UNIVERSITY OF NAIROBI

FACULTY OF ENGINEERING

DEPARTMENT OF ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING

REGULATIONS AND SYLLABUS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING

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REGULATIONS AND SYLLABUS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ENVIRONMENTAL & BIOSYSTEMS ENGINEERING

1.0 BACKGROUND

1.1 Purpose

This document contains the new undergraduate curriculum in ***Environmental and Biosystems Engineering***.

1.2 Introduction

The objective of the revision was to institute a comprehensive curriculum in engineering education and training at the undergraduate level covering sufficiently in breadth and depth the broad discipline of engineering.

1.3 Degree Programme

The department proposes to offer a **Bachelor of Science in Engineering (B.Sc. (Eng.))** degree programme with options in the following areas:

- **Environmental Engineering**

  The application of the science and art of engineering to the design and management in the open systems of natural resources of air, soil and water in order to minimize the adverse impact of human activities and other processes on the natural environment.

- **Irrigation and Water Resources Engineering**

  The application of the science and art of engineering to the planning, design and management of systems for control and utilization of water resources for industrial, amenity, domestic and livestock consumption, irrigation and the drainage of excess water from fields.

- **Power and Machinery Engineering**

  The design and management of energy systems, machinery and implements for production and processing in agriculture, forestry, amenity, aquaculture and related biology based production and processing systems.

- **Process and Food Engineering**

  The application of the science and art of engineering to the mechanical, chemical, thermal and other physical processes involved in the primary and secondary processing of food, fibre and other raw materials from agriculture, forestry and land and water environment in general.

- **Structures Engineering**

  The planning, design and management of buildings and other structures for human habitation, production, storage and processing of biology based products from agriculture, forestry, food and

other bioprocess industries and water and the environment in general.

The revised B.Sc. (Eng.) programme will produce graduates who are able to pursue careers in industry, research and education. Their education will include in-depth scientific exposition of engineering principles and concepts and will focus on the 'science of engineering'. The graduates will also be exposed to relevant practical work so that they may become hands-on engineers.

The structure of the course shall be as follows:

1. The candidates shall take all the courses prescribed for the first, second, third and fourth year of study.

2. At the end of the fourth year, the candidates shall choose an option in which to specialize. This will lead to the award of B.Sc. Engineering. (Environmental and Biosystems Engineering) in the relevant option.

3. In the fifth year of study the candidates shall take 9 courses; 2 compulsory and 7 electives. The compulsory courses in the fifth year of study shall be:

    - Engineering Project
    - Seminar

    The electives shall be taken from 2 areas, a maximum of two courses from the *Common Electives* and five courses from the area of *Specialization Elective Courses*.

4. ***At the end of all session 3 practical exercises (FEB 140, FEB 240, FEB 340 and FEB 440), each candidate will be required to submit a report on the exercise which will be examined and assessed as "Satisfactory" or "Not Satisfactory". Candidates must satisfactorily complete all session 3 exercises before graduating.***

2.0 REGULATIONS AND ENTRY REQUIREMENTS

The regulations and entry requirements of the Faculty of Engineering shall apply. Specifics of the same are outlined below.

Admission Requirements

F1. I Categories of Applicants:

Candidates shall be eligible for admission into the Bachelor of Science Degree in the Faculty of Engineering in the following categories:

(a) Candidates with KCSE:

For candidates with KCSE the basic admission requirement shall be the minimum entry requirement set for entry into the Public Universities, which is at least an average grade of C^+ in the Kenya Certificate of Secondary Education (KCSE). In addition candidates are expected to have performed well in of the following alternative cluster of subjects in KCSE Examinations, but at any rate shall have obtained at least a grade of C^+ in each of the cluster subjects, ***as well as in the English Language***.

Alternative A:

Physics
Chemistry
Mathematics
Biology **or** Geography **or** any Group IV subject ***excluding Home Science***

Alternative B:

Physical Sciences
Biological Sciences
Mathematics
Geography **or** any Group IV subject ***excluding Home Science***

Group IV Subjects:

Home Science	Power Mechanics
Art and Design	Electricity
Agriculture	Drawing and Design
Woodwork	Aviation Technology
Metalwork	Computer Studies

Candidates with KCSE who have obtained a grade below C^+, but at least a C^-, in only one cluster subject shall be allowed to take a bridging course in that subject to bring it to the grade of C^+ or better, provided that such a bridging course shall be taken at the University of Nairobi.

(b) Candidates with A-Levels or International Baccalaureate (IB):

The candidates shall have a minimum entry requirement of 2 Principal Level passes in Mathematics and Physics and a Subsidiary Level pass in Chemistry with a credit pass in English at 'O' Level, except that for Surveying, a Subsidiary Level pass in Geography shall also be acceptable in lieu of Chemistry.

(c) Candidates with Higher National Diploma or Equivalent:

The candidates shall have Higher National Diploma in the following broad areas of study:

Environmental and Biosystems Engineering
Civil Engineering
Electrical/Electronic Engineering
Mechanical Engineering
Surveying
Any other approved subject area.

(d) Candidates with Ordinary Diploma or Equivalent:

The candidates shall have an Ordinary Diploma with a Credit Pass in the following broad areas of study:

Environmental and Biosystems Engineering
Civil Engineering
Electrical/Electronic Engineering
Mechanical Engineering
Surveying
Any other approved subject area.

(e) Candidates with Diplomas from Science/Technical Teacher Training Colleges:

The candidates shall have Diploma with Credit Pass in Mathematics and Physics.

(f) Candidates with B.Sc. or B.Ed. (Science):

The candidates shall have B.Sc. or B.Ed. (Science) Honours Degrees, majoring in Physics or Mathematics, or equivalent from recognized institutions.

II Entry Levels for the Various Categories:

(a) Candidates with KCSE shall be admitted into the First Year of Study.

(b) Candidates with Higher National Diploma shall be admitted into the Third Year of Study, provided that they shall be required to take any **prerequisite** courses of the Second Year of study as determined by the Senate on the recommendation of the Faculty Board and the College Academic Board.

(c) All the other candidates shall be admitted into the Second Year of Study, provided that they shall be required to take any prerequisite courses of the First Year of study as determined by the Senate on the recommendation of the Faculty Board and the College Academic Board.

III Exemption From any Courses in the Programme:

(a) Where a candidate wishes to be exempted from any course or courses, he/she shall make a written formal application to the Academic Registrar together with supporting documentary evidence. Such a candidate may be required to sit and pass an exemption examination administered by the Faculty and approved by Senate after payment of a prescribed fee.

(b) Based on the assessment of the exemption examination the Faculty Board of Engineering shall make its recommendation to Senate. The Academic Registrar shall communicate the decision of Senate to the candidate.

Course Structure and Duration

F2. (a) Every curriculum for the degrees shall extend over not less than five, four or three academic years depending on the level of entry of the candidate.

(b) A candidate enrolled for the degree shall satisfactorily complete such curriculum in a period of not more than twice the minimum period for which he/she was registered for the degree.

F3. Each curriculum shall consist of an approved scheme of study.

F4. The choice of optional courses within an approved scheme of study shall, in all cases, be subject to the approval of the relevant Department.

F5. A candidate for the degree shall satisfactorily complete such coursework/practical assignments as may be required for each scheme of study. Satisfactory completion of such requirements shall be a condition of admission to the examinations at the end of that semester of study.

F6. Attendance of not less than two-thirds of the total lecture hours of all prescribed courses shall be a condition for admission to the examinations at the end of any semester of study.

F7. (a) The degree programme shall be divided into two parts: Part I and Part II. Part I shall comprise the First and Second Year courses while Part II shall comprise the Third, Fourth and Fifth Year courses.
(b) A candidate must pass all the courses offered in Part I and shall, under no circumstance, be allowed to start Part II courses before doing so.
(c) A candidate shall not take more than two or four academic years, depending on his/her level of entry, to complete Part I courses, and not more than six academic years to complete Part II courses.
(d) Each academic year shall be divided into two distinct semesters while there may also be a third semester for practical work as may be provided for in a specific degree programme.

Examinations

F8. Courses shall be evaluated in terms of course units. A course unit shall be defined as made up of four (4) hours of lecture/tutorial/practical per week for 15 weeks totalling 60 hours of teaching. All other course units shall be taken as a proportion of one unit of 60 hours.

F9. All courses taken in a given semester shall be examined by ordinary examinations at the end of that semester unless otherwise specified.

F10. Courses that spread over two semesters shall be examined at the end of the second semester.

F11. A written ordinary examination for one course unit, where it applies, shall have a duration of two (2) hours. A course with more than, or less than, 60 contact hours shall generally be examined for a duration proportional to the two hours for one course unit, such as

45 contact hours - 1.5-hour examination
75 contact hours - 2.5-hour examination

F12. The pass mark for each course shall be 40% of the maximum possible mark.

F13. (a) Each 60-hour course unit shall be graded independently out of a maximum of 50 marks in accordance with regulation F11 above.

(b) The complete assessment of one course unit shall consist of Continuous Assessment Tests (CATS), course/laboratory/field assignments, and end of semester examinations ordinarily carrying 5, 10 and 35 maximum marks respectively, except **Engineering Drawing** in which assignments, CAT's and end of semester examination shall be assigned **20, 10 and 20** maximum marks respectively.

(c) Where a course unit does not have any laboratory/field assignments or coursework, the CATS and end of semester written examination shall be assigned 10 and 40 maximum marks respectively.

(d) Where a course unit is examined entirely by coursework, it will be assessed out of a maximum mark of 50.

(e) The course Engineering Project in the Fifth Year of Study shall be considered to comprise two course units and shall be examined at the end of the Second Semester and shall be assessed out of a maximum mark of 100, distributed in such ratios for orals, written report and so on, as recommended by the relevant Departments.

(f) Where the distribution of marks for a course unit does not conform to (b), (c), (d) or (e) above, the distribution of the marks as approved by Senate shall be carried out.

(g) Where a course unit consists of more than or less than one 60-hour course unit the mark distributions in (b), (c) (d) and (e) shall apply on a specified maximum mark.

(h) For practical exercises that take place after the second semester examinations including industrial attachments, camps, etc, each candidate will be required to submit a report which will be examined and assessed as either "satisfactory" or "not satisfactory". Any candidate must satisfactorily complete all such exercises before graduating.

F14. In order to be allowed to proceed to the next year of study a candidate shall have obtained an aggregate mark of not less than 40% and in addition shall have

(a) Passed in all the courses taken in the current year of study, or
(b) Failed in not more than an equivalent of four (4) course units.

F15. A candidate shall be allowed to carry forward to the next year of study up to an equivalent of four (4) failed course units in the current year of study, except the second year of study for which regulation F7 (b) shall apply. Examinations in all course units carried forward shall be **resat** or **redone** at the next ordinary university examinations.

F16. A candidate who

(a) Obtains an aggregate mark of not less than 40% and has failed in more than an equivalent of four (4) course units but in not more than an equivalent of eight (8) course units, or

(b) Obtains an aggregate mark between 30% and 39% inclusive and has failed in not more than eight (8) course units, shall,
on the recommendation of the Faculty Board of Examiners and approval by the Senate, not be allowed to proceed to the next year of study, or in the case of a Fifth Year candidate, not be allowed to graduate, but shall be required to **retake** examinations in the failed courses at the next ordinary university examinations.

F17. A candidate who

(a) Obtains an aggregate mark of less than 30%, or
(b) Has failed in more than an equivalent of eight (8) course units, or
(c) Has failed in any course unit after four (4) attempts, or
(d) Has failed to take prescribed examinations without good cause shall,

on the recommendation of the Faculty Board of Examiners and approval by Senate, be discontinued from the course of study.

F18. A candidate in the Second or Fifth Year of study who fails to satisfy the Examiners in not more than the equivalent of four (4) course units in the current year, but obtains an aggregate average of 40% or above may, on the recommendation of the Faculty Board of Examiners and approval by Senate be allowed to take Supplementary Examinations in the failed course units within a period of three months from the end of the second semester examinations.

F19. A candidate in the Second or Fifth Year of study who fails to satisfy the Examiners in the Supplementary Examinations shall, on the recommendation of the Board of Examiners and approval of Senate, be allowed to **resit** examinations in the failed courses at the next ordinary university examinations, subject to the provision of F 17 (c).

F20. (a) A candidate who fails to take prescribed examinations with good cause may be allowed, on recommendation by the Faculty Board of Examiners and approval by Senate, to carry over such examinations to the next year of study provided such examinations comprise a total of not more than four (4) course units and subject to F7 (b). Where the outstanding examinations are in more than four course units the candidate shall be recommended not to proceed to the next year of study, but to take the examinations in the outstanding course units at the next ordinary university examinations.

(b) Examinations taken under this clause shall be treated in accordance with clause F 13 and shall be graded in full.

F21. (a) A pass obtained in a ***resit*** examination for a course carried forward according to F 15 shall graded as 40% of the maximum mark and will be entered as such in the candidate's transcript.
(b) A pass obtained in a ***retake*** examination for a course according to F16 shall be adopted in full.
(c) Where a candidate has obtained a pass in a resit/ retake examination the mark adopted according to this clause shall be used to calculate a new aggregate mark for the candidate.

Degree Award

F22. The final award for the degree shall be based on assessment of the performance of the candidate in the courses in Part II of study taken with relative weights of 1:2:3 for the Third, Fourth and Fifth years of study respectively.

F23. A candidate who qualifies for the award of the degree shall be placed in one of the four classes to be described as First, Second (Upper or Lower Division) and Pass. Honours degrees shall be awarded to candidates who have attained First Class and Second Class (Upper or Lower Division).

F24. The classification of the final award shall, based on the aggregate score according to F 22 above, be as follows:

First Class Honours	-	70% to 100%
Second Class Honours (Upper Division)	-	60% to 69%
Second Class Honours (Lower Division)	-	50% to 59%
Pass	-	40% to 49%
Fail	-	Below 40%

F25. A candidate who ***retakes*** a course in the Fifth year of study according to F19 shall not be eligible for the award of an Honours Degree.

F26. In the Final Year of study, a mark between 35% and 39% inclusive may be considered qualified for the rule of compensation, provided the candidate has an aggregate mark of at least 50%. Compensation shall be allowed in a maximum of the equivalent of two course units only and shall be applied by taking two marks from a passed subject with a mark above 40% to make up for every failed mark. The candidate's new aggregate shall be calculated on the basis of the individual course marks obtained after compensation. A candidate whose marks have been compensated shall be awarded a degree a class lower than that which corresponds to his/her new aggregate.

3. COURSE OUTLINES

3.1 Bachelor of Science in Environmental and Biosystems Engineering.

This programme will lead to award of one of the degree of *Bachelor of Science Engineering (Environmental and Biosystems Engineering)* in one of the following options :

- Environmental Engineering
- Irrigation and Water Resources Engineering
- Power and Machinery Engineering
- Process and Food Engineering
- Structures Engineering

FIRST YEAR

Session 1

CCS 001	Communication skills	-	(1 unit; 48 hours)
CCS 008	Elements of philosophy	-	(1 Unit; 48 hours)
FEB 101	Introduction to engineering	-	(1 unit; 48 hours)
FEB 103	Physics I	-	(1 unit; 48 hours)
FEB 105	Chemistry I	-	(1 unit; 48 hours)
FEB 111	Pure mathematics I	-	(1 unit; 48 hours)
FEB 113	Applied mathematics I	-	(1 unit; 48 hours)
Total		-	*(7 units; 336 hours)*

Session 2

FEB 102	Economics	-	(1 unit; 48 hours)
FEB 104	Physics II	-	(1 unit; 48 hours)
FEB 106	Chemistry II	-	(1 unit; 48 hours)
FEB 108	Earth science	-	(0.625 units; 30 hours)
FEB 112	Pure mathematics II	-	(1 unit; 48 hours)
FEB 114	Applied mathematics II	-	(1 unit; 48 hours)
FEB 116	Fundamentals of computing	-	(1 unit; 48 hours)
Total		-	*(6.625 units; 318 hours)*

Session 3

FEB 140	Workshop orientation	-	(8 Weeks)

SECOND YEAR

Session 1

FEB 211	Engineering mathematics I	-	(1 unit; 48 hours)
FEB 213	Computer applications	-	(1 unit; 48 hours)
FEB 223	Electrical circuits theory	-	(0.625 units; 30 hours)
FEB 231	Fluid mechanics I	-	(1 unit; 48 hours)
FEB 237	Material science and engineering	-	(1.25 units; 60 hours)
FEB 241	Engineering graphics	-	(1 unit; 48 hours)
FEB 271	Solid and structural mechanics I	-	(1.25 units; 60 hours)
Total		-	*(7.125 units; 360 hours)*

Session 2

FEB 212	Engineering mathematics II	-	(1 unit; 48 hours)
FEB 224	Electrical principles	-	(0.625 units; 30 hours)
FEB 226	Thermodynamics I	-	(1 unit; 48 hours)
FEB 232	Fluid mechanics II	-	(1 unit; 48 hours)
FEB 234	Mechanics of machines I	-	(1.25 units; 60 hours)
FEB 242	Introduction to geospatial technology	-	(1 unit; 48 hours)
FEB 246	Electronics	-	(1 unit; 48 hours)
Total		-	*(7.25 units; 342 hours)*

Session 3

FEB 240	Workshop practice	-	(8 weeks)

THIRD YEAR

Session 1

FEB 301	Instrumentation	-	(0.625 units; 30 hours)
FEB 303	Environmental science	-	(1 unit; 48 hours)
FEB 311	Principles of law	-	(0.625 units; 30 hours)
FEB 313	Engineering mathematics III	-	(1 unit; 48 hours)
FEB 321	Thermodynamics II	-	(1.25 units; 60 hours)
FEB 323	Soil mechanics	-	(0.625 units; 30 hours)
FEB 325	Solid and structural mechanics II	-	(1.25 units; 60 hours)
FEB 331	Applied fluid mechanics	-	(0.625 units; 30 hours)
Total		-	*(7 units; 336 hours)*

Session 2

FEB 304	Introduction to geoinformatics	-	(0.625 units; 30 hours)
FEB 306	Principles of agricultural science	-	(1 unit; 48 hours)
FEB 312	Numerical methods	-	(1 unit; 48 hours)

FEB 314	Engineering mathematics IV	-	(1 unit; 48 hours)
FEB 316	Engineering statistics	-	(1 unit; 48 hours)
FEB 322	Thermodynamics III	-	(1 unit; 48 hours)
FEB 324	Mechanics of machines II	-	(1.25 units; 60 hours)
FEB 383	Constructional materials	-	(0.625 units; 30 hours)
Total		-	*(7.5 units; 360 hours)*

Session 3

FEB 340	Engineering practice	-	(8 Weeks)

FOURTH YEAR

Session 1

FEB 403	Mechanical design	-	(1 unit; 48 hours)
FEB 407	Operations research	-	(0.625 units; 30 hours)
FEB 411	Management for engineers	-	(0.625 units; 30 hours)
FEB 421	Thermodynamics IV	-	(0.625 units; 30 hours)
FEB 423	Heat and mass transfer	-	(0.625 units; 30 hours)
FEB 425	Irrigation and drainage engineering	-	(0.625 units; 30 hours)
FEB 441	Power and machinery engineering	-	(0.625 units; 30 hours)
FEB 461	Process and food engineering	-	(0.625 units; 30 hours)
FEB 483	Environmental impact assessment	-	(0.625 units; 30 hours)
Total		-	*(6 units; 288 hours)*

Session 2

FEB 402	Geotechnical engineering	-	(0.625 units; 30 hours)
FEB 404	Structural design	-	(1 unit; 48 hours)
FEB 412	Environmental engineering	-	(0.625 units; 30 hours)
FEB 422	Professional practice	-	(0.625 units; 30 hours)
FEB 424	Water resources engineering	-	(0.625 units; 30 hours)
FEB 442	Principles of electrification	-	(0.625 units; 30 hours)
FEB 482	Built environment design	-	(0.625 units; 30 hours)
FEB 486	Infrastructure engineering	-	(0.625 units; 30 hours)
Total		-	*(5.375 units; 258 hours)*

Session 3

FEB 440	Industrial attachment	-	(8 Weeks)

FIFTH YEAR

Compulsory Courses:

FEB 540	Engineering project	-	(2 units; 96 hours)
FEB 550	Seminar	-	(1 unit; 48 hours)

Common Electives:

FEB 502	Remote Sensing	-	(1 unit; 48 hours)
FEB 503	Geoinformation systems	-	(1 unit; 48 hours)
FEB 505	Soil dynamics and earth moving	-	(0.625 units; 30 hours)
FEB 507	Field operations management	-	(0.625 units; 30 hours)
FEB 508	Numerical methods in engineering	-	(0.625 units; 30 hours)
FEB 509	Analogue and digital simulation	-	(0.625 units; 30 hours)
FEB 511	Agricultural mechanization	-	(0.625 units; 30 hours)
FEB 513	Elements of Mechatronics	-	(0.625 units; 30 hours)
FEB 568	Production planning and control	-	(0.625 units; 30 hours)
FEB 588	Experimental stress analysis	-	(0.625 units; 30 hours)
FEB 590	CAD/CAM	-	(0.625 units; 30 hours)
FEB 597	Elements of Precision Agriculture	-	(0.625 units; 30 hours)

3.2 Specialisation Elective courses:

3.2.1 Environmental Engineering

FEB 504	Waste management and pollution control	-	(0.625 units; 30 hours)
FEB 510	Forestry and woodland management	-	(0.625 units; 30 hours)
FEB 512	Soil and water pollution management	-	(0.625 units; 30 hours)
FEB 514	Environmental monitoring and control	-	(0.625 units; 30 hours)
FEB 515	Environmental law and policy	-	(0.625 units; 30 hours)
FEB 516	Soil erosion engineering	-	(0.625 units; 30 hours)
FEB 517	Design of waste management systems	-	(0.625 units; 30 hours)

3.2.2. Irrigation and Water Resources Engineering

FEB 515	Environmental law and policy	-	(0.625 units; 30 hours)
FEB 521	Hydrological design	-	(0.625 units; 30 hours)
FEB 522	Design of irrigation and drainage systems	-	(0.625 units; 30 hours)
FEB 523	Principles of pressurized irrigation	-	(0.625 units; 30 hours)
FEB 524	Water systems engineering	-	(0.625 units; 30 hours)
FEB 525	Groundwater hydrology	-	(0.625 units; 30 hours)
FEB 526	Surface water hydrology	-	(0.625 units; 30 hours)
FEB 591	Advanced fluid mechanics	-	(0.625 units; 30 hours)
FEB 592	Flow through porous media	-	(0.625 units; 30 hours)

3.2.3 Power and Machinery Engineering

FEB 506	Mechanical vibrations	-	(0.625 units; 30 hours)
FEB 541	Terrain and farm machinery design	-	(0.625 units; 30 hours)
FEB 543	Aquatic machinery engineering	-	(0.625 units; 30 hours)
FEB 544	Forestry engineering	-	(0.625 units; 30 hours)
FEB 546	Energy resource engineering	-	(0.625 units; 30 hours)
FEB 547	Transport systems	-	(0.625 units; 30 hours)
FEB 589	Combustion theory	-	(0.625 units; 30 hours)

3.2.4 Process and Food Engineering

FEB 517	Design of waste management systems	-	(0.625 units; 30 hours)
FEB 561	Food chemistry and microbiology	-	(0.625 units; 30 hours)
FEB 562	Physical properties of bio-materials	-	(0.625 units; 30 hours)
FEB 563	Plant design	-	(0.625 units; 30 hours)
FEB 564	Packaging	-	(0.625 units; 30 hours)
FEB 565	Materials handling	-	(0.625 units; 30 hours)
FEB 566	Food engineering systems	-	(0.625 units; 30 hours)
FEB 567	Food preservation	-	(0.625 units; 30 hours)
FEB 587	Thermal processing	-	(0.625 units; 30 hours)

3.2.5 Structures Engineering

FEB 581	Mechanical properties of building materials	-	(0.625 units; 30 hours)
FEB 583	Reinforced concrete design	-	(0.625 units; 30 hours)
FEB 593	Matrix structural analysis	-	(0.625 units; 30 hours)
FEB 594	Timber engineering	-	(0.625 units; 30 hours)
FEB 595	Construction management	-	(0.625 units; 30 hours)
FEB 596	Minor roads	-	(0.625 units; 30 hours)

4.0 COURSE DESCRIPTIONS

4.1 First year courses

CCS 001: COMMUNICATION SKILLS (1 UNIT; 48 HOURS)

The communication process; approaches to the study of communication; information retrieval and library use ; listening skills and lecture comprehension strategies; writing skills ; direction words, paragraphs and punctuations; methods of taking notes; writing in examinations; writing of assignments, resumes, and reports. Oral representation and public address; information dissemination techniques; communication technology; visual literacy.

CCS 008: ELEMENTS OF PHILOSOPHY (1 UNIT; 48 HOURS)

Nature of philosophy. Philosophical mind: Common sense; systematic and reflective thinking. Philosophy and science. Philosophy and culture. Right reasoning: deduction and induction; truth and falsehood; critical analysis. Ethics: ethics as providing norms for the good of individuals and society. Individual and society: freedom and determinism; rights and duties; basic values.

FEB 101: INTRODUCTION TO ENGINEERING (1 UNIT; 48 HOURS)

Definition of engineering: The scope of the engineering profession; the profession of engineering; fields of engineering; functions of engineering; levels of personnel in the engineering team - the scientist, the engineer, the technologist, the technician, the craftsman. The engineer as a professional: Responsibilities and obligations of the professional engineer; professional recognition; professional organisations; professional ethics. The engineering approach to problem solving. Tools of engineering: Calculations and analysis; computers and computer techniques; experimentation and testing; communication. The economic and social element in engineering: Engineering economics, engineering management; the social dimension. Industrial visits, public lectures by practising engineers and case studies.

FEB 102: ECONOMICS (1 UNIT; 48 HOURS)

Study of economic concepts basic to a wide range of social problems; application of these principles to understanding economic activity in firms, households and the economy. Introduction to economic theory: supply and demand for goods and services; market structure; the distribution of income.

FEB 103: PHYSICS I (1 UNIT; 48 HOURS)

Mechanics and properties of matter. Introduction to dynamics: Circular motion; Newton's Law of gravitation. Introduction to statics: Force systems on rigid bodies at rest; equilibrium; fluid statics. Introduction to properties of matter: Elasticity in solids, viscosity in fluids, friction. Sound and Vibration: Introduction to sound; wave phenomenon; sound waves; velocity of sound. Introduction to vibrations: Free vibration of particles; simple pendulum; free vibrations of rigid bodies. Heat: Internal energy and temperature; phase changes of the pure substance. Isothermal and isobaric compressibility of gases, liquids and solids. Heat Transfer: conduction, convention and radiation; kinetic theory of gases; perfect gas equation; intermolecular forces, specific heats and equipartition of energy.

FEB 104: PHYSICS II (1 UNIT; 48 HOURS)

Optics: Wave theory of light; interference; diffraction; polarization. Electricity and magnetism: Electrostatics; capacitors; resistors; current; voltage; power. Ohms Law, its applications. Measurements; Networks. Chemical effect of current. Magnetic field, force on a conductor. Electromagnetic induction. Magnetic properties of matter. AC ballistics. Valves. CRO. Junction Diode. Transistors. Atomic Physics. Radioactivity. Isotopes. The nucleus. X-Rays. Photoelasticity. Energy levels.

FEB 105: CHEMISTRY I (1 UNIT; 48 HOURS)

Inorganic chemistry: Solubility, precipitation, ion-exchange nitrification and denitrification, oxidation - reduction reactions, adsorption, characteristics and significance of some salts and elements (ammonia, nitrates, phosphates, sulphates, silicates, chlorine, oxygen, ozone, carbon, etc). Physical Chemistry; ions in solution, ionization energy, chemical energetics and bonding, chemical equilibrium kinetics.

FEB 106: CHEMISTRY II (1 UNIT; 48 HOURS)

Organic chemistry: Significance of saturated and unsaturated hydrocarbons, phenols, alcohols, ketones, aldehydes, organic nitrogen compounds, organic halogen compounds structures and characteristics of carbohydrates, proteins and liquids. Applied chemistry: Introduction to polymer sciences, hard and soft water (causes and treatment), electro-chemistry, the nitrogen cycle, fuels, fertilizers, soaps and non-soapy detergents, aerobic and anaerobic digestion.

FEB 108: EARTH SCIENCE (0.625 units; 30 hours)

Introduction to geology; lithological constituents of rocks; the geological time-scale; the concept of facies; elements of structural geology. Soil genesis and formation; factors of soil formation; parent material, relief, climate, vegetation, fauna, time and man. Physical properties of soil.

FEB 111: PURE MATHEMATICS I (1 UNIT; 48 HOURS)

Numbers and simple Functions: the real number system functions. Complex numbers, inequalities, exponents; trigonometric functions, definitions, definitions and graph elementary trigonometric formula, sine and cosine rule. Analytical Geometry, Analytical Geometry of lines and elementary conic scions. Graphs and graph sketching. Differential calculus; The derivative; derivatives of sums, products, quotients, chain rule, implicit differentiation, higher derivatives, rates of change.

FEB 112: PURE MATHEMATICS II (1 UNIT; 48 HOURS)

Applications of Differential Calculus: Trigonometric functions: their derivatives, stationary points, minima and maxima problems. Increasing and decreasing functions. Small increments, tangents. Applications of differentiation to curve sketching, convex inflexion points. Polar co-ordinates. Definite integral Calculus: Integration as inverse of differentiation. Definite integral as limit of sum Standard forms. Application of integration to area, volume.

FEB 113: APPLIED MATHEMATICS I (1 UNIT; 48 HOURS)

Kinematics of a particle: Kinematics of a particle in a straight line, scalar and vector quantities, addition of vectors, unit vectors, application to geometry and mechanics. Composition and resolution of velocities and accelerations; relative velocity. Newton's laws of motion, application to connected bodies, circular motion, projectiles. Simple statics: The fundamental theorems of statics, including reduction of a plane system of forces, theorems of moments, conditions of equilibrium in a plane. Centre of gravity, equilibrium of particles and rigid bodies under Coplanar forces, frameworks. Friction, coefficient of friction. Dynamics of Rigid Bodies: Moments and couples. Angular velocity and angular acceleration. Moment of inertia.

FEB 114: APPLIED MATHEMATICS II (1 UNIT; 48 HOURS)

Momentum and energy: Momentum impulse, conservation of momentum. Energy, conservation of energy and work principles, power. Angular momentum of rigid bodies. Simple Harmonic Motion: Hooke's Law, simple harmonic motion, motion in a circle with variable angular velocity. Elementary Statistics; Population and sample, raw data, classification. Principle of data tabulation, graphical representation of data. Average, mean, median, mode, spread, range quartiles, percentiles, standard deviation. Sample spaces, probability, discrete distribution, binomial, poisons, introduction to normal distributions.

FEB 116 FUNDAMENTALS OF COMPUTING (1 UNIT; 48 HOURS)

Introduction to computers: Definition, nature and function of computers; Historical background. Hardware devices: CPU; Secondary storage; input and output devices. Software: Definition; Algorithms; Operating System; Programming Languages; Application Software. Number systems. Data types and structures: number, characters, strings, graphics, sounds and others. Information storage: Records and files, tabulation and other methods of information organization. Information processing: access, summation and sorting. Processing errors: rounding, truncation and canceling errors. Introduction to Computer networks. The Internet. Email, searching and browsing.

FEB 140: WORKSHOP ORIENTATION (8 Weeks)

An exposure to operation in metal and wood workshops, operation and maintenance of machinery and equipment. Lecture on safety (10 hours). This course shall be graded by coursework.

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4.2 Second year courses

FEB 211: ENGINEERING MATHEMATICS I (1 UNIT; 48 HOURS)

Basic Mathematical concepts: elementary set operations, De Morgan's law, relations, Boolean algebras. Functions of a Single Variables: Types of functions, limits, continuity, Rolle's theorem, mean-value theorem. Differentiation: Derivatives of functions including inverse trigonometric, hyperbolic, in hyperbolic, logarithmic. Leibnitz's theorem, differentials, Applications of differentiation of integrals, applications including more advanced concepts of areas and volumes, centroids and moments of inertia. Sequences and series: properties of sequences, expansion of functions as power series. Taylor's and Maclaurin's series, remainder term, convergence of power series, applications.

FEB 212: ENGINEERING MATHEMATICS II (1 UNIT; 48 HOURS)

Ordinary differential equations: First order differential equations, second order and higher order equations with constant coefficients. Complex numbers: geometry of the complex plans, elementary functions, roots of complex numbers, De Moivre' s theorem. Vector and triple products, derivative of a vector. Applications, Matrices and Linear Equations: elementary matrix operations, inverses, determinants, solution of simultaneous linear equation.

FEB 213: COMPUTER APPLICATIONS (1 UNIT; 48 HOURS)

Introduction to office applications: wordprocessing, spreadsheets, simple database, advanced Internet-based applications (file transfer, HTML and java programming etc.) Computer applications in engineering: CAD/CAM systems, Control systems, Robotics, Virtual reality, Information systems in engineering, Artificial Intelligence and Bioinformatics. Introduction to programming: developing simple computer programs in a high-level programming language.

FEB 223: ELECTRICAL CIRCUITS THEORY (1 UNITS; 48 HOURS)

Kirchoff' s laws, magnetic circuits, stored energy, magnetic attraction, hysteresis and eddy current, self and mutual conductance, forces between conductors. Electrostatics: Permittivity, capacity, electric stress, stored energy. Circuit theory: Simple d.c transient in LR and RC networks, alternating current, resistance, capacitance and inductance, resonance, Q-factor, balanced three phase circuits; simple a.c network problems including parallel circuits.

FEB 224: ELECTRICAL PRINCIPLES (0.625 UNITS; 30 HOURS)

Measurements: Principles of operations and construction of measuring instruments, including cathode ray oscilloscope. Transducers display and recording instruments. Errors of measurements. Machines: Magnetic circuits, transformers, engineering considerations of rotating machines, direct current machines and alternating current machines.

FEB 226: THERMODYNAMICS I (1 UNIT; 48 HOURS)

Definitions; science of thermodynamics, basic energy, heat and work reservoirs, mechanical properties, thermodynamic equilibrium, Zeroth law, thermodynamic process. First law of Thermodynamic for closed systems, history, statement of first law, internal energy, enthalpy, application of first law to non-flow system, definition of C_p and C_v. First law for open system control, volume and surface, total energy of a fluid, conservation of energy, flow work and shaft work, general unsteady state equation, steady of energy, functional classification of steady state, properties of fluid; equations of state of a pure substance, the p-v-T surface of a simple compressible substance; thermodynamic diagrams; steam tables.

FEB 231: FLUID MECHANICS I (1 UNIT; 48 HOURS)

Introduction to fluid mechanics: Properties of fluids, dimensions and units. Hydrostatic pressure gauges and manometers. Forces and centres of pressure on plane and non-plane surfaces. Floating bodies, metacentre. Free surface correction and suspended loads. Bernouilli' s theorem for incompressible flow with proof.

FEB 232: FLUID MECHANICS II (1 UNIT; 48 HOURS)

Application of Bernoulli's theorem and momentum equations. Flow measurements: Methods of measurement of velocity and discharge, pitot tubes, orifices, nozzles, venturi meters and notches. Representation of energy changes in a flowing fluid system. Time to empty tanks; laminar and turbulent flow in pipes; Reynolds number, Darcy formula for pipe friction; simple boundary layer theory. Piped networks: Hardy-Cross procedure; Water hammer.

FEB 234: MECHANICS OF MACHINES I (1.25 UNITS; 60 HOURS)

Location of rigid bodies: Kinematic constraint, degree of freedom of translation rotation, surface, line and point contact. Kinematics of plane mechanisms: Definition of pair kinematic chain, mechanism, machine, inversion, various type of mechanism; velocity and acceleration diagram; cams. Dynamics and forces in plane mechanism: Inertia forces, dynamics of rigid bodies, force analysis of a simple crank-slider engine mechanism, engine torque diagrams, flywheel inertia. Friction and lubrication: Surface contact; fluid film lubrication; hydrostatic bearings; anti-friction bearings. Mechanical power transmission: Flat belt and V-belt drives, chain drives, gear strain, gearboxes, friction clutches, Hooke' s joint and constant velocity joint. Balancing of rotating systems: Balancing in one and two planes; moment and force vector diagram; practical balancing machines. The gyroscopic effect; gyroscopic couples for high-speed discs, the gyroscope.

FEB 237: MATERIALS SCIENCE AND ENGINEERING (1.25 UNITS; 60 HOURS)

Introduction to materials: Influence of processing on structure and properties; selection of materials. Atomic structure: Structure of the atom, bonding between atoms and molecules, influence on strength. Crystal structure: Types of crystal structures; miller indices; atomic packing factors. Defects in crystals: Point defects, line defects, area defects. Mechanical properties: Tensile testing, hardness, fatigue, charpy and creep tests. Yield in crystals: Influence of dislocation, methods of strengthening crystals. Equilibrium diagrams: Phases, components, cooling diagrams, isomorphic and eutectic phase diagrams; lever rule. Physical properties: Electrical conduction, thermal behaviour, optical properties, magnetism. Deformation processes: Forging, rolling, extrusion and drawing. Forming processes: Shearing, formability, bending deep drawing, super-elasticity. Ceramics. Polymers. Composites. Machining: Cutting forces; cutting parameters; lathes; milling; broaching; CNC control.

FEB 240: WORKSHOP PRACTICE (8 WEEKS)

An exposure to operations in concrete production. Engineering survey. Electrical machines. Steam generation and distribution; boilers, pipes, heat exchangers, economizers, foundry equipment. The course shall be examined by course work.

FEB 241: ENGINEERING GRAPHICS (1 UNIT; 48 HOURS)

Definition of technical graphics; various aspects of technical graphics; uses of technical graphics. Technical graphics equipment for pencil work and ink work. Types of 3-dimensional views i.e isometric, perspectives and oblique. Construction of loci, different types of thread forms; cams and gear teeth profiles; introduction to graphic techniques and equipment. Computer aided graphics.

FEB 242: GEOSPATIAL ENGINEERING FUNDAMENTALS (1 UNIT; 48 HOURS)

Geospatial technology and its relevance to environmental and biosystems engineering. Geospatial measurement techniques: Measurement of distances, angles, and heights. Establishment of geospatial control and topographic mapping. Measurement and computation of areas and earthworks. Georeferencing and introduction to positioning with satellite systems - e.g GPS, GLONASS, and Galileo systems and applications in environmental and biosystems engineering.

FEB 246: ELECTRONICS (1 UNIT; 48 HOURS)

Analogue electronics: Introduction to transistors. DC models, biasing analysis. Transistor characteristics and equipment circuits. Transistor amplifiers, principles of feedback circuits. Operational amplifiers. Oscillators. Power amplifiers. Power supplies. Digital electronics: Design of basic logic gates, integrated circuits, combination logic. Sequential logic. Computer memory. Very large scale integrated circuit.

FEB 271: SOLID AND STRUCTURAL MECHANICS I (1.25 UNITS; 60 HOURS)

Mechanics of materials loading, static and dynamic forces, structural analysis. Stress and strain in tension, compression and shear. Behaviour of materials under static loading, stress-strain diagrams, linear elasticity, tension, instability, elastic constants. Strain energy in tension, compression and shear. Analysis of design in simple tension and compression, non-uniform and thermal stress and strains. Thin-walled pressure vessels, volumetric strain, pressure effects. Elastic torsion analysis, design of shafts, strain energy in torsion. Bending beams: reaction by supports, shear forces and bending moments. Simple bending theory. Combined loading applied to design. Deflection of beams due to pure bending, statically determinate beams, moment-area method, strain energy in bending, constant strength beam theory.

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4.3 Third year courses

FEB 301: INSTRUMENTATION (0.625 UNITS; 30 HOURS)

The science and art of measurements. Definition of basic dimensions in engineering. Experimental accuracy and precision, random and systematic errors. Measurements of mechanical, electrical, hydraulics and sound energy. Performance characteristics of measuring instruments. Systems approach to process control. Open and closed loop system analysis and data collection, manipulation, transmission and recording. Transducers and sensors. Signal conditioning.

FEB 303: ENVIRONMENTAL SCIENCE (1 UNIT; 48 HOURS)

Introduction to ecological principles and concepts; terrestrial and aquatic animals. Plant taxonomy: Dendrology and silviculture; elements and processes of the natural environment, their characteristics, distribution and implication to animals, plants and humans. Introduction to land use and environmental models as tools in the planning process and as techniques for improving the quality of physical development plans. Environmental change; Greenhouse gas emissions and global warming.

FEB 304:INTRODUCTION TO GEOINFORMATICS (0.5 UNITS; 30 HOURS)

The scope of Geoinformatics - photogrammetry, remote sensing, cartography, and Geoinformation systems (GIS) and their application in environmental and biosystems engineering. Maps, mapping and their uses. Analogue and digital mapping techniques.

FEB 306: PRINCIPLES OF AGRICULTURAL SCIENCE (1 UNIT; 48 HOURS)

Principles of crop production; climate, cropping systems, land preparation protection and harvesting. Principles of animal production; breeding, growth and management systems. Principles of soil biochemistry, soil fertility. Soil genesis (pedology).

FEB 311: PRINCIPLES OF LAW (0.625 UNITS; 30 HOURS)

History of legal systems. Nature and sources of law. Law of tort. Constitution of Kenya. Labour law. Factories Act. Trade unions and disputes Act. Environmental Management Act. Agricultural and Water Acts. Physical Planning Act. Land Use legislation. Intellectual Property Rights. Criminal law. Industrial court and protection of essential services. Other related institutional and legal issues.

FEB 312: NUMERICAL METHODS (1 UNIT; 48 HOURS)

Computer calculations: Computer arithmetic; computational errors. Solutions of equations in one variable. Solution to linear systems of equations. Methods of approximating Eigen values. Interpolation and polynomial approximation. Approximation theory. Fourier transforms. Numerical differentiation and integration. Initial-value problems in ordinary differential equations including Euler's, Taylor's, Runge-Kutta-Fehlberg, etc. Boundary-value problems in ordinary differential equations. Overview of Finite Difference, Finite Element, and Boundary element methods. Computer software.

FEB 313: ENGINEERING MATHEMATICS III (1 UNIT; 48 HOURS)

Functions of several variables: limits, continuity differentiability, total derivatives, Taylor's and mean-value theorems, tangent planes, critical points, maxima, minima, saddle points, change of variable and Jacobians, implicit functions. Vector calculus: gradient, divergence and convergence, Stokes and Green theorems, applications. Matrices: special matrices, linear transformation and rotations, matrix partitioning, bilinear and quadratic forms differentiation of matrices.

FEB 314: ENGINEERING MATHEMATICS IV (1 UNIT; 48 HOURS)

Fourier series: Periodic functions; odd and even functions; expansion of functions; Dirichlet's conditions; differentiation and integration; Fourier integrals and transforms. Laplace transforms: Properties; differentiation and integration; inverse transforms; application to differential equations; evolutions; convolution theorem. Ordinary differential equations: Series solutions; Legendre and Bessel functions. Partial differential equations: Separations of variables; Laplace's heat and wave equations. Fourier series in simple boundary value problems.

FEB 316: ENGINEERING STATISTICS (1 UNIT; 48 HOURS)

Basic concepts: Role of statistics; simple techniques for describing statistical data. Probability and its applications: The factorial; combinations, and permutations; Baye's theorem. Random variables: Expectation and variance. Probability distributions. Statistical sampling: Sampling distributions; estimation; hypothesis testing; regression analysis and analysis of variance. Quality control and reliability analysis.

FEB 321: THERMODYNAMICS II (1.25 UNITS; 60 HOURS)

Second Law of Thermodynamics. Heat ,work and reservoirs. Plank and Kelvin's statement. Cycle efficiency. Reversibility and irreversibility. Perfect gas: Equation of state of a perfect gas; compressibility factor; gas constants; molecular weight; the mole; the molar volume; other property relations for a perfect gas. CV and Cp relation; perfect gas thermometer. Joules' closed vessel experiment. Air -standard cycles: Introduction to air standard cycles; internal and external combustion engines; cycle thermal efficiency; compression volume ratio; pressure ratio; work ratio; mean effective pressure; specific output; Carnot cycle; Otto cycle; Diesel cycle; Dual cycle; Atkinson cycle; Joule (Brayton) cycle; Erricson cycle; Stirring cycle. Single-stage single-reciprocating air compression and their effect on theoretical work; isothermal efficiency; clearance ratio; volumetric efficiency; heat generated; free delivery; actual compression. P-V diagram; brief discussion on dryness, cleanness etc. Engine trials: Torque; criteria of performance; efficiencies. Entropy; availability; psychometrics;

chemical reactions.

FEB 322: THERMODYNAMICS III (1 UNIT; 48 HOURS)

Vapour power cycles: Carnot and Rankine cycles. Isentropic efficiencies. Fluid flow; steam condenser; convergent and divergent nozzles. Mach number; supersaturation and superheat. Numerical solutions. Steam turbines: single stage and impulse turbine; internal efficiencies; reheat factor; P-V, T-S, h-s diagrams. Refrigeration cycles and heat pumps.

FEB 323: SOIL MECHANICS (0.625 UNITS; 30 HOURS)

Basic and engineering soil properties; The engineering definition of soil; development of soil mechanics. Soil composition. Physical properties of soil and their relationship. Grain size analysis and Atterberg limits. Water in soils and permeability. Classification of soils by origin and by engineering characteristics. Seepage, its effects and control. Fluid flow through soils. Compaction, effective stresses, and compression. Stress-strain properties and shear strength of soils. Settlement and stability analysis.

FEB 324: MECHANICS OF MACHINES II (1.25 UNITS; 60 HOURS)

The location of the rigid bodies: Kinematic constraint; degrees of freedom of translation and rotation; surface, line and point of contact. Kinematics of plane mechanisms: Definition of pair kinematic chain mechanism; machine inversion; various types of mechanisms; velocity and acceleration diagrams; cams. Dynamics of rigid bodies: force analysis of a simple crank-slider engine mechanism; engine torque diagrams; flywheel inertia. Vibrations: Introduction; description. Free versus forced vibrations; degrees of freedom: Equation of motion for undamped single degree free vibrations; Energy method; damped free vibrations. Inertia forces in Mechanics and balancing of reciprocating masses: Kinematics; Inertia forces and virtual work. Mechanical devices and control system elements. Introduction to nature of measurement systems: Electrical elements; mechanical elements.

FEB 325: SOLID AND STRUCTURAL MECHANICS II (1.25 UNITS; 60 HOURS)

Built-in and continuous beams; plane frame analysis. Analysis of stress and strain: Lame' s equations; Mohrs cycle of stress and strain; pure shear. Three-dimensional stress. Plastic deformation. Thick and compound cylinders. Shrink-fit. Thick spherical shells: Elastic failure in complex stress systems; von Mise' s and Tresca' s failure criterion; failure of brittle materials and application of failure theories. Deformation and bending of beams beyond elastic limits; plastic deformation of thick cylinders under internal pressures; residual stresses. Composite Beams: Types of composite beams and applications; equivalent section properties and stress and strain analysis of timber and steel beams, reinforced concrete and bimetallic strips.

FEB 331: APPLIED FLUID MECHANICS ((0.625 UNITS; 30 HOURS)

Open channel flow: Uniform and non-uniform flows. Specific energy. Hydraulic jump. Back-water profiles; weirs and flumes. Dimensional analysis and Similitude. Simple aerofoil theory. Introduction to boundary layers, compressibility and viscous flow. Dimensionless numbers. Pumps Pelton wheel, Francis and Kaplan turbines.

FEB 340: ENGINEERING PRACTICE (8 WEEKS)

Introductory lectures in Environmental and Biosystems Engineering (10 hours). Introduction to engineering practice. Basic principles and applications: Environmental engineering; irrigation and water resources engineering; power and machinery engineering; process and food engineering; structures engineering. Practical experience in servicing and maintenance of petrol and diesel engines. Tractor and motor vehicle servicing and maintenance. Maintenance of electrical machines and equipment. The course shall be examined by

coursework.

FEB 383: CONSTRUCTIONAL MATERIALS (0.625 UNITS; 30 HOURS)

Composition and structure of constructional materials; Elastic, plastic and viscous behaviour under various condition. Portland cement, concrete, timber, bituminous materials, stones, bricks, mortar, glass, rubber, roofing materials; fittings and paints.

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4.4 Fourth year courses

FEB 402: GEOTECHNICAL ENGINEERING (1 UNIT; 40 HOURS)

Properties of natural soil deposits and subsoil exploration, engineering solutions to problems of slope stability, foundation settlement and earth pressure. Introductory rock mechanics.

FEB 403: MECHANICAL DESIGN (1 UNIT; 48 HOURS)

Introduction to engineering design. A study of the application of the general principles and empiricism of mechanics of solids to the creative design of mechanical equipment. Product development, management and economics. Report writing. The methodology of intermediate design and practice in the design of a specific system which may utilize principles of any mechanical engineering discipline, fasteners, shafts and coupling, hydraulic and pneumatic machinery sealing.

FEB 404: STRUCTURAL DESIGN (1 UNIT; 48 HOURS)

Introduction to methods of design: Elastic method; plastic method; limit state method. Introduction to structural design: Reinforced concrete; prestressed concrete; timber; steel; masonry; composite materials. Introduction to foundation design: Foundation types; modes of load transfer; simple design. Laboratory assignment: Design and verification of strength by testing (one assignment). Computer applications.

FEB 407: OPERATIONS RESEARCH (0.625 UNITS; 30 HOURS)

Historical overview and nature of Operations Research. Linear Programming. Network models. Inventory models. Queuing models. Markovian decision models. Replacement models. Simulation.

FEB 411: MANAGEMENT FOR ENGINEERS (0.625 UNITS; 30 HOURS)

Function of management. Principles of management. Principles of organization. Decision making. Motivation and management. Financial statements and analysis. Budgets and budgeting. Capital budgeting. Costs and costs analysis. Maintenance management.

FEB 412: ENVIRONMENTAL ENGINEERING (0.625 UNITS; 30 HOURS)

Design considerations for environmental control systems. Water pollution control; sewerage treatment systems. Air pollution and control; GHG effects and design of control systems. Introduction to resource conservation, soil erosion, degradation and desertification. Human influence on environmental pollution. Engineering solutions to environmental degradation.

FEB 421: THERMODYNAMICS IV (0.625 UNITS; 30 HOURS)

Thermodynamics of state; perfect gas; low pressure table; principles of corresponding state; incompressible liquid; differential equations of state. Maxwell equation; Joule-Thompson coefficient; Clausius-Clapeyron equation. Mixtures. Fuels and combustion. SI and CI engines.

FEB 422: PROFESSIONAL PRACTICE (0.625 UNITS; 30 HOURS)

Financial, legal, regulatory, ethical and business aspects of engineering practice. Office organisation and management. Human resource management. Professional societies. Engineering registration. The role of engineering in development. The definition of the Professional Engineer and the Engineer's Registration Act.

FEB 423: HEAT AND MASS TRANSFER (0.625 UNITS; 30 HOURS)

Laminar flow convective heat transfer: Introduction, momentum and energy balance equations, fully developed flow in round ducts and other duct configurations, forced flow over a flat plate, laminar free convection over flat plates, entrance region in laminar flow. Heat transfer in turbulent flow: governing equations and eddy diffusivities, analogy between heat and momentum transfer, experimental results for turbulent free convection, turbulent flow over flat plates and submerged bodies, turbulent free convection over vertical flat plates. Radiative heat transfer: EMW spectrum and thermal radiation, body radiation, spectral distribution of black body radiation, real and grey surfaces, Kirchoff's law, algebra of shape factors, exchange in black and grey enclosures with radiating surfaces, combined modes of heat transfer. Exchange in absorbing and emitting media.

FEB 424: WATER RESOURCES ENGINEERING (0.625 UNITS; 30 HOURS)

The hydrological cycle: Rainfall; runoff; infiltration; percolation; seepage; evapotranspiration. National, regional and other water balances; the hydrometeorlogical network; agro-climatic and agro-ecological zones. Rural water resources: surface and ground water. Rainwater collection systems; water harvesting technology. Reservoirs, ponds and agricultural dams. Design of rainwater harvesting systems. Rural drinking water: demands; quality standards; treatment methods. Design of water delivery and storage systems. Wastewater treatment; pollution and sanitation. Design of waste management systems.

FEB 425: IRRIGATION AND DRAINAGE ENGINEERING (0.625 UNITS; 30 HOURS)

Introduction to irrigation and drainage; Definitions; extent; advantages and disadvantages. Overview of irrigation methods. Irrigation zones and potential in Kenya. Soil and water potential; soil-water dynamics; dynamic soil water availability. Crop water requirement: Determining evapotranspiration; crop factors; irrigation requirements; efficiencies. Irrigation water quality; salt balance and leaching; salinity management and reclamation. Water measurement and regulation; continuous and rotational delivery; water management and organizational structures. Field drainage: Drainage in agriculture; types and techniques. Steady state equations.

FEB 440: INDUSTRIAL ATTACHMENT (8 WEEKS)

Practical attachment in industry. The student shall be required to perform all the duties of an engineering trainee. This course shall be examined by field assessment and report.

FEB 441: POWER AND MACHINERY ENGINEERING (0.625 UNITS; 30 HOURS)

Study of motive and stationary power needs of agriculture, forestry and aquaculture. Power measurements. Theory of traction and trafficability. Power-implement relationships and force analysis. Tractor design and chassis mechanics. Agricultural machinery mechanisms. Design considerations and performance evaluation of equipment for land preparation, planting, spraying, fertiliser distribution and harvesting. Equipment for forestry and aquaculture. Power transmission and power trains design. Introduction to turbo-machinery. Ergonomics.

FEB 442: PRINCIPLES OF ELECTRIFICATION (0.625 UNITS; 30 HOURS)

Electricity generation and distribution. Load determination. Stray voltage. Wiring. Standby generators overload and circuit breakers. Lighting. Electric motors. Controls.

FEB 461: PROCESS AND FOOD ENGINEERING (0.625 UNITS; 30 HOURS)

Properties of Biomaterials. Design of processing systems for food and bio-products, including thermal processing, grading, size modification, drying, transportation of bulk and fluid products and packaging. Quality and inspection of grain and other food and bioresource products. Secondary processing of selected products.

FEB 482: BUILT ENVIRONMENT DESIGN (0.625 UNITS; 30 HOURS)

Psychometrics. Solar radiation. Heat and moisture transmission in buildings. Effects of thermal environment on humans, animals, plants and industrial processes. Ventilation, heating and cooling load calculations. Functional requirement and principles involved in housing animals, crops, bio-products and humans. Analysis of factors and properties affecting energy exchanges with the environment. Insolation, thermal exchange. HVAC equipments.

FEB 483: ENVIRONMENTAL IMPACT ASSESSMENT (0.625 UNITS; 30 HOURS)

Definition and scope. Objectives: Assessment of the impacts of social-economic and physical activities and developments on the environment eg., development of housing estates, provision of national and urban infrastructure, irrigation schemes etc. Acquisition of data for impact assessment: population distribution and dislocation, disposal of waste, recreation facilities, traffic flow; distribution and levels of income, values of land and other property; degradation of the environment, soil erosion, depletion of forests, water quality, air pollution, climate conditions etc. Sources of information: Development plans, geological and engineering survey information relating to earthquakes, volcanic eruptions, landslides, floods, and other natural hazards; survey record including maps, remotely sensed satellite imagery, engineering survey information etc. Processing, analysis, interpretation and presentation of data/results. Case study examples.

FEB 486: INFRASTRUCTURE ENGINEERING (0.625 UNITS; 30 HOURS)

Planning, analysis, design, operation and maintenance of infrastructure for production, processing, transport and habitation. Economic planning, building planning, farmstead planning, minor roads, fire protection rural dwellings, animal housing. Landscaping. Cost estimation and tender process. Construction supervision.

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4.5 Fifth year courses

FEB 502: REMOTE SENSING (1 UNIT; 48 HOURS)

Air photo interpretation. Characteristics of the different, current, satellite remote sensing systems and imagery, visual interpretation of remotely sensed imagery. Application of remote sensing in landform identification and evaluation, land use and land cover mapping, geologic and soils mapping, agriculture, population studies, forestry, water resources management, environmental pollution, wildlife ecology, urban and regional planning, wetlands and watershed mapping. Environmental monitoring and environmental impact assessment studies. Brief introduction to digital image processing.

FEB 503: GEOINFORMATION SYSTEMS (1 UNIT; 48 HOURS)

Definitions; GIS components, characteristics and sources of GIS data; GIS data capture; Geodatabases and GIS data management; GIS analysis functions; Application of GIS, especially in Biosystems and environmental management. Setting up a GIS installation; the National Spatial Data Infrastructure (NSDI) concept.

FEB 504: WASTE MANAGEMENT AND POLLUTION CONTROL (1UNIT; 48 HOURS)

The use of engineering principles for the design of systems for treatment and control of liquid and solid waste and the abatement in the total environment; quantitative approaches to environmental control in air, water and land systems. Methods of waste water treatment; aerobic and anaerobic treatment methods. Modelling the waste water treatment process. Air pollution, solid waste treatment; landfills and composting technologies.

FEB 505: SOIL DYNAMICS AND EARTH MOVING (0.625 UNITS; 30 HOURS)

Dynamic properties of soils and their assessment. Application aspects; estimation of soil compaction from stress distribution. Compression test data analysis. Hakansson' s compaction test. Design and performance of earth moving and tillage implements and machinery. Mechanics of traction.

FEB 506: MECHANICAL VIBRATION (0.625 UNITS; 30 HOURS)

Free and forced vibrations of mechanical systems having lamped mass and elasticity; multiple degrees of freedom; dissipative systems; random vibrations; engineering applications.

FEB 507: FIELD OPERATIONS MANAGEMENT (0.625 UNITS; 30 HOURS)

Analysis of field operations planning facility location, facility layout, service and queuing theory, quality control and machinery maintenance. Field operations management in fleets for farms, agro-industries, forestry and environment.

FEB 508: NUMERICAL METHODS IN ENGINEERING (0.625 UNITS; 30 HOURS)

Finite Element methods, Finite Difference methods and Boundary Element methods. Application of basic computer software packages for the solution of engineering problems in structures, water resources, heat transfer, geotechnical and related areas.

FEB 509: ANALOGUE AND DIGITAL SIMULATION (0.625 UNITS; 30 HOURS)

Principles of analogue and hybrid simulation developed and applied to engineering problems in engineering systems. Application of digital measurement systems and dynamic simulation to biological processes and equipment in engineering. Digital computer programmes to simulate the operation of complex discrete systems in time. Modelling, programme organization, pseudo-random-variable generation, simulation languages, statistical considerations; applications to a variety of problem areas.

FEB 510: FORESTRY AND WOODLAND MANAGEMENT (0.625 UNITS; 30 HOURS)

Application of micro-economic and management theory to management of forest and woodland resources and mills. Development of timber management plans which integrate economic and environmental considerations.

FEB 511: AGRICULTURAL MECHANIZATION (0.625 UNITS; 30 HOURS)
Historical perspective of agricultural mechanization and industrialization. Choice and basis of selection of power sources for the mechanization process. Organization form of the industry and firms. Cost theory and

optimum farm size. Information systems for agricultural firm management, Case studies for different farming systems. Mechanization project development.

FEB 512: SOIL AND WATER POLLUTION MANAGEMENT (1UNIT; 48 HOURS)

Nature and sources of pollutants; inorganic fertilizers; ecological hazards; movements to water sources. Organic agro-chemicals; ecological effects, interactions in the soil (sorption, biological degradation, chemical degradation, volatilization, transport). Heavy metals: Sources, effects, control. Industrial pollution; sources, pollution control, effects, etc. Management of soil and water salinity.

FEB 513: ELEMENTS OF MECHATRONICS (1UNIT; 48 HOURS)

Analogue and digital fundamentals. Microcontroller technologies and computer architecture. PIC processor, assembly and programming. Power amplification. Signal i/o, PIC A/D converter. PIC c-programming. Sensors: Tachometers; pots; encoders; infrared; ultrasonics; Acc's. Dynamic modelling; Communication. Control theory and design. Actuators. PM DC motors, stepper motors. Active material actuators. AC motors, gear reducers. PLCs. Real-time systems.

FEB 514: ENVIRONMENTAL MONITORING AND CONTROL (0.625 UNITS; 30 HOURS)

Definition of the environment and essence of environmental monitoring; the role of the environment in geomatics and the objectives of environmental monitoring e.g., to facilitate environmental planning, resource mapping, thematic mapping, minimise environmental degradation, hazard control. Use, distribution and maintenance of resources: condition of infrastructure and their impacts on socio-economic activities; land use/cover and urban growth structure; concentration and distribution of wildlife and human settlements; depletion of forests, extraction and exploitation of water and minerals; development activities within water bodies and their impact on the general environment; meteorological conditions and industrial pollution; environmental impact assessment. Techniques of monitoring: positioning, remote sensing and mapping; socio-economic surveys and field verifications; deformation monitoring and geographic information systems. Processing, analysis, interpretation and presentation of data. A study of design techniques, practices, equipment and systems for environmental control in production storage and processing structures.

FEB 515: ENVIRONMENTAL LAW AND POLICY (0.625 UNITS; 30 HOURS)

Major contemporary environmental problems; the common law foundations of environmental law especially doctrines and nuisance, trespass, negligence, Rylands V. Fletcher and riparian rights; changed character of problems and the law, especially the place of administrative law in the face of the common law doctrines; contemporary legislation and the role of environmental law in development; EIA and associated approaches to redress environmental problems; and concepts in international environmental law; the protection of genetic diversity; international water law. National Development Plans as a guide to the Government' s policy trends and investment programme in the environment over the year; case studies.

FEB 516: SOIL EROSION ENGINEERING (0.625 UNITS; 30 HOURS)

Soil erosion process, types of soil erosion, measurement of soil erosion, soil erosion models and soil erosion structures. Processes of soil erosion and engineering design for erosion control. Watershed planning and management. Modelling soil erosion, soil conservation policy.

FEB 517: DESIGN OF WASTE MANAGEMENT SYSTEMS (0.625 UNITS; 30 HOURS)

Application of bioengineering principles of pollution control in the design of management systems for wastes from food and fibre production and processing operations. Sewerage plants; design of oxidation ponds and land fills.

FEB 521: HYDROLOGICAL DESIGN (0.625 UNITS; 30 HOURS)

Engineering design of reservoirs, river training, spillway, dissipation and hydro-machinery. Water laws. Current approaches in hydrological design, design period, safety and risk of failure. Problems associated with hydrological design. Quality control on hydrological data, methods of estimating missing records, hydrological data simulation. Dams and dam design, design of runoff harvesting systems. Economic analysis.

FEB 522: DESIGN OF IRRIGATION AND DRAINAGE SYSTEMS (0.625 UNITS; 30 HOURS)

Engineering design of irrigation and drainage systems for optimum crop growth and environment. Field irrigation methods, crop water requirements, irrigation and drainage structures, irrigation and drainage policy. Planning irrigation development: planning phase, feasibility, design, implementation, evaluation and monitoring. Design of field irrigation methods; basin, furrow, sprinkler and drip. trickle irrigation systems. Principles of irrigation water abstraction, conveyance and application to fields including analysis of open channel and pipe flow, seepage, percolation and evapotranspiration. Principles of water movement to subsurface drains including depth and spacing; frequency analysis of drainage flow; hydrologic characteristics of drainage systems; drainage requirement of crops.

FEB 523: PRINCIPLES OF PRESSURIZED IRRIGATION (0.625 UNITS; 30 HOURS)

Relation between irrigation regime and choice of irrigation method. Types of sprinkler systems according to degree and method of portability, sprinkler type. Sprinkler characteristics and wetting pattern. uniformity and application efficiency. Design guidelines, suitability to various conditions. The basic principles to drip irrigation hydraulics and water regime. The components of a drip system. Design guidelines for laterals. The drip head. Accessories; filters, fertilizer injectors, vacuum breakers, flushing valves. Measurement and control devices, automation and computer assisted management of irrigation systems.

FEB 524: WATER SYSTEMS ENGINEERING (0.625 UNITS; 30 HOURS)

Meteorology, streamflow, evapotranspiration, hydrographs, runoff relations, runoff hydrographs, groundwater, unit hydrographs, flood routing, frequency and duration studies, and application of hydrologic techniques. Demographic studies, water supply and wastewater flow. Systems engineering approach to water resources planning and development. Water demand, quality and pollution. Estimation of water yield and peak discharge. Flood routing and planning reservoirs for catchments.

FEB 525: GROUNDWATER HYDROLOGY (0.625 UNITS; 30 HOURS)

Hydrological cycle and processes; acquifer classification and properties; Darcy's law, hydraulic cond uctivity, capillary tube model, intrinsic permeability. Generalised Darcy's law 3D anisotropic media, limitations of Darcy's law, flow in fractured media and cubic law. Groundwater contour maps, data interpolation/contouring methods and Kriging; Analysis of flow nets. Water balance analysis and application. Water quality balance analysis and applications. Aquifer flow equation, one-dimensional steady-state solutions. One-dimensional transient flow, stream-aquifer interaction. Unsaturated flow theory. Characteristics of unsaturated zone, constituitive relations, Richards Equation. Groundwater resource evaluation, sustainable development, recharge, well head protection, water quality constraints, seawater intrusion, land subsidence, artificial recharge. Transient well hydraulics for confined, leaky, and unconfined aquifers, radius of influence. Steady state well hydraulics, well fields, wells near boundaries, image methods, well recovery, capture zone, time dependent transport zone, area of influence. Pump tests and analysis, slug test**.** Groundwater contamination, transport processes**.** Analytical transport models and applications**.** Transport in heterogeneous media, heterogeneous conductivity. Transport of sorptive contaminants, retardation effects.

FEB 526: SURFACE WATER HYDROLOGY (0.625 UNITS; 30 HOURS)

The hydrological cycle; rainfall: measurements, spatial variations, time series; streamflow measurements: water-levels, discharges, rating curves, pre-calibrated structures; hydrographs of runoff: shape, components, the unit hydrograph theory; rainfall-runoff relations: infiltration, water balance, graphical correlations, simulation models; probability as a basis for design: theoretical distribution of peak discharges, rainfall intensity-duration-frequency curves, design storm, design flood; flood routing: reservoirs, river channel; sediment transport: the erosion process, suspended load, bed-load, reservoir sedimentation.

FEB 540: ENGINEERING PROJECT (2 UNITS; 96 HOURS)

The project is a practical assignment aimed at solving a particular engineering problem. It requires the application of knowledge gained in the courses up to the final year. It might deal with a problem in any of the five areas of specialization. This course shall be examined by coursework, oral presentation and report.

FEB 541: TERRAIN AND FARM MACHINERY DESIGN (0.625 UNITS; 30 HOURS)

Characteristics of terrain and farm machinery engineering. Functional analysis of machinery components. Studies relating to the more efficient utilization of existing machinery designs or their adaptability to special situations. Research and development of machines. Tyre design requirements and selection considerations. Off-road traction prediction for wheeled vehicles. Rural technology development processes. Machinery Testing and Ergonomics. Standardization.

FEB 543: AQUATIC MACHINERY ENGINEERING (0.625 UNITS; 30 HOURS)

Study of the principles and design methodology for aquatic machinery used for plant and animal production and processing and environmental control

FEB 544: FORESTRY ENGINEERING (0.625 UNITS; 30 HOURS)

Engineering solution to forestry problems. Principles and design methodology for harvesting and processing machinery for timber and wood products.

FEB 546: ENERGY RESOURCES ENGINEERING (0.625 UNITS; 30 HOURS)

Integrated approach to energy technology, analysis and economics. Estimation of energy requirements for intensification of specific production practices. Energy analysis and evaluation of alternative sources for meeting the needs. Technologies for energy conversion and utilization in the farm, household and in industry, including biomass, solar, wind and geothermal energy. Energy planning, energy conservation and development for a sustainable future.

FEB 547: TRANSPORT SYSTEMS (0.625 UNITS; 30 HOURS)

Objectives and functions of transportation; interaction between land -use and travel patterns; service characteristics of transportation modes. Design of unpaved and paved minor roads, minor crossings, culverts, drifts, small bridges.

FEB 550: SEMINAR (0.625 UNITS; 30 HOURS)

Topical issues in engineering, environment, agriculture, and all academic areas. This course shall be graded by course work.

FEB 561: FOOD CHEMISTRY AND MICROBIOLOGY (1UNIT; 48 HOURS)

Chemical components of food and their precursors. Aroma and flavour compounds. Changes in food components during processing and effect on quality microflora of food crops and commercial animals. Food as growth medium for micro-organisms. Microbiological standards and testing.

FEB 562: PHYSICAL PROPERTIES OF BIO-MATERIALS (0.625 UNITS; 30 HOURS)

Dimensional and shape characteristics, density porosity, moisture retention, rheological and other mechanical properties, structure and texture. The effect of physical properties on handling, mechanical damage, storage and measurement of thermal properties like specific heat, diffusion, and unit thermal conductance. Application to drying, dehydration and cooling.

FEB 563: PLANT DESIGN (0.625 UNITS; 30 HOURS)

Principles and design methodology for food and agro-industries. Plant layout, process charts, types and selection of processes. Building services, water supply, steam generation and distribution, sanitation, storm drainage, HVAC systems installation. Waste management and waste treatment plant design.

FEB 564: PACKAGING (0.625 UNITS; 30 HOURS)

Principles of packaging food, agricultural by-products: bagging, canning, bottling, cartons, sachets. The chemical and physical properties and manufacture of the basic materials used to construct packaging are discussed. The influence of packaging on shelf is presented. Emphasis is on newer packaging technologies and materials. Economics, design and regulation of food packaging are briefly presented. Terminology and literature of commercial packaging, selection of packaging methods and materials.

FEB 565: MATERIALS HANDLING (0.625 UNITS; 30 HOURS)

Design of the layout of processes and storage areas and the material-handling system for movement of items. Typical equipment used. Material flow analysis. The functions of identification, storage, movement, batching, merging and dispersion.

FEB 566: FOOD ENGINEERING SYSTEMS (0.625 UNITS; 30 HOURS)

Construction and layout of equipment and machinery for food processing plants. Equipment for steam and hot water generation, refrigeration, heat treatment, evaporation, filtration, flavour extraction, rectification, separation, homogenization, centrifugation, distillation, membrane processes, ion exchange absorption, mixing, leaching, milking, pressing, spraying and transport.

FEB 567: FOOD PRESERVATION (0.625 UNITS; 30 HOURS)

Diversity of food materials. Their quality as raw materials and as direct food. Deteriorative changes and their basis. Nutrients loss and conservation. Retardation of determination changes. Principles of food preservation by heating, low temperature, dehydration, fermentation, pressure, concentration, food additives, irradiation, atomic heating.

FEB 568: PRODUCTION PLANNING AND CONTROL (0.625 UNITS; 30 HOURS)

A survey of operation methods used in industry, including optimization, probability statistics, waiting line models, quality control, simulation models, forecasting, inventory control and scheduling models. Mathematical formulation and solution of problems of scheduling, inventory control and logistics using linear programming methods.

FEB 581: MECHANICAL PROPERTIES OF BUILDING MATERIALS (0.625 UNITS; 30 HOURS)

Elasticity; plasticity; viscoelasticity. Fatigue and fracture phenomenon for building materials. Constitutive equations. Stress intensity. Stability. Composites.

FEB 583: REINFORCED CONCRETE DESIGN (0.625 UNITS; 30 HOURS)

Analysis and design of reinforced concrete systems. Prestressed concrete, pre-cast concrete, concrete plate and shell structures, cylindrical shell, domes, hyperbolic and elliptical paraboloids.

FEB 587: THERMAL PROCESSING (0.625 UNITS; 30 HOURS)

Pasteurization and Sterilisation: Introduction: the unifying theory on food preservation; The General Method: the basic concept in process calculations; Design, validation and optimization of thermal processes: formula methods and theoretical methods; Technical infrastructure for thermal processing; Recent development in thermal processing. *Evaporative drying*: Water binding in biological systems (water sorption phenomena, water activity, water sorption isotherms, isotherm equations, temperature and water binding, hysteresis and sorption); Phase diagrams of foods, relation between moisture content/water activity and food quality/stability; Thermodynamics of humid air: hygrometric characteristics of humid air, thermal characteristics of humid air, psychometric charts; Evaporative drying: kinetics of drying, calculation of drying times, characterisation of the efficiency of the drying process, drying with air recirculation, isothermal drying, industrial drying systems; Cooking. Refrigeration and freezing

FEB 588: EXPERIMENTAL STRESS ANALYSIS (0.625 UNITS; 30 HOURS)

Static and dynamic strain analysis by electrical gauges; grid techniques; brittle coating; analogies; reflective photoelasticity in normal and oblique incidence; motion measurements.

FEB 589: COMBUSTION THEORY (0.625 UNITS; 30 HOURS)

A study of chemical thermodynamics and kinetics, the basic equation of change, and application of fundamentals to combustion in engineering systems.

FEB 590: COMPUTER AIDED DESIGN AND MANUFACTURE (0.625 UNITS; 30 HOURS)

Principles of CAD/CAM and design for automatic manufacturing and assembly; simulation design and manufacturing; simulation of manufacturing processes.

FEB 591: ADVANCED FLUID MECHANICS (0.625 UNITS; 30 HOURS)

Two and three-dimensional Navier-stokes equation. Generalized differential and integral equations of momentum and energy. One and Two dimensional compressible flow. Application of numerical methods in fluid mechanics.

FEB 592: FLOW THROUGH POROUS MEDIA (0.625 UNITS; 30 HOURS)

Analysis of flow through porous media; saturated and partially saturated flow; free surface analysis; introduction to numerical techniques. Darcy' s law, modelling infiltration/seepage process. Estimation of seepage losses from canals and earthdams. Compressible flow in porous media. Ergun equation.

FEB 593: MATRIX STRUCTURAL ANALYSIS (0.625 UNITS; 30 HOURS)

Analysis of skeletal structures by force and displacement methods using matrices. Computer programmes for

analysis. Stiffness methods. Relaxation methods.

FEB 594: TIMBER ENGINEERING (0.625 UNITS; 30 HOURS)

Basic properties of and design practice for timber when used as a construction material in engineering structures. Seasoning of timber. Timber harvesting, transport and storage. Timber grading. Treatment of timber. Joints and connections. Maintenance of timber structures.

FEB 595: CONSTRUCTION MANAGEMENT (0.625 UNITS; 30 HOURS)

Planning, scheduling and supervision of construction projects; use of critical path method, bar charts and other techniques. Estimation of costs and pricing. Contracts and tender documents' specification, tender process. Laws of agreement and labour relations.

FEB 596: MINOR ROADS (0.625 UNITS; 30 HOURS)

Introduction to topics in transportation engineering and analysis; geometric design, traffic flow, freeway capacity, traffic signals, demand-performance equilibrium, pricing, and design under uncertainty. Road construction.

FEB 597: ELEMENTS OF PRECISION AGRICULTURE (0.625 UNITS; 30 HOURS)

GPS, technology and practice. Variable rate control. Application, theory and technology. Soil sampling scheme design for precision agriculture. Yield and soil attribute map production. Analysis of spatial variability in, and interaction between, soil attributes and crop yield. Temporal variability in crop yield. Optimal management units. Interpretation of yield and soil information for management decisions.