-------|
| Geol. 105   | Rock Study .....                     | 2 | ..... | 2 | 2     |
| Geol. 151   | Stratigraphy .....                   | 3 | ..... | 3 | ..... |
| Met. 156    | Metallography .....                  | 3 | ..... | 2 | 3     |
| Min. 11     | Surveying .....                      | 3 | 1     | 3 | ..... |
| Soc.Sci. 1* | Introduction to Social Science ..... | 4 | ..... | 4 | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

*Second Quarter*

| Course No.   | Title                                | Credits | Rec. | Lect. | Lab. |
|--------------|--------------------------------------|---------|------|-------|------|
| Anal.Chem. 9 | Quantitative Analysis .....          | 3       | 1    | 1     | 6    |
| Geol. 106    | Petrography .....                    | 2       |      | 2     | 2    |
| Geol. 152    | Stratigraphy .....                   | 3       |      | 3     |      |
| Min. 12      | Surveying .....                      | 3       | 1    | 3     |      |
| Soc.Sci. 2*  | Introduction to Social Science ..... | 4       |      | 4     |      |

*Third Quarter*

|             |                                      |   |   |   |    |
|-------------|--------------------------------------|---|---|---|----|
| M.&M. 26    | Technical Mechanics: Statics .....   | 5 | 5 |   |    |
| Geol. 153   | Stratigraphy .....                   | 3 |   | 3 |    |
| Min. 13     | Mine Surveying .....                 | 2 | 1 | 2 |    |
| Min. 14     | Surveying Field Work .....           | 5 |   |   | 20 |
| Soc.Sci. 3* | Introduction to Social Science ..... | 4 |   | 4 |    |

*Summer Field Trips*

|           |   |   |  |  |  |
|-----------|---|---|--|--|--|
| Min. 15   | Field work in surveying on the iron ranges of Minnesota | 8 |  |  |  |
| Geol. 100 | Field work in geology on the iron ranges of Minnesota   | 3 |  |  |  |

## FOURTH YEAR

*First Quarter*

|            |  |   |   |   |  |
|------------|--|---|---|---|--|
| M.&M. 128  | Strength of Materials .....            | 5 | 5 |   |  |
| Geol. 101  | Sedimentation .....                    | 3 |   | 3 |  |
| Hum. 21*   | Structural Geology .....               | 3 |   | 3 |  |
| Geol. 125  | Oil Field Development .....            | 3 |   | 4 |  |
| Pet.E. 111 | Humanities in the Modern World I ..... | 5 |   | 5 |  |
| Hum. 1*    |  |   |   |   |  |
| or         | The Greek Heritage .....               | 5 |   | 5 |  |
| Hum. 11*   |  |   |   |   |  |
| or         | Humanities in the United States .....  | 3 |   | 3 |  |

## FOURTH YEAR

*Second Quarter*

|            |   |   |   |   |   |
|------------|---|---|---|---|---|
| M.&M. 129  | Hydraulics .....                          | 4 | 4 |   |   |
| Geol. 131  | Advanced Petrology .....                  | 4 | 1 | 3 | 4 |
| Min. 107   | Mine Mapping .....                        | 1 |   |   | 3 |
| Pet.E. 122 | Oil Field Production .....                | 3 |   | 4 |   |
| Hum. 2*    | Humanities in the Modern World II .....   | 5 |   | 5 |   |
| or         |   |   |   |   |   |
| Hum. 12*   | The Roman and the Medieval Heritage ..... | 5 |   | 5 |   |
| or         |   |   |   |   |   |
| Hum. 2*    | Humanities in the United States .....     | 3 |   | 3 |   |

*Third Quarter*

|            |  |   |   |   |   |
|------------|--|---|---|---|---|
| M.&M. 127  | Technical Mechanics: Dynamics .....      | 5 | 5 |   |   |
| E.E. 41    | Electrical Engineering Survey .....      | 3 |   | 2 | 3 |
| Geol. 112  | Economic Geology .....                   | 3 |   | 3 |   |
| Pet.E. 131 | Petroleum Refining .....                 | 2 |   | 2 |   |
| Hum. 3*    | Humanities in the Modern World III ..... | 5 |   | 5 |   |
| or         |  |   |   |   |   |
| Hum. 13*   | The Renaissance Heritage .....           | 5 |   | 5 |   |
| or         |  |   |   |   |   |
| Hum. 23*   | Humanities in the United States .....    | 3 |   | 3 |   |
| Electives  | Science, Literature, and Arts .....      | 3 |   |   |   |

*Summer Field Trip*

|            |   |   |  |  |  |
|------------|---|---|--|--|--|
| Pet.E. 135 | Study of oil well drilling and production methods and refining practice in one or more oil fields ..... | 6 |  |  |  |
|------------|---|---|--|--|--|

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

## INSTITUTE OF TECHNOLOGY

## FIFTH YEAR

*First Quarter*

| Course No. | Title                                  | Credits | Rec.  | Lect. | Lab.  |
|------------|--|---------|-------|-------|-------|
| Engl. 85   | Advanced Technical Communication ..... | 3       | 3     | ..... | ..... |
| Min. 126   | Engineering Construction .....         | 3       | ..... | ..... | 8     |
| Min. 141   | Reports and Administration .....       | 4       | ..... | 5     | ..... |
| Pet.E. 152 | Petroleum Production Technology .....  | 3       | ..... | 1     | 6     |
| Electives  | Science, Literature, and Arts .....    | 5       | ..... | ..... | ..... |

*Second Quarter*

|            |   |   |       |       |       |
|------------|---|---|-------|-------|-------|
| Engl. 86   | Advanced Technical Communication .....  | 3 | 3     | ..... | ..... |
| Geol. 144  | Interpretation of Geological Maps ..... | 3 | ..... | ..... | 6     |
| Min. 127   | Engineering Construction .....          | 3 | ..... | ..... | 8     |
| Pet.E. 144 | Advanced Petroleum Engineering .....    | 5 | ..... | 4     | 6     |
| Pet.E. 153 | Petroleum Production Technology .....   | 3 | ..... | 1     | 6     |

*Third Quarter*

|            |                                       |   |       |       |       |
|------------|---------------------------------------|---|-------|-------|-------|
| Pet.E. 134 | Petroleum Plant .....                 | 2 | ..... | 3     | ..... |
| Pet.E. 138 | Oil Field Mapping .....               | 2 | ..... | ..... | 6     |
| Pet.E. 145 | Advanced Petroleum Engineering .....  | 5 | ..... | 4     | 6     |
| Pet.E. 154 | Petroleum Production Technology ..... | 3 | ..... | 1     | 6     |
| Electives  | Institute of Technology .....         | 7 | ..... | ..... | ..... |

## GEOLOGICAL, MINING, AND PETROLEUM ENGINEERING

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered Prior to the Fall Quarter, 1946

## SOPHOMORE YEAR

*First Quarter*

|          |                                      |   |       |       |       |
|----------|--------------------------------------|---|-------|-------|-------|
| M.&M. 24 | Calculus I: Differential .....       | 5 | 5     | ..... | ..... |
| Phys. 7  | General Physics .....                | 5 | 1     | 4     | 2     |
| Geol. 11 | General and Historical Geology ..... | 5 | ..... | 5     | 1     |
| Min. 11  | Surveying .....                      | 3 | 1     | 3     | ..... |
| Met. 1   | Assaying .....                       | 3 | ..... | 3     | 4     |

*Second Quarter*

|          |                             |   |   |       |       |
|----------|-----------------------------|---|---|-------|-------|
| M.&M. 25 | Calculus II: Integral ..... | 5 | 5 | ..... | ..... |
| Phys. 8  | General Physics .....       | 5 | 1 | 4     | 2     |
| Geol. 23 | Mineralogy .....            | 5 | 1 | 3     | 4     |
| Min. 12  | Surveying .....             | 3 | 1 | 3     | ..... |

*Third Quarter*

|          |  |   |       |       |       |
|----------|--|---|-------|-------|-------|
| Phys. 9  | General Physics .....                    | 5 | 1     | 4     | 2     |
| Geol. 24 | Mineralogy .....                         | 5 | 1     | 3     | 4     |
| Min. 13  | Mine Surveying .....                     | 2 | 1     | 2     | ..... |
| Min. 14  | Surveying Field Work .....               | 5 | ..... | ..... | 20    |
| Min. 120 | First Aid (1 week, 3 hrs. per day) ..... | 0 | ..... | ..... | ..... |

*Summer Field Trips*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| Min. 15   | Field work in surveying on the iron ranges of Minnesota | 8 | ..... | ..... | ..... |
| Geol. 100 | Field work in geology on the iron ranges of Minnesota   | 3 | ..... | ..... | ..... |

## GEOLOGICAL ENGINEERING

## FOUR-YEAR COURSE

## JUNIOR YEAR

*First Quarter*

|           |                                    |   |       |       |       |
|-----------|------------------------------------|---|-------|-------|-------|
| M.&M. 26  | Technical Mechanics: Statics ..... | 5 | 5     | ..... | ..... |
| Geol. 105 | Rock Study .....                   | 2 | ..... | 2     | 2     |
| Geol. 125 | Structural Geology .....           | 3 | ..... | 3     | ..... |
| Geol. 151 | Stratigraphy .....                 | 3 | ..... | 3     | ..... |
| Min. 106  | Mine Mapping .....                 | 2 | ..... | ..... | 8     |
| Min. 111  | Exploration .....                  | 4 | ..... | 5     | ..... |

*Second Quarter*

| Course No. | Title                                   | Credits | Rec.  | Lect. | Lab.  |
|------------|---|---------|-------|-------|-------|
| Geol. 61   | Blowpipe Analysis .....                 | 3       | ..... | 2     | 4     |
| Geol. 106  | Petrography .....                       | 2       | ..... | 2     | 2     |
| Geol. 124  | Metamorphic Geology .....               | 3       | ..... | 3     | ..... |
| Geol. 144  | Interpretation of Geological Maps ..... | 3       | ..... | ..... | 6     |
| Geol. 152  | Stratigraphy .....                      | 3       | ..... | 3     | ..... |
| Min. 112   | Exploration and Development .....       | 4       | ..... | 5     | ..... |

*Third Quarter*

|           |                                       |   |       |       |       |
|-----------|---------------------------------------|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics .....   | 5 | 5     | ..... | ..... |
| Geol. 131 | Advanced Petrology .....              | 4 | 1     | 3     | 4     |
| Geol. 145 | Interpretation of Geologic Maps ..... | 3 | ..... | ..... | 6     |
| Geol. 153 | Stratigraphy .....                    | 3 | ..... | 3     | ..... |
| Min. 113  | Development and Exploitation .....    | 4 | ..... | 5     | ..... |

*Summer Field Trip*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Geol. 150 | Field Geology. Detailed systematic work conforming with standards of official surveys. Preparation of geologic maps, structure sections, reports; paragenesis of ores and their relations to geologic structures. Field, Black Hills, South Dakota ..... | 6 | ..... | ..... | ..... |
|-----------|--|---|-------|-------|-------|

## SENIOR YEAR

*First Quarter*

|           |                                  |   |       |       |       |
|-----------|----------------------------------|---|-------|-------|-------|
| Geol. 91  | Invertebrate Paleontology .....  | 3 | ..... | ..... | 6     |
| Geol. 101 | Sedimentation .....              | 3 | ..... | 3     | ..... |
| Geol. 110 | Economic Geology .....           | 3 | ..... | 3     | ..... |
| Geol. 132 | Advanced Petrology .....         | 4 | 1     | 3     | 4     |
| Met. 106  | Nonferrous Metallurgy .....      | 3 | ..... | 3     | ..... |
| Met. 110  | Mineral Dressing .....           | 3 | ..... | 2     | 3     |
| Min. 141  | Reports and Administration ..... | 4 | ..... | 5     | ..... |

*Second Quarter*

|           |                                 |   |       |       |       |
|-----------|---------------------------------|---|-------|-------|-------|
| Geol. 92  | Invertebrate Paleontology ..... | 3 | ..... | ..... | 6     |
| Geol. 111 | Economic Geology .....          | 3 | ..... | 3     | ..... |
| Geol. 140 | Applied Petrography .....       | 3 | ..... | 1     | 4     |
| Geol. 166 | Mineralography .....            | 3 | ..... | ..... | 6     |
| Met. 107  | Nonferrous Metallurgy .....     | 3 | ..... | 3     | ..... |
| Met. 111  | Mineral Dressing .....          | 3 | ..... | 2     | 3     |

*Third Quarter*

|           |   |   |       |       |       |
|-----------|---|---|-------|-------|-------|
| Geol. 93  | Invertebrate Paleontology .....         | 3 | ..... | ..... | 6     |
| Ger. 112  | Economic Geology .....                  | 3 | ..... | 3     | ..... |
| Geol. 141 | Applied Petrography .....               | 3 | ..... | 1     | 4     |
| Geol. 167 | Mineralography .....                    | 3 | ..... | ..... | 6     |
| Min. 143  | Mining Law, Quarries, and Placers ..... | 3 | ..... | 4     | ..... |

## MINING ENGINEERING

## FOUR-YEAR COURSE

## JUNIOR YEAR

*First Quarter*

|           |                                    |   |       |       |       |
|-----------|------------------------------------|---|-------|-------|-------|
| M.&M. 26  | Technical Mechanics: Statics ..... | 5 | 5     | ..... | ..... |
| Geol. 105 | Rock Study .....                   | 2 | ..... | 2     | 2     |
| Met. 106  | Nonferrous Metallurgy .....        | 3 | ..... | 3     | ..... |
| Met. 110  | Mineral Dressing .....             | 3 | ..... | 2     | 3     |
| Min. 106  | Mine Mapping .....                 | 2 | ..... | ..... | 8     |
| Min. 111  | Exploration .....                  | 4 | ..... | 5     | ..... |

## INSTITUTE OF TECHNOLOGY

|            |                                   | <i>Second Quarter</i> |       |       |       |
|------------|-----------------------------------|-----------------------|-------|-------|-------|
| Course No. | Title                             | Credits               | Rec.  | Lect. | Lab.  |
| M.&M. 128  | Strength of Materials .....       | 5                     | 5     | ..... | ..... |
| Geol. 106  | Petrography .....                 | 2                     | ..... | 2     | 2     |
| Met. 107   | Nonferrous Metallurgy .....       | 3                     | ..... | 3     | ..... |
| Met. 111   | Mineral Dressing .....            | 3                     | ..... | 2     | 3     |
| Min. 112   | Exploration and Development ..... | 4                     | ..... | 5     | ..... |

|           |                                     | <i>Third Quarter</i> |       |       |       |
|-----------|-------------------------------------|----------------------|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics ..... | 5                    | 5     | ..... | ..... |
| E.E. 41   | Electric Engineering Survey .....   | 3                    | ..... | 2     | 3     |
| Met. 108  | Nonferrous Metallurgy .....         | 3                    | ..... | 3     | ..... |
| Met. 112  | Mineral Dressing .....              | 3                    | ..... | 2     | 3     |
| Min. 113  | Development and Exploitation .....  | 4                    | ..... | 5     | ..... |

|          |   | <i>Summer Field Trip</i> |       |       |       |
|----------|---|--------------------------|-------|-------|-------|
| Min. 139 | Study of mining operations, mine plants, and metallurgical plants in one or more western mining camps ..... | 6                        | ..... | ..... | ..... |

## SENIOR YEAR

|           |                                   | <i>First Quarter</i> |       |       |       |
|-----------|-----------------------------------|----------------------|-------|-------|-------|
| Geol. 110 | Economic Geology .....            | 3                    | ..... | 3     | ..... |
| Geol. 125 | Structural Geology .....          | 3                    | ..... | 3     | ..... |
| M.E. 12   | Materials and Processing II ..... | 2                    | ..... | 2     | 3     |
| Met. 121  | Ore Testing .....                 | 2                    | ..... | 1     | 3     |
| Min. 126  | Engineering Construction .....    | 3                    | ..... | ..... | 8     |
| Min. 141  | Reports and Administration .....  | 4                    | ..... | 5     | ..... |

|           |                                    | <i>Second Quarter</i> |       |       |       |
|-----------|------------------------------------|-----------------------|-------|-------|-------|
| M.&M. 129 | Hydraulics .....                   | 4                     | 4     | ..... | ..... |
| Geol. 111 | Economic Geology .....             | 3                     | ..... | 3     | ..... |
| M.E. 13   | Materials and Processing III ..... | 2                     | ..... | 2     | 3     |
| M.E. 138  | General Laboratory .....           | 2                     | ..... | ..... | 4     |
| Min. 127  | Engineering Construction .....     | 3                     | ..... | ..... | 8     |
| Min. 142  | Coal Mining .....                  | 4                     | ..... | 5     | ..... |
| Min. 144  | Advanced Mining .....              | 3                     | ..... | ..... | 8     |

|           |   | <i>Third Quarter</i> |       |       |       |
|-----------|---|----------------------|-------|-------|-------|
| Geol. 112 | Economic Geology .....                  | 3                    | ..... | 3     | ..... |
| M.E. 6    | Machine Shop Practice .....             | 2                    | ..... | 2     | 3     |
| Met. 156  | Metallography .....                     | 3                    | ..... | 2     | 3     |
| Min. 143  | Mining Law, Quarries, and Placers ..... | 4                    | ..... | 5     | ..... |
| Min. 145  | Advanced Mining .....                   | 4                    | ..... | ..... | 8     |

## PETROLEUM ENGINEERING

## FOUR-YEAR COURSE

## THIRD YEAR

|            |                                    | <i>First Quarter</i> |       |       |       |
|------------|------------------------------------|----------------------|-------|-------|-------|
| M.&M. 26   | Technical Mechanics: Statics ..... | 5                    | 5     | ..... | ..... |
| Geol. 105  | Rock Study .....                   | 2                    | ..... | 2     | 2     |
| Geol. 125  | Structural Geology .....           | 3                    | ..... | 3     | ..... |
| Geol. 151  | Stratigraphy .....                 | 3                    | ..... | 3     | ..... |
| Pet.E. 111 | Oil Field Development .....        | 3                    | ..... | 4     | ..... |

|            |   | <i>Second Quarter</i> |       |       |       |
|------------|---|-----------------------|-------|-------|-------|
| M.&M. 128  | Strength of Materials .....             | 5                     | 5     | ..... | ..... |
| Geol. 106  | Petrography .....                       | 2                     | ..... | 2     | 2     |
| Geol. 144  | Interpretation of Geological Maps ..... | 3                     | ..... | ..... | 6     |
| Geol. 152  | Stratigraphy .....                      | 3                     | ..... | 3     | ..... |
| Min. 107   | Mine Mapping .....                      | 1                     | ..... | ..... | 3     |
| Pet.E. 112 | Oil Field Production .....              | 3                     | ..... | 4     | ..... |



*Third Quarter*

| Course No. | Title                               | Credits | Rec.  | Lect. | Lab.  |
|------------|-------------------------------------|---------|-------|-------|-------|
| M.&M. 127  | Technical Mechanics: Dynamics ..... | 5       | 5     | ..... | ..... |
| Geol. 112  | Economic Geology .....              | 3       | ..... | 3     | ..... |
| Geol. 131  | Advanced Petrology .....            | 4       | ..... | 3     | 4     |
| Pet.E. 131 | Petroleum Refining .....            | 2       | ..... | 2     | ..... |
| Pet.E. 138 | Oil Field Mapping .....             | 2       | ..... | ..... | 6     |

*Summer Field Trip*

|            |   |   |       |       |       |
|------------|---|---|-------|-------|-------|
| Pet.E. 135 | Study of oil well drilling and production methods and refining practice in one or more oil fields ..... | 6 | ..... | ..... | ..... |
|------------|---|---|-------|-------|-------|

FOURTH YEAR

*First Quarter*

|            |                                       |   |       |       |       |
|------------|---------------------------------------|---|-------|-------|-------|
| Geol. 101  | Sedimentation .....                   | 3 | ..... | 3     | ..... |
| Geol. 110  | Economic Geology .....                | 3 | ..... | 3     | ..... |
| M.E. 13    | Materials and Processing III .....    | 2 | ..... | 2     | 3     |
| Min. 126   | Engineering Construction .....        | 3 | ..... | ..... | 8     |
| Min. 141   | Reports and Administration .....      | 4 | ..... | 5     | ..... |
| Pet.E. 152 | Petroleum Production Technology ..... | 3 | ..... | 1     | 6     |

*Second Quarter*

|            |                                       |   |       |       |       |
|------------|---------------------------------------|---|-------|-------|-------|
| M.&M. 129  | Hydraulics .....                      | 4 | 4     | ..... | ..... |
| Geol. 111  | Economic Geology .....                | 3 | ..... | 3     | ..... |
| Min. 127   | Engineering Construction .....        | 3 | ..... | ..... | 8     |
| Pet.E. 144 | Advanced Petroleum Engineering .....  | 5 | ..... | 4     | 6     |
| Pet.E. 153 | Petroleum Production Technology ..... | 3 | ..... | 1     | 6     |

*Third Quarter*

|            |                                       |   |       |   |       |
|------------|---------------------------------------|---|-------|---|-------|
| Geol. 153  | Stratigraphy .....                    | 3 | ..... | 3 | ..... |
| M.E. 6     | Machine Shop Practice .....           | 2 | ..... | 2 | 3     |
| Met. 156   | Metallography .....                   | 3 | ..... | 2 | 3     |
| Pet.E. 134 | Petroleum Plant .....                 | 2 | ..... | 3 | ..... |
| Pet.E. 145 | Advanced Petroleum Engineering .....  | 5 | ..... | 4 | 6     |
| Pet.E. 154 | Petroleum Production Technology ..... | 3 | ..... | 1 | 6     |

METALLURGICAL ENGINEERING

Five-year course leading to the degree of bachelor of metallurgical engineering, required of all students except veterans, beginning with freshmen who enter in the fall of 1946. Students taking the five-year combined curricula are required to take prescribed courses including summer field trips and electives. Exclusive of summer field trips a total of 255 credits is required for graduation. The equivalent of approximately one year's work in the Arts College is distributed over a five-year program to provide a more general education for all except veterans who are more mature and anxious to begin their professional careers without further delay.

A four-year course requiring 209 credits for graduation, exclusive of field trip, and leading to a degree of bachelor of metallurgical engineering is open only to veterans and those who enter prior to the fall of 1946.

Courses in metallurgy are designed to prepare the student for responsible positions in metallurgical industries. The instruction deals with the production and uses of ferrous, nonferrous, and precious metals. Metallurgists are concerned with the preparation of raw materials for smelting, the design and operation of furnaces to convert ores into metals, and the structure and physical properties of metals and alloys.

Lectures cover the construction and operation of mineral dressing and concentrating machinery, together with typical combinations of mineral dressing machines. The sequence of physical and chemical changes occurring during smelting, furnace design, fuels, re-

fractories, methods, and efficiency of heat application and control over quality of product are stressed in courses dealing with metallurgical processes.

Laboratories equipped with various types of furnaces are provided so that the students can become familiar with high temperature equipment and conduct experiments demonstrating important features of metallurgical processes.

Metallography is an important branch of metallurgy dealing with the application of metals and alloys. The work relates to internal structures as studied by the microscope, and to the physical and chemical properties of metals and alloys. A knowledge of metallography is essential in the design and development of new machines and equipment fabricated from metals.

Laboratory courses accompany lecture work. The metallographic laboratory is equipped with the most up-to-date microscopes and apparatus for heat treating and physical and mechanical testing. Practice is obtained in taking photomicrographs.

Students taking the five-year combined course with business administration may substitute business courses for Biol. 7-8-9; Soc. Sci. 1-2-3; Geol. 106; Hum. 1-2-3 or 11-12-13 or 21-22-23; E.E. 41; Met. 121-122-123, 133; Engl. 85-86 and Institute of Technology and Science, Literature, and the Arts electives.

### FIVE-YEAR COURSE

#### SECOND YEAR

##### *First Quarter*

| Course No.  | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Geol. 11    | General and Historical Geology .....      | 5       | ..... | 5     | ..... |
| Nat.Sci. 7* | General Biology .....                     | 3       | ..... | 2     | 2     |

##### *Second Quarter*

|             |                                    |   |       |       |       |
|-------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25    | Calculus: Integral .....           | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Geol. 23    | Mineralogy .....                   | 5 | 1     | 3     | 4     |
| Nat.Sci. 8* | General Biology .....              | 3 | ..... | 2     | 2     |

##### *Third Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| Phys. 9     | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Geol. 24    | Mineralogy .....                       | 5 | 1     | 3     | 4     |
| Met. 1      | Assaying .....                         | 3 | ..... | 3     | ..... |
| Nat.Sci. 9* | General Biology .....                  | 3 | ..... | 2     | ..... |
| Electives   | Institute of Technology .....          | 2 | ..... | ..... | ..... |

#### THIRD YEAR

##### *First Quarter*

|              |                                      |   |       |       |       |
|--------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 26     | Technical Mechanics: Statics .....   | 5 | 5     | ..... | ..... |
| Anal.Chem. 9 | Quantitative Analysis .....          | 3 | 1     | 1     | 6     |
| M.E. 12      | Materials and Processing II .....    | 2 | ..... | 2     | 3     |
| Met. 106     | Nonferrous Metallurgy .....          | 3 | ..... | 3     | ..... |
| Soc.Sci. 1*  | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

##### *Second Quarter*

|             |                                      |   |       |       |       |
|-------------|--------------------------------------|---|-------|-------|-------|
| M.&M. 128   | Strength of Materials .....          | 5 | 5     | ..... | ..... |
| Geol. 106   | Petrography .....                    | 2 | ..... | 2     | 2     |
| M.E. 13     | Materials and Processing III .....   | 2 | ..... | 2     | 3     |
| Met. 11     | Metallurgy of Pig Iron .....         | 3 | ..... | 3     | ..... |
| Met. 107    | Nonferrous Metallurgy .....          | 3 | ..... | 3     | ..... |
| Soc.Sci. 2* | Introduction to Social Science ..... | 4 | ..... | 4     | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

*Third Quarter*

| Course No.   | Title                                | Credits | Rec.  | Lect. | Lab.  |
|--------------|--------------------------------------|---------|-------|-------|-------|
| M.&M. 127    | Technical Mechanics: Dynamics .....  | 5       | 5     | ..... | ..... |
| M.E. 6       | Machine Shop Practice .....          | 2       | ..... | 2     | 3     |
| Met. 12      | Metallurgy of Steel .....            | 3       | ..... | 3     | ..... |
| Met. 108     | Nonferrous Metallurgy .....          | 3       | ..... | 3     | ..... |
| Soc. Sci. 3* | Introduction to Social Science ..... | 4       | ..... | 4     | ..... |

FOURTH YEAR

*First Quarter*

|                |                                       |   |       |       |       |
|----------------|---------------------------------------|---|-------|-------|-------|
| Met. 110       | Mineral Dressing .....                | 3 | ..... | 2     | 3     |
| Met. 153       | Metallography .....                   | 4 | ..... | 3     | 4     |
| Phys.Chem. 101 | Physical Chemistry .....              | 3 | 1     | 3     | ..... |
| Hum. 1*        | Humanities in the Modern World I..... | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 11*       | The Greek Heritage .....              | 5 | ..... | 5     | ..... |
| or             |                                       |   |       |       |       |
| Hum. 21*       | Humanities in the United States ..... | 3 | ..... | 3     | ..... |
| Electives      | Science, Literature, and Arts .....   | 5 | ..... | ..... | ..... |

*Second Quarter*

|                |   |   |       |   |       |
|----------------|---|---|-------|---|-------|
| Met. 111       | Mineral Dressing .....                    | 3 | ..... | 2 | 3     |
| Met. 154       | Metallography .....                       | 4 | ..... | 3 | 4     |
| Phys.Chem. 102 | Physical Chemistry .....                  | 3 | 1     | 3 | ..... |
| E.E. 41        | Electrical Engineering Survey .....       | 3 | ..... | 2 | 3     |
| Hum. 2*        | Humanities in the Modern World .....      | 5 | ..... | 5 | ..... |
| or             |   |   |       |   |       |
| Hum. 12*       | The Roman and the Medieval Heritage ..... | 5 | ..... | 5 | ..... |
| or             |   |   |       |   |       |
| Hum. 22*       | Humanities in the United States .....     | 3 | ..... | 3 | ..... |

*Third Quarter*

|                |                                       |   |       |   |       |
|----------------|---------------------------------------|---|-------|---|-------|
| Met. 112       | Mineral Dressing .....                | 3 | ..... | 2 | 3     |
| Met. 133       | Electrometallurgy .....               | 3 | ..... | 3 | ..... |
| Met. 155       | Metallography .....                   | 4 | ..... | 3 | 4     |
| Phys.Chem. 103 | Physical Chemistry .....              | 3 | 1     | 3 | ..... |
| Hum. 3*        | Humanities in the Modern World .....  | 5 | ..... | 5 | ..... |
| or             |                                       |   |       |   |       |
| Hum. 13*       | The Renaissance Heritage .....        | 5 | ..... | 5 | ..... |
| or             |                                       |   |       |   |       |
| Hum. 23*       | Humanities in the United States ..... | 3 | ..... | 3 | ..... |

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*Summer Field Trip*

|   |   |       |       |       |       |
|---|---|-------|-------|-------|-------|
| Study of metallurgical operations in important iron and steel centers ..... | 6 | ..... | ..... | ..... | ..... |
|---|---|-------|-------|-------|-------|

FIFTH YEAR

*First Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Engl. 85  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| Met. 121  | Ore Testing .....                      | 2 | ..... | 1     | 3     |
| Met. 134  | Advanced Metallurgy .....              | 4 | ..... | 3     | 4     |
| Met. 163  | Advanced Metallography .....           | 3 | ..... | 3     | ..... |
| Electives | Institute of Technology .....          | 3 | ..... | ..... | ..... |
| Electives | Science, Literature, and Arts .....    | 3 | ..... | ..... | ..... |

*Second Quarter*

|           |  |   |       |       |       |
|-----------|--|---|-------|-------|-------|
| Engl. 86  | Advanced Technical Communication ..... | 3 | 3     | ..... | ..... |
| Met. 122  | Advanced Mineral Dressing .....        | 3 | 1     | 2     | ..... |
| Met. 135  | Advanced Metallurgy .....              | 4 | ..... | 3     | 4     |
| Met. 164  | Advanced Metallography .....           | 3 | ..... | 3     | ..... |
| Electives | Institute of Technology .....          | 3 | ..... | ..... | ..... |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

*Third Quarter*

| Course No. | Title                               | Credits | Rec.  | Lect. | Lab.  |
|------------|-------------------------------------|---------|-------|-------|-------|
| Met. 123   | Advanced Mineral Dressing .....     | 3       | 1     | 2     | ..... |
| Met. 136   | Advanced Metallurgy .....           | 4       | ..... | 3     | 4     |
| Met. 165   | Advanced Metallography .....        | 3       | ..... | 3     | ..... |
| Electives  | Institute of Technology .....       | 3       | ..... | ..... | ..... |
| Electives  | Science, Literature, and Arts ..... | 2       | ..... | ..... | ..... |

FOUR-YEAR COURSE—Open Only to Veterans and Students Who Entered  
Prior to the Fall Quarter, 1946

## SECOND YEAR

*First Quarter*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| M.&M. 24 | Calculus I: Differential .....            | 5 | 5     | ..... | ..... |
| Phys. 7  | General Physics: Mechanics and Heat ..... | 5 | 1     | 4     | 2     |
| Geol. 11 | General and Historical Geology .....      | 5 | ..... | 5     | ..... |
| Met. 11  | Metallurgy of Pig Iron .....              | 3 | ..... | 3     | ..... |

*Second Quarter*

|              |                                    |   |   |       |       |
|--------------|------------------------------------|---|---|-------|-------|
| M.&M. 25     | Calculus II: Integral .....        | 5 | 5 | ..... | ..... |
| Phys. 8      | General Physics: Electricity ..... | 5 | 1 | 4     | 2     |
| Anal.Chem. 9 | Quantitative Analysis .....        | 3 | 1 | 1     | 6     |
| Geol. 23     | Mineralogy .....                   | 5 | 1 | 3     | 4     |

*Third Quarter*

|          |  |   |       |       |       |
|----------|--|---|-------|-------|-------|
| Phys. 9  | General Physics: Sound and Light ..... | 5 | 1     | 4     | 2     |
| Geol. 24 | Mineralogy .....                       | 5 | 1     | 3     | 4     |
| Met. 1   | Assaying .....                         | 3 | ..... | 3     | 4     |
| Met. 12  | Metallurgy of Steel .....              | 3 | ..... | 3     | ..... |
|          | Electives .....                        | 2 | ..... | ..... | ..... |

## THIRD YEAR

*First Quarter*

|          |                                    |   |       |       |       |
|----------|------------------------------------|---|-------|-------|-------|
| M.&M. 26 | Technical Mechanics: Statics ..... | 5 | 5     | ..... | ..... |
| M.E. 12  | Materials and Processing II .....  | 2 | ..... | 2     | 3     |
| Met. 106 | Nonferrous Metallurgy .....        | 3 | ..... | 3     | ..... |
| Met. 110 | Mineral Dressing .....             | 3 | ..... | 2     | 3     |
| Met. 153 | Metallography .....                | 4 | ..... | 3     | 4     |

*Second Quarter*

|           |                                    |   |       |       |       |
|-----------|------------------------------------|---|-------|-------|-------|
| M.&M. 128 | Strength of Materials .....        | 5 | 5     | ..... | ..... |
| M.E. 13   | Materials and Processing III ..... | 2 | ..... | 2     | 3     |
| Met. 107  | Nonferrous Metallurgy .....        | 3 | ..... | 3     | ..... |
| Met. 111  | Mineral Dressing .....             | 3 | ..... | 2     | 3     |
| Met. 154  | Metallography .....                | 4 | ..... | 3     | 4     |

*Third Quarter*

|           |                                     |   |       |       |       |
|-----------|-------------------------------------|---|-------|-------|-------|
| M.&M. 127 | Technical Mechanics: Dynamics ..... | 5 | 5     | ..... | ..... |
| E.E. 41   | Electrical Engineering Survey ..... | 3 | ..... | 2     | 3     |
| Met. 108  | Nonferrous Metallurgy .....         | 3 | ..... | 3     | ..... |
| Met. 112  | Mineral Dressing .....              | 3 | ..... | 2     | 3     |
| Met. 155  | Metallography .....                 | 4 | ..... | 3     | 4     |

*Summer Field Trip*

|          |   |   |       |       |       |
|----------|---|---|-------|-------|-------|
| Met. 175 | Study of metallurgical operations in important iron and steel centers ..... | 6 | ..... | ..... | ..... |
|----------|---|---|-------|-------|-------|

## FOURTH YEAR

*First Quarter*

| Course No.     | Title                     | Credits | Rec.  | Lect. | Lab.  |
|----------------|---------------------------|---------|-------|-------|-------|
| Met. 121       | Ore Testing .....         | 2       | ..... | 1     | 3     |
| Met. 134       | Advanced Metallurgy ..... | 4       | ..... | 3     | 4     |
| Met. 163       | Advanced Metallurgy ..... | 3       | ..... | 3     | ..... |
| Phys.Chem. 101 | Physical Chemistry .....  | 3       | 1     | 3     | ..... |
|                | Electives .....           | 6       |       |       |       |

*Second Quarter*

|                |                           |   |       |   |       |
|----------------|---------------------------|---|-------|---|-------|
| Met. 133       | Electrometallurgy .....   | 3 | ..... | 3 | ..... |
| Met. 135       | Advanced Metallurgy ..... | 4 | ..... | 3 | 4     |
| Met. 164       | Advanced Metallurgy ..... | 3 | ..... | 3 | ..... |
| Phys.Chem. 102 | Physical Chemistry .....  | 3 | 1     | 3 | ..... |
|                | Electives .....           | 5 |       |   |       |

*Third Quarter*

|                |                                    |   |       |       |       |
|----------------|------------------------------------|---|-------|-------|-------|
| M.&M. 141      | Materials Testing Laboratory ..... | 1 | ..... | ..... | 2     |
| M.E. 6         | Machine Shop Practice .....        | 2 | ..... | 2     | 3     |
| Met. 136       | Advanced Metallurgy .....          | 4 | ..... | 3     | 4     |
| Met. 165       | Advanced Metallurgy .....          | 3 | ..... | 3     | ..... |
| Phys.Chem. 103 | Physical Chemistry .....           | 3 | 1     | 3     | ..... |
|                | Electives .....                    | 4 |       |       |       |

## PHYSICS

Five-year course leading to the degree, bachelor of physics, B.Phys.

- A. The sequence leading to the degree, bachelor of physics, is intended to be sufficiently broad to provide for the needs of those who desire to prepare for the industrial research field or for graduate work in physics as a major. The outline given below may be modified on petition. A total of 245 earned credits is required.
- B. A student entering this course may take the freshman program outlined for the first year in any of the curricula of the Institute of Technology except that for architecture. Those who maintain a satisfactory average (C or better) during the first year may register in this course.

It is clear that a student having the above objectives must attain an adequate background in mathematics and in chemistry. The work in physics is planned to give a greater or lesser contact with theoretical physics and experimental physics, depending upon the special aptitude of the applicant. Any special interest of the applicant may be met by a careful choice of elective courses which meets the approval of his adviser. The Department of Physics reserves the right to limit the registration in this course to those who have given evidence of being able to profit by it. Those who contemplate registering in this course should consult the chairman of the department.

## SECOND YEAR

*First Quarter*

| Course No.  | Title                                     | Credits | Rec.  | Lect. | Lab.  |
|-------------|---|---------|-------|-------|-------|
| M.&M. 24    | Calculus I: Differential .....            | 5       | 5     | ..... | ..... |
| Phys. 7     | General Physics: Mechanics and Heat ..... | 5       | 1     | 4     | 2     |
| Org.Chem. 1 | Elementary Organic Chemistry .....        | 4       | 2     | 3     | 4     |
| Nat.Sci. 7* | General Biology .....                     | 3       | ..... | 2     | 2     |

*Second Quarter*

|             |                                    |   |       |       |       |
|-------------|------------------------------------|---|-------|-------|-------|
| M.&M. 25    | Calculus II: Integral .....        | 5 | 5     | ..... | ..... |
| Phys. 8     | General Physics: Electricity ..... | 5 | 1     | 4     | 2     |
| Org.Chem. 2 | Elementary Organic Chemistry ..... | 4 | 2     | 3     | 4     |
| Nat.Sci. 8* | General Biology .....              | 3 | ..... | 2     | 2     |

\* See page 73 for alternate sequences which may be substituted as a unit.

| Course No.   | Title                                    | Credits | Rec.  | Lect. | Lab.  |
|--------------|--|---------|-------|-------|-------|
| M.&M. 151    | Differential Equations .....             | 3       | 3     | ..... | ..... |
| Phys. 9      | General Physics: Sound and Light .....   | 5       | 1     | 4     | 2     |
| Anal.Chem. 7 | Quantitative Analysis .....              | 4       | 1     | 1     | 8     |
| E.E. 11      | Elements of Electrical Engineering ..... | 3       | 2     | 1     | ..... |
| Nat.Sci. 9*  | General Biology .....                    | 3       | ..... | 2     | 2     |

## THIRD YEAR

*First Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 150   | Calculus III: Intermediate Calculus ..... | 3 | 3     | ..... | ..... |
| Phys. 101   | Theoretical Physics .....                 | 5 | 5     | ..... | ..... |
| Phys. 107   | Modern Physics .....                      | 3 | ..... | 3     | ..... |
| Soc.Sci. 1* | Introduction to Social Science .....      | 4 | ..... | 4     | ..... |

*Second Quarter*

|             |  |   |       |       |       |
|-------------|--|---|-------|-------|-------|
| M.&M. 152   | Calculus IV: Special Topics in Advanced Calculus ..... | 3 | 3     | ..... | ..... |
| Phys. 103   | Theoretical Physics .....                              | 5 | 5     | ..... | ..... |
| Phys. 109   | Modern Physics .....                                   | 3 | ..... | 3     | ..... |
| Soc.Sci. 2* | Introduction to Social Science .....                   | 4 | ..... | 4     | ..... |

*Third Quarter*

|             |   |   |       |       |       |
|-------------|---|---|-------|-------|-------|
| M.&M. 153   | Calculus V: Special Topics in Advanced Calculus ..... | 3 | 3     | ..... | ..... |
| Phys. 105   | Theoretical Physics .....                             | 5 | 5     | ..... | ..... |
| Phys. 111   | Modern Physics .....                                  | 3 | ..... | 3     | ..... |
| Phys. 144   | Electrical Measurements .....                         | 3 | 1     | 1     | 4     |
| Soc.Sci. 3* | Introduction to Social Science .....                  | 4 | ..... | 4     | ..... |

## FOURTH YEAR

*First Quarter*

|                |  |   |       |   |       |
|----------------|--|---|-------|---|-------|
| Phys.Chem. 101 | Physical Chemistry .....               | 3 | 1     | 3 | ..... |
| Phys. 134      | Experimental Optics .....              | 3 | ..... | 3 | 3     |
| Hum. 1*        | Humanities in the Modern World I ..... | 5 | ..... | 5 | ..... |
| or             |  |   |       |   |       |
| Hum. 11*       | The Greek Heritage .....               | 5 | ..... | 5 | ..... |
| or             |  |   |       |   |       |
| Hum. 21*       | Humanities in the United States .....  | 3 | ..... | 3 | ..... |
|                | Electives                              |   |       |   |       |

*Second Quarter*

|                |   |   |       |       |       |
|----------------|---|---|-------|-------|-------|
| Phys.Chem. 103 | Physical Chemistry .....                  | 3 | 1     | 3     | ..... |
| E.E. 117       | Engineering Electronics .....             | 3 | 3     | ..... | ..... |
| E.E. 118       | Engineering Electronics Laboratory .....  | 1 | ..... | ..... | 2     |
| Phys. 110      | Modern Experimental Physics .....         | 3 | ..... | ..... | 3     |
| Hum. 2*        | Humanities in the Modern World II .....   | 5 | ..... | 5     | ..... |
| or             |   |   |       |       |       |
| Hum. 12*       | The Roman and the Medieval Heritage ..... | 5 | ..... | 5     | ..... |
| or             |   |   |       |       |       |
| Hum. 22*       | Humanities in the United States .....     | 3 | ..... | 3     | ..... |
|                | Electives                                 |   |       |       |       |

*Third Quarter*

|                |  |   |       |       |       |
|----------------|--|---|-------|-------|-------|
| Phys.Chem. 105 | Physical Chemistry .....                 | 3 | 1     | 3     | ..... |
| E.E. 119       | Engineering Electronics .....            | 3 | 3     | ..... | ..... |
| E.E. 120       | Engineering Electronics Laboratory ..... | 1 | ..... | ..... | 2     |
| Phys. 112      | Modern Experimental Physics .....        | 3 | ..... | ..... | 3     |
| or             |  |   |       |       |       |
| Phys. 136      | Spectrum Analysis .....                  | 3 | ..... | 3     | 3     |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

| Course No.                                  | Title                                    | Credits | Rec.  | Lect. | Lab.  |
|---|--|---------|-------|-------|-------|
| Hum. 3*<br>or<br>Hum. 13*<br>or<br>Hum. 23* | Humanities in the Modern World III ..... | 5       | ..... | 5     | ..... |
|   | The Renaissance Heritage .....           | 5       | ..... | 5     | ..... |
|   | Humanities in the United States .....    | 3       | ..... | 3     | ..... |
|   | Electives                                |         |       |       |       |

FIFTH YEAR

First Quarter

|                              |  |   |   |       |       |
|------------------------------|--|---|---|-------|-------|
| Engl. 85                     | Advanced Technical Communication .....           | 3 | 3 | ..... | ..... |
| Phys. 181<br>or<br>Phys. 191 | Atomistic and Elementary Quantum Mechanics ..... | 3 | 3 | ..... | ..... |
|                              | Mathematical Physics .....                       | 3 | 3 | ..... | ..... |
|                              | Electives  |   |   |       |       |

Second Quarter

|                              |  |   |   |       |       |
|------------------------------|--|---|---|-------|-------|
| Engl. 86                     | Advanced Technical Communication .....           | 3 | 3 | ..... | ..... |
| Phys. 183<br>or<br>Phys. 193 | Atomistic and Elementary Quantum Mechanics ..... | 3 | 3 | ..... | ..... |
|                              | Mathematical Physics .....                       | 3 | 3 | ..... | ..... |
|                              | Electives  |   |   |       |       |

Third Quarter

|                              |  |   |   |       |       |
|------------------------------|--|---|---|-------|-------|
| Phys. 185<br>or<br>Phys. 195 | Atomistic and Elementary Quantum Mechanics ..... | 3 | 3 | ..... | ..... |
|                              | Mathematical Physics .....                       | 3 | 3 | ..... | ..... |
|                              | Electives  |   |   |       |       |

Acceptable electives may be taken in Astronomy, Chemistry, Economics, Engineering, English, Geology, History, Languages, Mathematics, Philosophy, Political Science, Psychology, or the biological sciences.

SUBSTITUTE SEQUENCES FOR THE FIVE-YEAR CURRICULA

Work in the Humanistic-Social stem of the five-year Engineering Curricula has been selected to cover the area of Life Science, Social Science, and the Humanities. For each area, specific courses are recommended as providing the best integration of subject matter as well as the most efficient and economical means of covering the field.

To provide greater flexibility, certain sequences of courses may be substituted as a unit for the designated recommended courses. These alternate units do not provide general coverage but permit concentration in relative courses within the general area.

Sequence units which may be substituted for the recommended sequence in General Biology:

|                |  | Credits |
|----------------|--|---------|
| 1. 1-2-3       | General Botany .....                   | 10      |
| 2. Zool. 1 2-3 | General Zoology .....                  | 10      |
| 3. Psy. 1-2    | General Psychology .....               | 6       |
| and Psy. 3     | Psychology Applied to Daily Life ..... | 3       |

Sequence units which may be substituted for the recommended sequence in Social Science:

|   |   |    |
|---|---|----|
| 1. Labor Problem Unit—Total 11 to 16 credits.                                       |   |    |
| Econ. 6-7<br>or<br>Econ. 8-9<br>or<br>Econ. 82<br>and<br>Econ. 83<br>or<br>Hist. 17 | Principles of Economics .....               | 10 |
|   | General Economics .....                     | 6  |
|   | Competition and Monopoly in Modern Industry |    |
|   | The Inequality of Incomes .....             | 6  |
|   | Modern Economics and Social Problems .....  | 5  |

\* See pages 73 and 74 for alternate sequences which may be substituted as a unit.

|   |   |    |
|---|---|----|
| together with<br>B.A. 161<br>and<br>B.A. 164  | Labor Problems and Trade Unionism<br>Labor Legislation and Social Insurance ..... | 6  |
| 2. Political Science Units—Total 9 to 12 credits.   |   |    |
| Pol.Sci. 10<br>or<br>Pol.Sci. 15<br>and<br>Pol.Sci. 25<br>and<br>Pol.Sci. 123<br>or<br>Pol.Sci. 124-125<br>or<br>Pol.Sci. 153<br>or<br>Pol.Sci. 155<br>or<br>Pol.Sci. 161 | Fundamentals of Government and Politics .....                                     | 3  |
|   | Elements of Political Science .....   | 3  |
|   | World Politics .....  | 3  |
|   | City Planning .....   | 3  |
|   | Recent Social Legislation .....   | 6  |
|   | Far Eastern Governments .....   | 3  |
|   | Government in Latin America .....   | 3  |
|   | Problems in Democracy .....   | 3  |
| 3. Sociology Unit—Total 13 credits.   |   |    |
| Soc. 1<br>and<br>Soc. 2<br>together with<br>Soc. 14<br>or<br>Soc. 104   | Introduction to Sociology<br>Individual and Minority Group Adjustment .....       | 10 |
|   | Rural Sociology .....   | 3  |
|   | City Planning .....   | 3  |

Sequences which may be substituted for the recommended sequences in the Humanities:

|   |  |   |
|---|--|---|
| 1. Philosophy Unit—Total 9 to 15 credits.   |  |   |
| Phil. 1<br>or<br>Phil. 1A<br>Phil. 2<br>or<br>Phil. 2A<br>Phil. 3<br>or<br>Phil. 3A<br>Phil. 10<br>or<br>Phil. 20<br>or<br>Phil. 70<br>or<br>Phil. 135<br>or<br>Phil. 153 | Problems in Philosophy .....           | 5 |
|   | Selected Problems in Philosophy .....  | 3 |
|   | Logic .....                            | 5 |
|   | Selected Problems in Logic .....       | 3 |
|   | Ethics .....                           | 5 |
|   | Selected Problems in Ethics .....      | 3 |
|   | Science and Religion .....             | 3 |
|   | Social Philosophy .....                | 3 |
|   | Philosophies of Social Reform I .....  | 3 |
|   | Philosophy of Modern Literature .....  | 3 |
|   | Philosophy of Science .....            | 3 |
| 2. English Unit   |  |   |
| Engl. 37-38-39  | Twentieth-Century Literature .....     | 9 |
| 3. History Unit   |  |   |
| Hist. 1-2-3   | Civilization of the Modern World ..... | 9 |
| 4. Fine Arts-Music Units. 9 to 15 credits in Fine Arts and Music to be announced.   |  |   |



The sequence courses plus electives chosen from the departments listed below must total a minimum of 45 credits.

|              |                   |  |
|--------------|-------------------|--|
| Anthropology | History           | Preventive Medicine<br>and Public Health |
| Astronomy    | Humanities        | Psychology                               |
| Botany       | Journalism        | Speech                                   |
| Classics     | Languages         | Social Science                           |
| English      | Marriage          | Sociology                                |
| Fine Arts    | Music             | Zoology                                  |
| Geography    | Philosophy        |  |
| Geology      | Political Science |  |

SUBSTITUTIONS

In order that students whose courses of study are irregular may avoid delays on account of program conflicts or other difficulties, the following substitutions will be approved by petition. Additional credits thus earned may be applied as elective credits.

| Course               | Credits | Substitute Course      | Credits |
|----------------------|---------|------------------------|---------|
| Aero.E. 115 .....    | 3       | M.&M. 129 .....        | 4       |
| Arch. 104 .....      | 3       | M.&M. 180 .....        | 3       |
| Drawing 7 .....      | 3       | Arch. 106 .....        | 3       |
| Drawing 8 .....      | 3       | Draw. 1 and 2 .....    | 6       |
| Drawing 21 .....     | 2       | Drawing 3 .....        | 3       |
| Drawing 26 .....     | 2       | Drawing 28 .....       | 2       |
| Drawing 28 .....     | 2       | Drawing 28 .....       | 2       |
| M.&M. 84 .....       | 5       | Drawing 26 .....       | 2       |
| M.&M. 85 .....       | 3       | M.&M. 26 and 127 ..... | 10      |
| M.&M. 86 .....       | 3       | M.&M. 128 .....        | 5       |
| M.&M. 87 .....       | 1       | M.&M. 141 .....        | 1       |
| M.&M. 91 .....       | 4       | M.&M. 24 and 25 .....  | 10      |
| M.&M. 92 .....       | 4       | M.&M. 26 or 84 .....   | 5       |
| M.&M. 93 .....       | 4       | M.&M. 85 or 128 .....  | 3 or 5  |
| M.&M. 130 .....      | 5       | M.&M. 129 .....        | 4       |
| Anal.Chem. 132 ..... | 3       | Anal.Chem. 105 .....   | 3       |