**Haramaya University**

**VICE-PRESIDENT FOR ACADEMIC AFFAIRS**

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**Syllabi for Masters Programs**

**Compiled By THE OFFICE OF ACADEMIC ProgramS Directorate**

**May 2020**

**Haramaya University**

**MSc Programs (Haramaya Instutute of Technology)**

**Program Name: Master of Science In Agricultural Mechanization**

* + - 1. ***Course Breakdown by Semester***

***YEAR I***

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Course Title** | **Cr. Hr.** | |
| **I** | **II** |
| AGME611 | Research Methods in Agric. Mechanization | 3 | 0 |
| AGME621 | Organization of Machinery Servicing | 3 | 0 |
| **AGME631** | **Business Organization & Management** | **4** | **0** |
| AGME641 | Theory and Practice of Tillage | 3 | 0 |
| **AGME651** | **Advances in Land Development Machinery** | **3** | **0** |
| **AGME612** | **Energy Management in Agriculture** | **0** | **3** |
| AGME622 | Mechanics of Tractor & Implements | 0 | 3 |
| AGME632 | Graduate seminar | 0 | 1 |
| AGME642 | Fundamental of Mechanization Strategy Formulation | 0 | 3 |
| AGME652 | Selection and Mgm't of Agricultural Machinery | 0 | 3 |
| AGME662 | Agricultural Materials Handling (E)\* | 0 | 3 |
| AGME672 | Mechanics of Biological Materials(E)\* | 0 | 3 |
| **AGME682** | **Instrumentation & Machinery Performance Evaluation (E)\*** | **0** | **3** |
| **Total** | | **16** | **16** |

\* At least on elective must be taken

**YEAR II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Course Title** | **Cr. Hr.** | |
| **I** | **II** |
| AGME711 | M.Sc. thesis Research | 6 | 6 |
| **Total** | | **6** | **6** |

**GRADUATE COURSES IN AGRICULTURAL MECHANIZATION (OPTION II)**

**YEAR I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Course Title** | **Cr. Hr.** | |
| **I** | **II** |
| AGME611 | Research Methods in Agric. Mechanization | 3 | 0 |
| AGME621 | Organization of Machinery Servicing | 3 | 0 |
| **AGME631** | **Business Organization & Management** | **4** | **0** |
| AGME641 | Theory and Practice of Tillage | 3 | 0 |
| **AGME651** | **Advances in Land Development Machinery** | **3** | **0** |
| **AGME612** | **Energy Management in Agriculture** | **0** | **3** |
| AGME622 | Mechanics of Tractor & Implements | 0 | 3 |
| AGME632 | Graduate seminar | 0 | 1 |
| AGME642 | Fundamental of Mechanization Strategy Formulation | 0 | 3 |
| AGME652 | Selection and Mgm't of Agricultural Machinery | 0 | 3 |
| AGME662 | Agricultural Materials Handling (E)\* | 0 | 3 |
| AGME672 | Mechanics of Biological Materials(E)\* | 0 | 3 |
| **AGME682** | **Instrumentation & Machinery Performance Evaluation (E)\*** | **0** | **3** |
| **Total** | | **16** | **15** |

\* *At least on elective must be taken*

**YEAR II**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Code** | **Course Title** | | **Cr. Hr.** | |
|  | | **I** | **II** |
| **AGME721** | **Pumps and Pumping Station** | | **3** | **0** |
| **AGME731** | **Sugarcane Production, Protection & Transportation** | | **3** | **0** |
| **AGME741** | **Environmental Impacts of Sugar Production** | | **3** | **0** |
| **AGME751** | **Seminar on Sugar Mechanization** | | **1** | **0** |
| **Total** | | | **10** | **0** |
|  | | | | |
| **AGME761** | | **Masters Project\*** | **4** | **4** |

*\*Research project proposal must be finalized during the first semester*

**GRADUATE COURSES IN AGRICULTURAL MACHINEERY ENGINEERING**

**YEAR I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Year I** | | | |
| **Code** | **Course Title** | **Cr. Hr.** | |
| **I** | **II** |
| **AGMD611** | **Introduction to CAD, CAM & CAE** | **3** | **0** |
| AGEN621 | Experimental Design and Analysis | 3 | 0 |
| AGMD631 | Soil and Tillage Mechanics | 3 | 0 |
| AGMD641 | Instrumentation in Agricultural Machinery | 3 | 0 |
| **AGMD651** | **Advances in Machine Design** | **3** | **0** |
| ***AGMD612*** | ***Advanced Manufacturing Technology*** | ***0*** | ***3*** |
| AGMD622 | Mechanics of Tractor & Implements | 0 | 3 |
| AGMD632 | Graduate seminar | 0 | 1 |
| AGMD642 | Design of Agricultural Machinery I | 0 | 3 |
| AGMD652 | Design of Agricultural Machinery II | 0 | 3 |
| AGMD662 | Performance Evaluation of Agric. Machinery (E)\* | 0 | 3 |
| **AGMD672** | **Agricultural Machinery Noise and Vibrations (E)\*** | **0** | **3** |
| **AGMD682** | **Design of Agricultural Processing Machinery (E)\*** | **0** | **3** |
| **Total** | | **15** | **16** |

*\* At least on elective must be taken*

**YEAR II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Year II** | **Cr. Hr.** | |
| **I** | **II** |
| AGMD711 | M.Sc. thesis Research | 6 | 6 |
| **Total** | | **6** | **6** |

* + - 1. ***Course Description***

**AGRICULTURAL MECHANIZATION (AGME)**

**AGME611 RESEARCH METHODS IN AGRICULTURAL MECHANIZATION (3 Cr. Hr.)**

Probability, probability laws, random variable mathematical expectation; probability distributions, binomial, Poisson, normal and gamma distribution; sampling, sampling distributions, law of large numbers, exact sampling distributions t and chi-square distributions; estimation point and interval estimation; testing of hypothesis basic concepts tests based on t and chi-square distributions; correlation, regression nonlinear regression, multiple regression; design of experiments basic concepts basic designs CRD and RBD data transformation covariance analysis in RBD; factorial experiments basic concepts comparison with single factor experiments; split-plot design; split-split-plot design, split-block design; and response curve.

**AGME621 ORGANIZATION OF MACHINERY SERVICING (2 Cr. Hr.)**

Components of a servicing and repair organizational development: turning, layout parts management, workflows and scheduling, Storage of agricultural machinery Administrative and technical procedures.

**AGME631 BUSINESS ORGANIZATION & MANAGEMENT (4 Cr. Hr.)**

Basics of business organizations and management; roles and objectives of business organization; elements and functions of management and processes and approaches to management; assessment of internal and external environments of a business organization; planning and organizing new business; comparing the different forms of ownership, functions of human resource management and labour relations; marketing and consumer behaviour; and management of finances; computing depreciation and valuation of assets, and network analysis for scheduling and managing business activities using Critical Path Method (CPM) and Program Evaluation and Review Techniques (PERT) tools.

**AGME641 THEORY AND PRACTICE OF TILLAGE (2+1 =3 Cr. Hr.)**

Measurements/quantification of transient and inherent physical properties of soils including soil consistency and Atterberg limits; effect of physical properties on energy/power demand and resulting seedbed condition; shear strength of soil it measurement, Mohr-Coulomb equation, effect of moisture content and density on soil strength; draft force, mobility and traction; reasons for tillage, agronomic, weed control, disease and pest control, planting, irrigation and drainage, soil and water conservation (terrace, ridge, furrow, surface roughness, mechanization (planting, cultivations, application of chemicals, soil injection and fertilizers placement, harvesting, and transportation, removable of stool and stump; basic soil implement mechanics; choice of implements for particular operations, principles of traction - optimization of performance, tracks, tyres and ballast; mechanics and assessment of compaction by loaded vehicles : tracks and wheel systems; and alleviation of compaction from the optimum choice of tyre/wheel track system(s).

**AGME651 ADVANCES IN LAND DEVELOPMENT MACHINERY (2+1 = 3 Cr. Hr.)**

Engineering fundamentals related to earth moving machinery; soil strength, swelling, shrinkage and compaction measurements; land grading; grade resistance and gradability; tractors and crawlers;, land cleaning, reclamation and grading; land leveling equipment; power shovels, drag lines, clamshells, rubber tyres for earth moving machinery; trenching machinery and wagons; economic analysis of land development machinery; and choosing and using earth moving machines, mechanical characteristics, rippers, dozers, scrapers, graders, excavators, trenchers, loaders, and hole diggers.

**AGME612 ENERGY MANAGEMENT IN AGRICULTURE (3 Cr. Hr.)**

Energy resources on the farm: conventional and non-conventional forms of energy and their use; heat equivalents and energy coefficients for different agricultural inputs and products; pattern of energy consumption and their constraints in production of agriculture; direct and indirect energy; identification of energy efficient machinery systems, energy losses and their management; energy analysis techniques and methods: energy balance, output and input ratio, resource utilization, conservation of energy sources; energy conservation planning and practices; energy forecasting, energy economics, energy pricing and incentives for energy conservation; factors effecting energy economics; and energy modelling.

**AGME622 MECHANICS OF TRACTOR & IMPLEMENTS (2+1 = 3 Cr. Hr.)**

Mechanics of farm tractor chassis; kinematics and dynamics of wheeled tractors; center of gravity location; external forces affecting kinematics; turning moment; stability; Implement tractor system; forces on symmetrical and unsymmetrical soil working tools, their effect on tractor hitching; trailed - mounted and semimounted hitching; effect on drawbar pull, weight transfer; track type tractors; stability of tractor implements system on slopes; modern trends in tractor design; articulate tractors - their turning mechanics, implement interaction and stability aspects; front wheel drives for tractors; power transmission systems-final drive design based on transmission load, hydrostatic transmissions and hydraulic torque converters; hitch system design; three point linkage force analysis and strength design; hydraulic system - basics and design; front axle and steering design; human factors in tractor design; traction theory, traction and mobility, steerability, and tractor drawbar performance prediction.

**AGME 632 GRADUATE SEMINAR** **(1 Cr. Hr.)**

Review and discussion of current literature and research finding in the field of agricultural mechanization. With this, it is also intended to acquaint the student to the methodology for preparation and presentation of scientific papers.

**AGME642 MECHANIZATION SYSTEM AND STRATEGY FORMULATION (3 CR. Hr.)**

Concept of economic mechanization; criteria for selection of mechanization inputs; work-study, works measurement, standard times and standard performance; calculation of energy use in primary agricultural operations; workability and timeliness; the application of labour, planning; quantitative computer-based techniques such as linear programming, dynamic programming and simulation of network analysis to mechanization planning, mechanization system; assessing mechanization needs, farming systems research; technology adaptation and diffusion; local manufacturing institutions and infrastructures; and programmesand projects.

**AGME652 SELECTION AND MGM'T OF AGRICULTURAL MACHINERY (3 CR. Hr.)**

Farm size; farm records; economic performance; operator, machine and power performances; drawbar pull power requirements; costs of farm operations; field pattern, field shape, size and soil conditions as factors of performance; timeliness costs, time efficiencies and scheduling of operations; selection of farm machinery; cost analysis of owning and operating farm machinery (cost determination - depreciation - machine size - depreciation methods; variable costs, breakeven point,); mode of ownership and use of machinery and implements (renting and leasing. Joint ownership); systems approach in farm machinery management and application of programming techniques to problems of farm power and machinery selection; equipment replacement criteria and inventory control of spare parts; work design in agriculture; selection of optimum mechanization systems by modelling; man-machine-task system in farm operations; comparing ownership and rental costs; matching of transport to processing, and minimization of transport costs; planning of work systems in agriculture; and organization of labour; determination of least cost plough size.

**AGME662 AGRICULTURAL MATERIALS HANDLING (E)** **(2+1 = 3 CR. Hr.)**

Definition of materials handling, physical properties of agricultural materials in relation to handling; safety with hazardous materials; environment and odorous materials; classes of handling machinery (flight conveyors (bucket, cradle, shelf, etc.), augers, belts, blowers, wagons and trailers); engineering principles of conveyors (bucket, cradle, shelf, etc.), augers, belts, blowers (pneumatic conveyors), wagons and trailers; power requirement of each; transportation of grains, vegetables and fruit, and sugarcane from farms to market, processing plants, storage sites; conveying of materials within processing plants using different types of conveyors, augers, elevators etc.; and loading and unloading equipment; selection and management of material handling equipment/machinery.

**AGME672 MECHANICS OF BIOLOGICAL MATERIALS (E)** **(2+1 = 3 CR. Hr.)**

Physical characteristics of different seeds and grains, fruits and vegetables; shape and size, description of shape and size, volume and density, porosity, surface area; rheology; moisture content and water in agricultural materials 9hydroscopic properties); ASTM standard, terms, physical states of materials, classical ideal material; rheological models and equations; visco elasticity; creep-stress and relaxation; non Newtonian fluid and viscometry; rheological properties; force, deformation, stress, strain, elastic, plastic behaviour; contact stresses between bodies; Hertz problems; firmness and hardness; mechanical damage; dead load and impact damage; vibration damage; friction, effect of load, sliding velocity; temperature, water film and surface roughness; friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose; flow of bulk granular materials; aerodynamics and hydrodynamics of agricultural products, drag coefficients, terminal velocity; thermal properties: specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow; electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field; optical properties (light absorption, transmission and reflectance), and wafering and pressing of agricultural materials

**AGME672 INSTRUMENTATION AND MACHINERY PERFORMANCE EVALUATION (E)** **(2+1 = 3 CR. Hr.)**

Strain and stress; strain relationship, strain gauges; mechanical, optical, electrical, acoustical and pneumatic etc. and their use; various methods of determining strain/stresses experimentally; measuring devices for displacement (linear and rotational), velocity, force, torque/moment and shaft power; strain gauges: types and their application in two and three dimensional force measurement; design and analysis of strain gauges (ring and octagonal ring dynamometers) and their applications in agricultural machinery.

The aim and importance of implements and power source test and performance evaluation; test techniques in agricultural machinery, test principles; the test methods (standards); laboratory and test and performance evaluation; soil, crop and other test constraints; determination of the work efficiency and quality in agricultural machinery; principles of the test equipment being used in agricultural machinery tests; the measurement technique of the drawbar power, power, fuel consumption etc.; test methods of soil cultivation, planting, drilling, and fertilizing equipment and sprayer and dusters; and the preparation of the test reports.

**AGME711 MSc THESIS RESEARCH (6 Cr. Hr. 15)**

Independent research work in agricultural mechanization to be conducted by candidates; in priority area of the nation, employer or the student as the case may be, under the supervision of an advisor(s) as a partial requirement for the Master of Science degree in agricultural machinery mechanization. This research work will have a maximum of 12 months for the collection of data, analysis of the same, write up and submission.

**AGME721** **PUMPS AND PUMPING Station (2 + 1 = 3 CR. Hr.)**

Pump definition, pump classifications, and ANSI pump standard; introduction to centrifugal pumps, principle of centrifugal pumps, the pump’s hydraulic components, inlet flange and inlet, impeller, coupling and drive, impeller seal, cavities and axial bearing, volute casing, diffuser and outlet flange, return channel and outer sleeve, pump types and systems, the UP pump, the TP pump, the NB pump, the MQ pump, the SP pump, the CR pump, the MTA pump’ the SE pump, the SEG pump, performance curves, standard curves, absolute and relative pressure, head, differential pressure across the pump, total pressure difference, static pressure difference, dynamic pressure difference, geodetic pressure difference, energy equation for an ideal flow, power, speed, hydraulic power, efficiency, net positive suction head, axial thrust, radial thrust; pumps operating systems, single pump in a system, pumps operated in parallel, pumps operated in series, annual energy consumption, energy efficiency index (EEI); pump losses, loss types (mechanical losses, bearing loss and shaft seal loss, hydraulic losses), care, safety, operation, maintenance, and repair of pumps; cost of owning and operating pumps.

**AGME731 SUGARCANE PRODUCTION, PROTECTION & TRANSPORTATION (3 CR. Hr.)**

Agronomic requirements of sugarcane; soil tillage and land preparation for sugarcane; land leveling machines and implements, primary and secondary tillage implements, land forming implements (furrowers/riggers); sugarcane planting (manual and machine); mode of fertilizer application and applicators; sugarcane cultivation (mechanical weed control) equipment; irrigation furrow maintenance equipments; sprayer and dusters: - selection, procurement; calibration, use, care, maintenance and repair and safety with the sprayers and dusters and chemicals (including defoliators) in use; harvesting of sugarcane: - physico-mechanical properties of sugarcane stalks; resistance to cutting, speed of cutting of stalks, cutting angle of the knife segment; kinematics of the drive mechanisms of cutting equipment and its power requirement; cut cane gathering, loading and unloading machines; selection, procurement, hitching, and handling of wagon and trailers; and trailer and tractor mechanics.

**AGME741 ENVIRONMENTAL IMPACTS OF SUGAR PRODUCTION (3 CR. Hr.)**

environmental impacts of cultivation of sugarcane, impacts on biodiversity: - ecosystem- and habitat-scale impacts and clearance for sugarcane cultivation; impacts on water quality and aquatic ecosystems; problems arising from sugarcane irrigation-over-exploitation of water resources; runoff in cane cultivation systems leaching in cane cultivation systems; impacts on soils (impact of sugarcane cultivation on soil quantity; erosion); impacts on air quality (emissions from soils under sugarcane cultivation, pre-harvest cane burning, cane process related odours, gases); positive environmental aspects of sugar production (bagasse and its use as a fuel, mulches, fertilizer and soil amendments, animal feed, and in the manufacture of paper and chemicals; use of molasses in fermentation/ethanol production); methods and practices of reducing the negative impacts of sugar production, broad measures to reduce multiple environmental impacts; and appropriate planning to this effect.

**AGME751SEMINAR ON SUGAR MECHANIZATION (1 CR. Hr.)**

A seminar shall be presented by each Agricultural Mechanization (Sugar Mechanization) MSc candidate based on case study, survey or literature review regarding advances made, pitfalls encountered and lessons learnt from sugar mechanization either at home or abroad.

**AGME761 MASTERS PROJECT** **(5 Cr. Hr)**

Independent research work in agricultural mechanization to be conducted by candidates, in the priority area of the nation, employer or the student as the case may be, under the supervision of an advisor(s) as a partial requirement for the Master of Science degree in agricultural me mechanization (sugar mechanization). This research work will have a maximum of 6 months for the collection of data, analysis of the same, write up and submission.

**AGRICULTURAL MACHINERY ENGINEERING (AGMD)**

**AGMD611 INTRODUCTION TO CAD, CAM & CAE (1 + 2 = 3 Cr. Hr.)**

Basic computer graphics, coordinate systems, homogeneous transformations; geometric and interactive graphics, modeling algorithms and systems, modeling functions, data structures, Boolean and Euler operations, non-manifold modeling; representation and manipulations of curves: Hermite, Bi-cubic, Beizer, B-spline; representation and manipulation of surfaces: basic terminology of parametric surfaces, bilinear, ruled,, Coons, Hermite, Bezier, and Bspline; basics of finite element method; Mesh algorithms; optimization algorithms: gradient-based an heuristic-based methods; part programming: G-code APT programming; tool path generation algorithms: 2D-pocketing, Lathe machining, 3-axis surface machining, and multi-axis surface machining; rapid prototyping manufacturing; computer-aided analysis and synthesis of common mechanical components; application of numerical methods and optimal techniques to machine design problems; computer-aided selection of standard mechanical components; and introduction to FEM.

**AGMD 621 EXPERIMENTAL DESIGN AND ANALYSIS** **(2 + 1 = 3 Cr. Hr.)**

Research characteristics and classification; research methods and techniques; classification of research methods; formulation of research problem and hypothesis; research design research methods and techniques; classification of research methods; formulation of research problem and hypothesis; research design; review of significant testing, principles of experimental design, design and analysis of experiments, analysis of variance, regression and correlation in experimentation modeling and simulation in agricultural engineering; introduction to optimization techniques.

**AGMD631 SOIL AND TILLAGE MECHANICS (2 + 1 = 3 Cr. Hr.)**

Dynamic properties of soil and their measurement, the mechanical components of soil-machine relationships (soil-tool interface: adhesion and angle of external resistance); stress-strain relationships, effect of density, moisture content and soil type on soil strength; Mohr- Coulomb principles; active and passive soil pressure, plane and curved soil failure surfaces, theory of soil failure; force and its distribution on tillage machinery; (wire and wedge cutting, behaviour of soil under load, probe geometry and mode of failure); mechanics of tillage tools and geometry of soil-tool system, design parameters and performance of tillage tools; the general soil mechanics equation; analysis of force distributions in two and three dimensional systems; pulling force, soil aggregate mechanics (energy input and degree of soil fragmentation, measurement and analysis of forces and the resulting soil disturbance); and soil compaction by agricultural vehicles and machines, and assessment of extent and severity.

**AGMD641 INSTRUMENTATION IN AGRICULTURAL MACHINERY (2 + 1 = 3 Cr. Hr.)**

Strain and stress; strain relationship, strain gauges; mechanical, optical, electrical, acoustical and pneumatic etc. and their use; various methods of determining strain/stresses experimentally; measuring devices for displacement (linear and rotational), velocity, force, torque/moment and shaft power; strain gauges: types and their application in two and three dimensional force measurement; design and analysis of strain gauges (ring and octagonal ring dynamometers) and their applications in agricultural machinery. introduction to functional elements of instruments; active and passive transducers; analogue and digital modes; null and deflection methods; performance characteristics of instruments including static and dynamic characteristics; devices for measurement of force, moment/torque, acceleration, velocity, displacement, temperature, relative humidity, pressure, sound, vibration, flow etc.; recording devices and their type; measuring instruments for calorific value of solid, liquid, and gaseous fuels; measurement of gas composition using GLC; basic signal conditioning devices - data acquisition system - micro computers for measurement and data acquisition; and data storage and their application.

**AGMD651 ADVANCES IN MACHINE DESIGN** **(2 + 1 = 3 Cr. Hr.)**

Design process, information collection and concept generation; mechanical design process; stress-strain analysis: stress definition and notation; transformation of stress; principal stresses, strain relations for linear elastic materials; stress concentration; generalized Hooke’s Law; determination of stresses in relationship to the strength properties of machine elements under various loading conditions; deflection, post-yield behavior, residual stresses, shafts, power trains, and rotational machinery; deflection of machine elements: linear, torsional and bending; application of strain energy and Castigliano’s theorem; design of shafts, beams, columns, bolted and welded joints; contact stress; design criteria:; maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory; failure prevention; steady loading; variable loading-Fatigue; thermal loads and thermal stresses; mechanical elements; design optimization.; human factors in system development; information input process; visual displays-auditory and tactual displays; speech communications; human control of systems; human motor activities; controls, tools and related devices; anthropometry; arrangement and utilization of work space; and atmospheric conditions.

**AGMD612 ADVANCED MANUFACTURING TECHNOLOGY (1 + 2 = 3 Cr. Hr.)**

The structure and properties of construction material, equilibrium diagram, time temperature transformation curves, heat treatment, ferrous metals and alloys; non-ferrous metals and alloys; non-metallic material (plastic, elastomers, ceramics and composites), material selection, surface treatment and finishing; measurement and quality assurance (measurement and inspection, non-destructive inspection), and testing, process capability and quality control, tolerances-limits and clearances; casting processes; forming processes (hot and cold working, hot rolling of metals, forging, extrusion, cold rolling, cold forging, cold drawing, forming of plastic ceramic and composites, dies, shearing and blanking and dies: bending and drawing); material removal processes (machining process, cutting, turning, boring, drilling, milling, broaching-sawing, filing, abrasive machining processes, work holding devices, machining centres, thread manufacture, gear manufacturing and non-traditional machining processes (FCM, EDH, LBM, AJM, Wire EDM); joining processes (gas flame, welding, arc and gas cutting, straightening, resistance welding, brazing and soldering, adhesive, bonding and mechanical fasteners, manufacturing concerns in welding and joining); and numerical control (command system, codes, programme, cutter position X and Y incremental movements, linear contouring, Z movement and commands); processes and techniques related to manufacturing, manufacturing system and automation, production systems and Integrated manufacturing production system.

**AGMD622 MECHANICS OF TRACTOR & IMPLEMENTS** **(2 + 1 = 3 Cr. Hr.)**

Mechanics of farm tractor chassis; location of center of gravity; external forces affecting kinematics; implement tractor system; forces on symmetrical and unsymmetrical soil working tools, their effect on tractor hitching; trailed, mounted and semimounted hitching; effect on drawbar pull, weight transfer; track type tractors; stability of tractor implements system on slopes; articulate tractors - their turning mechanics, implement interaction and stability aspects; front wheel drives for tractors; hitch system design; three point linkage force analysis and strength design; traction theory, traction and mobility, traction devices, tyres-types, function & size, their selection; mechanics of traction devices; deflection between traction devices and soil, slippage and sinkage of wheels, evaluation and prediction of traction performance; steerability; tractor drawbar performance prediction; special problems of wet land traction and floatation.

**AGMD632 GRADUATE SEMINAR (1 Cr. Hr.)**

Review and discussion of current literature and research finding in the field of agricultural machinery design. With this it is also intended to acquaint the student to the methodology for preparation and presentation of scientific papers.

**AGMD642 DESIGN OF AGRICULTURAL MACHINERY I** **(2+1 = 3 Cr. Hr.)**

The wedge theory, schematic diagrams of ploughs, determination of basic parameters, mould board working surface, forces acting on a plough, theory and principles of concave disk tools and forces acting on the disk, design of V- shaped sweeps and determination of basic parameters, force estimation and design of wide earth moving tool; estimation of forces acting on rotary tillers and design of rotary tillage machines and, estimation of forces acting on deep tillage implements (chisel plough and subsoilers); design of shank, standards, and legs of mole drain plough based on beam deflection, strain energy and Castigliano’s theorem; analysis and design of rigid wheels; design of safety devices brakes (disk, plate, centrifugal, and cone), dog clutch, pitman’s, leaf, helical, coil springs as safety mechanisms); design of thick and hydraulic cylinders; design and analysis of Hooke’s or universal joints; and selection of manufacturing method (casting, machining, welding, forging, etc.).

**AGMD 652 DESIGN OF AGRICULTURAL MACHINERY II (2 + 3 = 3 Cr. Hr.)**

Machines for sowing, fertilizer application and planting; design of seed hopper, seed metering mechanisms; seed drill tubes and boots; machines for bulk application of mineral fertilizers, organic fertilizers, liquid fertilizer; design of centrifugal type apparatus, potato planters; design of sprayers, aerosol generators, dusters and fumigators; design of cutters and mowers based cutting resistance of plant materials, speed of cutting, cutting angle, knife geometry, and cutting mode compression, shear (rotary or push-in); drive mechanisms of cutting equipment and design of the same, functional requirements of grain harvesting and processing machines and design of cutting, feeding, threshing, separating and cleaning, grading, and sorting mechanisms; root crop harvesting and separation of roots, tubers, etc. from clods and stone.

**AGMD662** **PERFORMANCE EVALUATION OF AGRICULTURAL MACHINERY** **(E) (2 + 1 = 3 Cr. Hr.)**

The aim and importance of test techniques in agricultural machinery, test principles; explanation of soil, crop and other test constraints, determination of the work efficiency and quality in agricultural machinery, the test methods (standards) and principles of test equipment being used in agricultural machinery tests, calibration of measuring devices including balances and gauges; the measurement technique of the drawbar power, power, fuel consumption etc.; design and instrumentation of soil bin (wet and dry) and other test rigs; theory and application of force, torque and moment measuring rings (dial gauge and strain gauge); octagonal and extended octagonal dynamometers and their calibration and applications; the test methods of soil cultivation, planting, drilling, sprayer and duster and fertilizing equipment; the preparation of the test reports; and code of conduct and ethical issues in testing and performance evaluation.

**AGMD672 AGRICULTURAL MACHINERY NOISE AND VIBRATIONS (E) (2+1 = 3 Cr. Hr.)**

Noise and vibration theory, definition, units and parameters; measurement and analysis equipment; study of different vibration measurement and evaluation; measurement and analysis of vibration on different components of thresher, combine, reaper, power tiller and tractor; determination of modulus of elasticity, rigidity, and MI by free vibration test; evaluation of logarithmic decrement and damping factor; whirling of shaft; heat motion in two pendulum system; detailed analysis of multi- degree of freedom system; types of vibrations- free and forced, in damped and without damped analysis of one, two and multiple degree of freedom systems and their solution using Newton’s motion, energy method; longitudinal, transverse

and torsional vibrations; Rayleigh’s methods, Lagrange equation; introduction of transient vibration in systems, vibration of continuous media; balancing of single rotating weight and number of weights in same plane and different planes; and complete balancing of reciprocating parts of engine.

**AGMD 682 DESIGN OF AGRICULTURAL PROCESSING MACHINERY II (2+1= 3 Cr. Hr.)** Principles and practices of durable and perishable products processing machines, design of conveyor/elevator (buckets, cradles, shelves, belts), auger, centrifuges, pneumatics; mixer; dehulling and milling machines; cutting devices material of which they are made, design of separating, cleaning, grading, and sorting machines; design of extruders and design of oil expellers; design of filtration and extraction mechanisms; and fans and pumps.

**AEMD711 MSc. THESIS RESEARCH (8 Cr. Hr.)** Independent research work in agricultural machinery design, construction and performance evaluation to be conducted by candidates in the area of national, employer or candidate priority under the supervision of advisor(s) as a partial requirement for the Master of Science degree in agricultural machinery engineering. This research work will have a maximum of 12 months for the collection of data, analysis of the same, write up and submission.

**Course Name: *Master of Science in Engineering Hydrology***

* + - 1. ***Course Breakdown by Semester***

***Year I Semester I***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Code*** | ***CourseTitle*** | ***Cr.Hr.*** | ***L*** | ***L/P*** | ***HS*** | ***CP*** | ***Prerequisite*** |
| ***EngH 611*** | *Reservoir Planning &Sedimentation* | *3* | *2* | *3* | *7* | *6* |  |
| ***EngH 621*** | *AtmosphericDynamics* | *2* | *1* | *3* | *5* | *4* |  |
| ***EngH 631*** | *NumericalMethods &*  *ComputerProgramming* | *3* | *2* | *4* | *5* | *6* |  |
| ***EngH 641*** | *Statistics andResearch*  *Methods inHydrology* | *2* | *1* | *3* | *5* | *4* |  |
| ***EngH 651*** | *HydrologicalProcesses &Measurements* | *3* | *2* | *3* | *6* | *5* |  |
| ***SemesterTotal*** | | ***13*** | ***7*** | ***16*** | ***28*** | ***25*** |  |

***Semester II***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course***  ***Code*** | ***CourseTitle*** | ***Cr.Hr*** | ***L*** | ***L/P*** | ***HS*** | ***CP*** | ***Prerequisite*** |
| ***EngH 612*** | *DamEngineering* | *3* | *2* | *3* | *6* | *5* |  |
| ***EngH 622*** | *ComputationalHydrology* | *3* | *2* | *3* | *6* | *5* |  |
| ***EngH 642*** | *UrbanHydrology* | *3* | *2* | *3* | *7* | *6* | ***EngH 651*** |
| ***EngH 652*** | *Deterministic Hydrology* | *3* | *2* | *3* | *6* | *5* | ***EngH 651*** |
| ***SemesterTotal*** | | ***12*** | ***8*** | ***12*** | ***25*** | ***21*** |  |

***Year II Semester I***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course***  ***Code*** | ***CourseTitle*** | ***Cr.Hr.*** | ***L*** | ***L/P*** | ***HS*** | ***CP*** | ***Prerequisite*** |
| ***EngH 711*** | *GIS&RemoteSensinginHydrology* | *2* | *1* | *3* | *7* | *5* |  |
| ***EngH 741*** | *Stochastic Hydrology* | *3* | *2* | *3* | *7* | *6* | ***EngH 651,***  ***EngH 651,EngH 641*** |
| ***EngH751*** | *Advanced Ground Water Hydrology and Modeling* | *3* | *2* | *3* | *7* | *6* | ***EngH 611*** |
| ***EngH 761*** | *WaterResourcesPlanning&Management* | *3* | *1* | *0* | *8* | *5* |  |
| ***EngH 731*** | *GraduateSeminarin*  *EngineeringHydrology* | *1* | *0* | *0* | *8* | *2* |  |
| ***SemesterTotal*** | | ***12*** | ***7*** | ***9*** | ***45*** | ***28*** |  |

***Semester IV***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ***Course Code*** | ***CourseTitle*** | ***Cr.Hr.*** | ***L*** | ***LP*** | ***HS*** | ***CP*** | ***Prerequisite*** |
| ***EngH 712*** | *MSc Thesis Research* | *6* |  |  | *90* | *30* | ***Allcourses*** |

* + - 1. **Course Description**

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| --- | --- |
| ***CourseTitle*** | ***NumericalMethodsandComputerPrograming*** |
| *CourseCode* | ***EngH 631*** |
| *Prerequisite* | ***None*** |
| *CreditHours* | *3* |
| *Aimsand*  *Objectives* | *Thiscourseisaimedatteachingstudentonrelevantnumericaltechniques*  *usefulin hydraulic computations. This coursewillalsointroduce programminglanguages.Thestudentshould be able to program numericalmethods applicabletowaterresourcesproblems.* |
| *OutlineSyllabus* | *Computer Programming with Fortran or, C++, or Matlab: learning*  *Programminglogic,syntax,I/OandFileprocessing,datastructures;arrays, selectionstatements,looping, pointers(optional),subprograms and modules.*  *Numericaltechniques: linearsystems(matrix,Gausselimination,LU decomposition),Ordinary differential equations,Partialdifferential equations;numerical differentiationandintegration, solutionofnon- linearequations(bracketingmethods,openmethods),finite difference methods,Directsearch methods(NealderMeadmethod,Rosenbrock method), Applicationsto waterresources.* |
| *Assessment* | *o40% programwritingassignments*  *o20% numericalmethodsassignment*  *o40% finalExamination* |
| *References* | *1.Fortran 90/95 - S.T.Chapman*  *2.ComputerOriented NumericalMethods -V. RajaRaman*  *3.Introductionto numericalmethodsfor waterresources– W.L. Wood* |

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| --- | --- |
| ***CourseTitle*** | ***UrbanHydrology*** |
| *CourseCode* | ***EngH 642*** |
| *Prerequisite* | ***EngH 651*** |
| *CreditHours* | *3* |
| *Aimsand*  *Objectives* | *Thecourseisaimedatin-depthinvestigationandanalysisof impactsof*  *urbanizationonhydrological processes,and henceurban stormwater quantityandquality,urbanstormdrainage,andgeneralconceptsofurban stormwatermanagement* |
| *OutlineSyllabus* | *Impactofurbanization inurbanmicro-climateandHydrology,localdesign*  *standards,regulations and procedures forstormwatermanagement, urbanrainfall-runoffanalysis,Designstorm (Triangular hyetograph, alternating blockmethod,instantaneous intensitymethod),Urbanstorm drainage design, DesignofDetentionbasin,stormwatermodellingand management, sustainableurbanstorm water quantityand quality management, drainagesystemandbestmanagement practices, wastewaterestimation.SWMM model,Flood risk assessment* |
| *Assessment* | *o20% assignments*  *o30% mid-termexam*  *o50% finalExamination* |
| *References* | *1. DavidButterandJohnW.Davies(2004),UrnabDrainage,SponPress*  *2. WilliH.Hager(2010)WastewaterHydraulics(theoryandpractice) Springer*  *3. VenTe ,AppliedHydrology,McGraw-Hill,1988* |

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| ***CourseTitle*** | ***DeterministicHydrology*** |
| *CourseCode* | ***EngH 652*** |
| *Prerequisite* | ***EngH 651*** |
| *CreditHours* | *3* |
| *Aimsand*  *Objectives* | *Thecourseisaimedatprovidingfundamentalandadvancedknowledgeof*  *watershed,river/channelhydraulicand physicalmodelingmethods pertainingto planning,designing and managementof hydrologic and hydraulic systems. Students aresupposedtoutilizeadvancedsoftware usedforrainfall-runoff modelingandriversystemsanalysistosolve hydrologicproblems.* |
| *OutlineSyllabus* | *Introduction andbackgroundonhydrologicalmodeling*  * Typesandclassificationof hydrologicalmodels(onProcessbased, Spatialandtemporalscale,solutiontechniques) ModelSelection*  *Criteria*  *Model parameterization,Modelcalibration,validation and*  *Uncertainty analysis,Modelefficiency (Modelerroranalysis)*  * Systemtheoreticmodels/Blackboxmodels:Simplelinearmodels, Linearperturbation models,ArtificialNeuralNetwork*  *Conceptualmodels:Tank model*  *Physically basedmodels:MIKESHEtheoreticalconcept*  * Hydrologic Modellinganditsapplication(SWATModel,HEC-HMS, SMARetc)*  *Hydraulicmodelingandits application (HEC-RAS,HEC-GeoRAS)*  *Physical Modellingconcepts anditsapplication* |
| *Assessment* | *o30% Assignment andpresentation*  *o20% mid-termexam*  *o50% finalExamination* |
| *References* | *1. J.E.Nash,LecturenotesonDeterministicModels,NationalUniversity*  *ofIreland,Galway, Ireland.*  *2. O’Connor,K.M.,(Edit), RiverFlowForecasting,specialissue,(1992), JournalofHydrology,Elsevier.*  *3. ChungYuXu(2002),Textbookofhydrologicmodels,Departmentof*  *EarthSciencesand Hydrology,UpsalaUniversity,Sweden.*  *4. KeithJ. Beven,(2002)RainfallRunoff Modelling,JohnEiley&son,Ltd*  *5. RichardH.McCune(2003)ModelingHydrologicchange(Statistical*  *Method),LewisPublishers*  *6. ThorstenWagener,HowardS.Wheater,Hoshin V.Gupta (2004) Rainfall-Runoff ModellinginGaugedandUngaugedcatchments, ImperialCollegePress* |
| ***CourseTitle*** | ***StochasticHydrology*** |
| *CourseCode* | ***EngH 741*** |
| *Prerequisite* | ***EngH 651,EngH 651,EngH 641*** |
| *CreditHours* | *3* |
| *Aimsand*  *Objectives* | *To impart knowledge on prediction of flow characteristics (flood or*  *drought) and be able to analyseusing the most up-to-date tools to performthe work.* |
| *OutlineSyllabus* | *Flood frequency analysis(Normal,Exponential,ExtremeValueI*  *(Gumbel),GeneralExtremevalue,PearsonTypeIII,Gamma, Logarithmic distribution,Pareto,Kappa,Wakeby),*  * Parameterestimation methods (L-moments,Probability Weighted moment,Likelihoodmethods)*  *Analysisof Uncertainty inparameterestimation*  * Analysisof extreme(Drought,low flow, floodflow) hydrological events,partialdurationseries,flow durationcurves*  * RegionalFloodfrequency analysis:Identificationof homogeneous regions,Discordancy test,Heterogeneitytest,Development of regionalflood frequencycurves*  * Timeseriesanalysisandmodelingofselected stochastic processes, random,autoregressiveandmovingaverageprocesses(AR, MA, ARMA,andARIMAModels,etc)* |
| *Assessment* | *o30% Assignment andpresentation*  *o20% mid-termexam*  *o50% finalExamination* |
| *References* | *1. Cunnane,StochaticHydrology, Departmentof EngineeringHydrology,*  *University CollegeGalway, Ireland.*  *2. Cunnane,statisticalDistributionsforFloodFrequency Analysis,World MeterologicalOrganisation. OperationalHydrology report No.33, WMO, No.718.*  *3. A. RamachandraRao,KhaledH. Hamed(2000), FloodFrequency*  *Analysis,CRCPress* |

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| ***CourseTitle*** | | ***HydrologicalProcesses and Measurement*** |
| *CourseCode* | | ***EngH 651*** |
| *Prerequisite* | | ***None*** |
| *CreditHours* | | *3* |
| *Aimsand*  *Objectives* | | *Theaimofthecourseistointroducethefieldmeasurementtechniques*  *available forthemajor hydrological processes suchasinfiltration,soil moisture,evaporation,interceptionetc.and theirestimationmethods whicharewidelyapplicablein physicalaswell asconceptualmodelsof watersheds,agricultural fields,etc.theconcepts ofenergybalanceofthe earthandwatermovementintheunsaturated(vadose) andsaturated zone* |
| *OutlineSyllabus* | | *Introduction to the major hydrological processes and field*  *measurement techniques*  * Elements of evaporation phenomena and plant growth: Weather Phenomena(solarradiationandenergybalanceontheearth’ssurface, airtemperature,windspeed, humidityofairandtransportofwater vaporintheair)*  *Evaporationfromwaterbodies,baresoil,vegetation(transpiration)*  *andmethodsofEvaporationestimation(Penman,Penman-Monthieth, Hagreaves,Turc,etc)*  * Unsaturated(vadosezone)phenomena:Infiltration,waterflowand retentionintheunsaturatedzoneandmethodofestimations, (Darcy equation,Richardsequation,Green-Aptequations,etc) andother empiricalmethods.* |
| *Assessment* | | *o30% assignments*  *o20% mid-termtest*  *o50% finalExamination* |
| *References* | | *1. J.R.Rydzewski,(1987),IrrigationDevelopmentPlanning:anIntroductionfor*  *Engineers, JohnWileyandSons, NewYork,p265.*  *2. Monteith, J.L.&Unsworth,M.A. (1990), PrinciplesofEnvironmental Physics,*  *2ndEdition,Arnold,London.*  *3. Dolezal,F.,(1991) PhysicalProcesses, LectureHandouts,International PostgraduateCourse on Hydrology,NationalUniversity of Ireland,Galway, Ireland.*  *4. Bras, R.L.(1990),Hydrology, AddisonWesleyPublishingCo.*  *5. Brutsaert,W.,(1982),Evaporationintotheatmosphere;KluwerAcademic*  *Publishers, Holland.* |
| *CourseTitle* | | ***GIS andRemote Sensing inHydrology*** | |
| *CourseCode* | | *EngH 711* | |
| *Prerequisite* | | *None* | |
| *CreditHours* | | *2* | |
| *Aims and*  *Objectives* | | *Theaimofthecourseistofamiliarizethestudentswiththeemergingtechnologies*  *andtoolsapplicableinwatershedandwaterresourcesmanagementhydrology andsatellitedata gatheringtechniques.* | |
| *OutlineSyllabus* | | *IntroductiontoGIS;Spatialdataanalysis(digitizingandmappingspatialdata);*  *ApplicationofGISinhydrology/waterresources(watersheddelineation, site selection,irrigationsuitabilityanalysis);ArcGIS–GoogleEarth dataimport-export techniques;IntroductiontoRemoteSensing;ElectromagneticenergyandRemote Sensing;SensorsandPlatforms;;ImageProcessinganddigitalimageclassification (ERDASImageProcessing).* | |
| *Assessment* | | *o30%Assignment andpresentation*  *o20%mid-termexam*  *o50%final Examination* | |
| *References* | | *1) Maidment,D.R.(Internet)HydrologicalModelingusingGIS,CentreforWater*  *resources,UniversityofTexas*  *2) Paul VBolstand(2002). GIS Fundamentals, A first book on Geographic informationsystems, BookMaster.*  *3) BurughP.A.,(1986)PrinciplesofGISforlandresourcesassessment.Oxford*  *Sciencepublications,Oxford.*  *4) CilwelReed(1995).Manualonremotesensing(2ndEdition)AmericanSociety of photogrammetry.*  *5) LiilesandT.M.&R.W.Kieter(1994.RemotesensingandImageinterpretation, WilleyPublishing.*  *6) ARCV*[*IEW: www.esri.com*](http://www.esri.com/)  *7) IDRISI: Clark University Geographical information systems,* [*www.geo.info.hu/idrisi/kilimanjaro*](http://www.geo.info.hu/idrisi/kilimanjaro) | |

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| *CourseTitle* | ***StatisticsandResearchMethods inHydrology*** |
| *CourseCode* | *EngH641* |
| *Prerequisite* | *None* |
| *CreditHours* | *2* |
| *Aims and*  *Objectives* | *To gainanincreasedunderstandingoftheapplicationofscientificmethods tothe*  *field.*  *Toenablestudentstodeterminetheappropriatestatisticaltechniquestobeused.* |
| *OutlineSyllabus* | *Basic Statistical Concepts in Hydrology; Confidence interval and hypothesis*  *testing.Expectationand estimation.Time-seriesanalysistechniques.Error analysis.Correlation and regression. HydrologicalData Presentation. Scientific Writing;ethicsinresearch;problemidentificationandconceptualization;research andprojectdesign;hydrologic,hydro-geologicand meteorologicfield surveysand datacollection;quantitativeandqualitativeanalysisofwaterresourceandrelated data;proposal documentation for,and reporting on,research and project activities;supervised projectandpreparationandsubmissionofmini-thesis.* |
| *Assessment* | *o20%assignments*  *o30%mid-termexam*  *o50% final Examination* |
| *References* | *1. Montgomery,D.C.,2001.DesignandAnalysisofExperiments.5thEdition.*  *Arizona StateUniversity. JohnWiley&Sons.*  *2. Bajpai,A.C., Claus, I.M. and Fairly,J.A., 1979.StatisticalMethodsfor Engineers andScientists. JohnWiley&Sons.*  *3. DestaHamito,2001.ResearchMethodsinForestry:PrinciplesandPractices*  *with ParticularReference to Ethiopia. LarensteinUniversity Professional*  *Education,Deventer,the Netherlands.*  *4.DeVeaux,R.D.,Velleman,P.F.andBock,D.E.,2006.IntroStats.2ndEd.Pearson Education Inc.*  *5LeBlanc,D.C.,2004.Statistics:ConceptsandApplicationsforScience.JonesandBartlettPublishers.* |

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| *CourseTitle* | ***AtmosphericDynamics*** |
| *CourseCode* | *EngH621* |
| *Prerequisite* | *None* |
| *CreditHours* | *2* |
| *Aims and*  *Objectives* | *This course aims to build on knowledge of the fundamental set of physicalprinciplesbyapplying themtoquantitativelydescribethebehavior oflarge-scale atmosphericmotions.*  *Bytheend ofthiscoursestudentswillhavetodevelopquantitativeanalysisof atmospheric propagationand instabilityofflowassociatedwithmountain barriers,shallowwater waves,large-scalebaroclinicRossby wavesandgravity waves.* |
| *OutlineSyllabus* | *Introduces the fundamentals of atmospheric circulation that govern weather and climate in the tropics and mid-latitudes. This includes large-scale flows and eddies, the General Circulation and mid-latitude storm systems. Meteorological data will be used to illustrate air flow patterns, jet streams, mid-latitudes cyclones and their intensification.In-depthtreatmentofgaslaws;atmospherethermodynamicsandstability;clouddynamicsandadiabatic process, properties of moist air, formation of clouds, atmospheric convection, boundary layer meteorology, and vertical stabilities in the atmosphere,*  *3aticcharts;atmospheric motionandthegoverninglaws; planetaryandsecondary circulation;jetstreams;vorticity;cyclogenesis; meteorologicalinstrumentsandtheir operations;weather maps anddata exchange;codesandplottingof charts.* |
| *Assessment* | *o20%assignments*  *o30%mid-termexam*  *o50% final Examination* |
| *References* | *1. Holton,J.R. 2004. AnintroductiontoDynamicMeteorology, Elsevier*  *AcademicPress,4thEd.*  *2. Benoit,C.R.1994,IntroductiontoGeophysical FluidDynamics,PrenticeHall.* |
| *CourseTitle* | ***AdvancedGroundwater Hydrology and Modeling*** |
| *CourseCode* | *EngH751* |
| *Prerequisite* | *None* |
| *CreditHours* | *3* |
| *Aims and*  *Objectives* | *Toquantitativelyunderstandtheprocessofthe hydrologiccycle.*  *To exploretherelationshipbetweensurfacewaterandgroundwater.*  *To understand the geologic controls on water occurrence and flow in the subsurface.* |
| *OutlineSyllabus* | *Principlesofgroundwaterflow;solutionstoequationsofflowinconfinedand*  *unconfinedaquifers;computation ofdrawdowndue towellpumpingin various aquifersettings;determination of aquiferparametersfromtime-drawdowndata understeady-stateandnon-equilibriumflowconditions;effect ofpartial well penetration;regionalgroundwaterflowsystemsundersteady-stateandtransient conditions;groundwaterbudgetsandaquifer management;groundwater modellingandtypes ofpublishednumericalsimulationmodels;finitedifference andfiniteelementapproaches;datarequirementsandtheaccuracyof models; applicationofgroundwatermodels;generalapplicationofhydrogeologytohuman concerns;businessandethical aspectsof hydrogeological practice.* |
| *Assessment* | *o30%assignmentsandpractical*  *o30%mid-termexam*  *o40% final Examination* |
| *References* | *1. C.W.Fetter. 2001. AppliedHydrogeology. 4thEd,*  *2.* |
| *CourseTitle* | ***GraduateSeminarinEngineeringHydrology*** |
| *CourseCode* | *EngH731* |
| *Prerequisite* | *Second Year Semester I* |
| *CreditHours* | *1* |
| *Aims and*  *Objectives* | *Presentationofseminarbystudentsonadvancedtopicsintheareaofengineering*  *Hydrologythatisnotcoveredinothercourses. With thisitis alsointendedto acquaintthestudentstothemethodologyofpreparationandpresentation of scientificpapers.* |
| *Assessment* | *Presentation* |

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| *CourseTitle* | ***MSc Thesis Research*** |
| *CourseCode* | *EngH712* |
| *Prerequisite* | *All courses* |
| *CreditHours* | *6* |
| *Aims and*  *Objectives* | *Theobjective of thefinal MScthesisis todevelop studentscapacityandability to*  *undertakeanddisseminateoriginalinformation obtainedthroughliterature searches,discussionswithacademicstaffandprofessionalengineers,and other relatedprofessionalstoobtainadeeperunderstandingofasubjectthan made possiblebyfollowing ataughtProgramofstudy.Furthermoreithelpstodevelop knowledgeof an appropriatestandardtomakea contributiontothefield.* |
| *OutlineSyllabus* | *Specificcontent tobeagreed betweenstudent,supervisorandIGC*  *Thesis preparation* |
| *Assessment* | *oThesis evaluationshouldbemadebyExternal andInternal examiners,*  *andChairman* |
| *References* | *Haramaya University Thesis orDissertationGuideline* |

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| ***CourseTitle*** | | ***ComputationalHydraulics*** | |
| *CourseCode* | | ***EngH 622*** | |
| *CreditHours* | | *3* | |
| *Prerequisite:* | | *None* | |
| *Aims and*  *Objectives* | | *Toacquaintwiththeuseofnumericalmodelsinfree-surfacehydraulics,numerical*  *methodsusedforsolutionofflowphenomenaandfinallytoacquirewithskills necessarytowriteprograms andmodels for hydraulicsproblems* | |
| *Outline*  *Syllabus* | | *Basis ofmathematicalmodelingin hydraulics*  *Conservationlaws describingfree-surfaceflows*  *Basic hydrodynamics;St. Venant’sequations&their solution*  *Methodof characteristics*  *Methodof finitedifferences:explicit andimplicitschemes*  *Developmentof numericalmodels foronedimensional free-surfaceflows*  * Modelingof flowin open channel networkswith inclusionof hydraulic structuresandirregularcross-sections*  * Numericalsolutionof two–dimensional nearlyhorizontal flowsusingmethod of finitedifferencesandmethodof finitevolumes*  *Modelingof advection-diffusionin oneandtwo dimensions*  *Modelingsedimenttransport*  *Introductiontoproblems of modelingshortwaves* | |
| *Assessment* | | *o20%assignments*  *o30%mid-termexam*  *o50% final Examination* | |
| *References* | | *1. ComputerOrientedNumerical Methods - V.Raja Raman*  *2. Introductiontonumericalmethods for waterresources–W.L.Wood* | |
| ***CourseTitle*** | | ***WaterResourcesPlanning andManagement*** | |
| *CourseCode* | | ***EngH 761*** | |
| *CreditHours* | | *3* | |
| *Prerequisite:* | | *None* | |
| *Aims and*  *Objectives* | | *Togiveknowledgeonbroadaspectsofwater resourcesplanningandmanagementfor sustainable useofwater formultiplepurpose.* | |
| *Outline*  *Syllabus* | | *Introductionto water resourcesmanagement:Need for planning, stagesofplanning, data requirements etc.*  *Principlesof IntegratedWater ResourcesManagement(IWRM).*  * Methodsof engineeringeconomic analysis likethe annual uniform method, presentworthmethod, rate ofreturnmethod.*  * Toolsof waterresourcessystemanalysis:linear programming, non- linear programminganddynamicprogramming. Optimal sizingof reservoirs: Deterministicapproachusingthecritical lowflowperiodandstochastic approachusing MonteCarlosimulation.*  *Optimaloperationofmultipurposereservoirs:Determinationoftheoptimalreservoiroperatingrule,determinationofoptimal releasesfromreservoirs in seriesandparallel.*  * Determinationofcatchment yieldas afunctionof storageusingmass balanceapproach, waterusecoefficients, conjunctiveuseof surface waterandground water:determinationofamountfromboth surfaceandgroundwater.* | |
| *Assessment* | | *o40%termpaper(group work)andpresentation*  *o10%assignment(individualwork)*  *o50%final examination* | |
| *References* | | *1. DavidC.Major andRoberto L.Leuton,(1979),AppliedWaterResources*  *SystemsPlanning, Prentice Hall, NewJersey.*  *2. LouchsD.P, Jerry,R. WaterResourcesSystemsPlanningandAnalysisPrenticeHall N.J* | |
| ***CourseTitle*** | | ***ReservoirPlanning and Sedimentation*** |
| *CourseCode* | | ***EngH611*** |
| *CreditHours* | | *3* |
| *Prerequisite:* | | *EngH 611* ***-*** *RiverEngineeringandSedimentTransport* |
| *Aims and*  *Objectives* | | *Toteachfundamentalsofsedimentmechanicsandprinciplesofsedimentation.*  *Similarlyopenchannel hydraulicswillbediscussed.* |
| *Outline*  *Syllabus* | | *SedimentMechanics andReservoirsedimentation.*  * Energy:conceptsoftotal energy,specificenergy,alternativedepths, critical depth, hydraulicjumpandthe local phenomenon.*  * Statesof flowandflowresistance:Steady/unsteadyflows;uniform/non- uniformflows:Eulersequation, resistancetoflow,flowresistanceequations, andnumericalsolutionsofthe same.*  * Typesofsurfacecurves,wavevelocity, solitarywaves,monoclinicalrising wave,seddoris law. Developmentsof St. Venantequations for unsteadyflow inopen channels.*  * Methodof characteristics.Scouringandsiltingin erodible channels. Designof erodiblechannels.*  *Sedimenttransportinopenchannels–Basicequations, sediment properties,suspended load, bed load,channel regulation, bed formationandstability.* |
| *Assessment* | | *o40%termpaper(group work)andpresentation*  *o10%assignment(individual work)*  *o50%final examination* |
| *References* | | *1. Morris, GregoryL. and Fan, Jiahua. 2009. Reservoir Sedimentation*  *Handbook,McGraw-Hill BookCo., NewYork.*  *2. Nash, J.E. Flow inPipes and Open Channels, National University ofIreland, Galway.*  *3. Giles,Fluid Mechanics andHydraulics,Schaumseries,McGrawHill*  *4. Evelt, J.B. andLi,C.Fluid Mechanics andHydraulics,Schaumseries,*  *5. Fox,R.W.ANDMcDonald,A.T.IntroductiontoFluidMechanics,Wiley,1995.*  *6. Mott, R.L. Applied Fluid Mechanics, PrenticeHall,4thEdition,1994.* |
| ***CourseTitle*** | | ***DamEngineering*** |
| *CourseCode* | | ***EngH 612*** |
| *CreditHours* | | *3* |
| *Prerequisite:* | | *None* |
| *Aims and*  *Objectives* | | *Thiscourseisdesignedtoacquaintstudentswiththebasicdesignprincipleofdam*  *engineering.* |
| *Outline*  *Syllabus* | | *Elements of dam engineering; classification of dams; site assessment and*  *selectionof appropriatetype of dam;foundations andtheir treatment;*  *Differentiatethegeneral characteristicsof concreteandembankmentdams;*  * Selectappropriatesite forconstructionofdifferenttypesofdamsandknowthe methodof foundationpreparation;*  * Knowthebasicdesignprincipleandanalysisofgravity,buttress,archand embankmentdams;*  * Understandthevariousmodeoffailureinalltypeofdamsandrecognizeits constructional features;*  *Familiarize themselves with the technique of diverting river water for the*  *purposeof constructions.* |
| *Assessment* | | *o40%termpaper(group work)andpresentation*  *o10%assignment(individual work)*  *o50%final examination* |
| *References* | | *nd*  *1. Novak,Moffat,Nalluri&Narayanan(1996)HydraulicStructures,2 Ed.*  *Chapman&Hall*  *2. Davis&Sorensen (1980).HandBookof Applied Hydraulics.*  *3. Jansen(1988)AdvancedDamEngineering:ForDesign,Construction& Rehabilitation, VanNostrand Reinhold, NewYork*  *4. USBR(1977).DesignofGravityDams,USGovernmentPrintingOffice*  *Denver.*  *5. USBR (1987).Designof Small Dams.*  *6. Robin Fell, Patrick MacGregor (1992). Geotechnical Engineering of*  *EmbankmentDams.*  *7. Otherrelevanthydraulicstructuresbooks, journals, internet,etc.* |

***9. Research Area***

*Aftersuccessfulcompletionofthecoursework,thestudentareexpectedtofocusinthefollowing researchareasfortheir thesis.*

*Systemsforfresh watersuppliesforurban,industrialandagriculturaluse*

*Floodcontroland waterhazardmitigation*

*Erosion andsedimentcontrol*

*Erosion,transport andfateofcontaminated sediments*

*Conventionaland‘green’infrastructureforstormwaterdrainageofcities,highways,*

*airports andcatchments*

*Preservation,conservationandutilization ofsurfacewaterand wetlands*

*Groundwater utilization,management andremediation*

*Vadosezoneexperimentation andmodeling*

*Operation of reservoirsandlakes*

*Planningandmanagementofthehydrologicenvironmentinresponsetohumanimpact andpotentialglobal climatechanges*

*Complexsystems involving interaction between water, vegetation, soils and anthropogenicprocesses*

*Climatedynamics andvariability*

*Land-atmosphereinteractions*

*Multiphaseflow andgeochemicalprocesses*

*Dataassimilation anddatafusion*

*Environmentalsensing*

*Nonlineardynamicsof coupledclimatic andhydrologic systems*

*Landusechangeandclimate*

***Program Name:* MSc. in Chemical Engineering (Process Engineering)**

* + 1. **Course Breakdown**

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| **Year I Semester I** | | | | | | | |
| **Course Title** | Course Number | Lecture  (Hrs.) | Home-Study  (Hrs.) | Tut.  (Hrs.) | Lab.  (Hrs.) | Cr. Hr. | ECTS |
| Advanced Computational Fluid Dynamics | ChEg 6133 | 3 | 8 | 2 | 2 | 4 | 8 |
| Advanced Chemical Engineering Thermodynamics | ChEg 6135 | 4 | 8 | 3 | - | 4 | 8 |
| Advanced Reaction Engineering | ChEg 6141 | 3 | 8 | 3 | 1 | 4 | 9 |
| Advanced Transport Phenomena | ChEg 6143 | 4 | 8 | 3 | - | 4 | 8 |
| Total | | | | | | 16 | 33 |

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| **INTER SEMESTER BREAK** | | | | | | | |
| **Year I Semester II** | | | | | | | |
| **Course Title** | **Course Number** | **Lecture**  (Hrs.) | **Home-Study**  (Hrs.) | **Tut.**  (Hrs.) | **Lab.**  (Hrs.) | **Cr. Hr.** | **ECTS** |
| Advanced Separation Processes | ChEg 6142 | 4 | 8 | 3 | - | 4 | 8 |
| Advanced Process Dynamics and Control | ChEg 6144 | 3 | 7 | 3 | - | 3 | 7 |
| Characterization of Materials | ChEg 6148 | 3 | 9 | - | 3 | 3 | 8 |
| Process Systems Engineering | ChEg 6146 | 3 | 7 | 3 | - | 3 | 7 |
| Elective I | ChEg 6152 | 3 | 7 | 3 | - | 3 | 7 |
| Total | | | | | | 16 | 37 |
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| **Year II Semester I** | | | | | | | | |
| **Course Title** | | **Course Number** | **Lecture**  (Hrs.) | **Home-Study**  (Hrs.) | **Tut.**  (Hrs.) | **Lab.**  (Hrs.) | **Cr. Hr.** | **ECTS** |
| Research Methods and  Experimental Design | | ChEg 7121 | 3 | 6 | 2 | 2 | 4 | 7 |
| Elective II | | ChEg 7153 | 3 | 7 | 3 | - | 3 | 7 |
| Thesis Phase-I (Seminar) | | ChEg 7161 | - | 10 | 3 | - | 2 | 7 |
| Total | | | | | | | 9 | 21 |
| **SEMESTER BREAK** | | | | | | | | |
| **Year II Semester II** | | | | | | | | |
| **Course Title** | **Course Number** | | **Lecture**  (Hrs.) | **Home-Study**  (Hrs.) | **Tut.**  (Hrs.) | **Lab.**  (Hrs.) | **Cr. Hr.** | **ECTS** |
| Thesis Phase-II (M.Sc. Thesis) | ChEg 7162 | | - | 45 | 3 | 8 | 6 | 30 |
| Total | | | | | | | 6 | 30 |

**b) Course Descriptions**

**3.1 Process Engineering Course Characterization Forms**

**3.1.1 Course Characterization Form**

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg7121 | | | |
| Course Title | Research Methods and Experimental Design | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | RESEARCH METHODS | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 4 | | | |
| Course work load  distribution in hours | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 32 | 32 | 96 |
| Course Objectives | This course is intended to equip students with the methodological skills they need to successfully complete a major research project, and enable them to develop a critical and engaged attitude to research methods and experimental design. In addition to it providing students with the ability to consider hypothesis, design and plan experiments to test them, run experiments and analyze data using basic statistics; derive results, and validate them, and write up scientific reports based on the experimental studies. It is intended to provide profound knowledge in experimentation and experimental design strategy. | | | |
| Learning Outcomes | **At the end of the course, a learner should be able to**   * + - Identify relevant literatures for a given research topic within the research circles     - Extract knowledge from the research literatures on developing research methodology     - Develop research strategy relevant to the research topic     - Develop research proposal and plan     - Develop and evaluate a strategy for analyzing the hypotheses, experimentally analyzing results, and presenting them visually     - Write a scientific report on results and solutions     - Understand fundamentals of experimental design and statistical analysis and apply this knowledge in a practical context     - Categorize different variables in statistical analysis and evaluate sample data using basic statistical measures such as distribution, probability, significance, variance and correlation     - Define and formulate research problems, and questions, and where appropriate, formulate hypotheses that can be tested     - Understand the relationships between, and the rational for using, particularly qualitative and quantitative research methods     - Understand different forms of sampling, sampling error, and potential biases in the interpretation of research findings     - Understand and apply the concepts of general, validity, reliability and explicability     - Appraise and evaluate library resources applicable to a research at post graduate level     - Design an experiment to have reliable result with minimum number of experiments, that can save time and cost of experiment | | | |

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| Course Description/  Content | **Type and characteristics of research projects**   * + - Selecting an appropriate research methodology     - Research proposal development and management techniques     - Literature reviewing method, resource collection and documentation     - Research outcome presentation and analysis     - Typical applications of experimental design     - Review of basic statistical principles     - Guidelines for designing experiments     - Basic statistical concept     - Simple comparative experiments     - Experiments with a single factor     - The analysis of variance     - Randomized blocks, Latin squares, and related designs     - 2k factorial design     - Blocking and confounding in the 2k factorial design     - Two, three and mixed level factorial and fractional factorial designs     - Factorial experiments with random factors     - Nested and split plot designs     - Fitting regression models     - Response surface methods and other approaches to process optimization |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) |
| Semester | 3 |
| Status of Module | Compulsory |

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| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial and Assignments |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Projects 10%  Exam 50% |
| Attendance  Requirements | At least 75% of the Lecture |
| Literature | 1. Kothari, C.R. 2004. Research Methodology, Methods and Techniques; Second Edition, New Age International (P) Limited, ISBN (13): 978-81-224-2488-1. 2. Ranjit Kumar, 2011. Research Methodology a step-by-step guide for beginners; Third Edition, ISBN: 978-1-84920-300-5 3. John W. Creswell (2013) Research Design: Qualitatively, Quantitatively and Mixed Methods Approach, Fourth Edition, ISBN: 1452226091. 4. Douglas C. Montogomery (2001), Design and Analysis of Experiments, Fifth Edition, Wiley and Sons, ISBN: 0-471-31649-0. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg7151 | | | |
| Course Title | Industrial Ecosystems Engineering | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours (Semester basis (total) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The objectives of this course are to give students broad and basic principles of industrial metabolism, industrial symbiosis, integrated pollution prevention and control (IPPC) and the design of eco-industrial parks. Tools such as waste minimization assessment, life-cycle analysis (LCA), Inventory analysis, Impact Assessment (IA), material flow analysis (MFA), design for environment (DFE) and regional baseline analysis will be addressed. | | | |
| Learning Outcomes | **After completing this Course, students are expected to**   * + - Know environmental analysis of civil infrastructure systems     - Understand basic principles of industrial metabolism     - Know integrated pollution prevention     - Understand life-cycle assessment     - Know environmental management system     - Know green building program     - Understand sustainable energy and industrial system     - Know pollution prevention     - Know green design and manufacturing | | | |
| Course Description/  Content | * Introduction to Industrial Ecosystems * Industry and the Environment * Green House gases * Principles of Pollution Prevention and Cleaner Production * Audit for Cleaner Production * Pollution Prevention Technologies * Pollution Prevention through Product Life -Cycle Design * Approach to Life-Cycle Assessment * Pollution Prevention in Process Development and Design * Pollution Prevention through Reactor Design * Pollution Prevention through Process Control * Hazardous Waste Management * Definition and identification of Hazardous Waste * Consequences of hazard substances * Risk and Inherent Security / Safety * Reducing hazards risk * Inherent safety / security * Avoiding Hazardous substances * Chemical reaction hazard identification * Process hazard identification * Inventories of hazardous materials * Hazardous Waste Treatment * Physical Treatment * Chemical Treatment * Physico-Chemical Treatment * Biological Treatment * Hazardous waste Management * Disposal of hazardous waste * Storage of Hazardous Waste * Hazardous Waste Transportation * Hazardous waste Compatibility * Applied toxicology & Chemical safety * Physical forms of Chemicals * Human Exposure to Chemicals * Eco-Industrial Estate * Basic about Industrial Estate * Environmental Management System in industrial state * Industrial ecosystem * Green Chemistry * Introduction to Green Chemistry * Definition and principle of green chemistry * Green process and products * The Measure of Greenness * The Generation of Sustainable Process Alternatives * Mass and Energy Indices * The Hierarchical Approach * The Sustainable Process Index * Chemical Reaction in Green Chemistry * Greening solvent * Greening the reaction condition * Greening Energy * Green Chemistry by using process intensification * Process intensification in reactions * Process intensification in reactor * Process intensification in unit operations and processes * Green Application of catalyst * Definition and characteristics of catalyst * Type of catalyst * Homogeneous catalyst * Heterogeneous catalyst * Biocatalyst * Catalyst deactivation, sintering, and thermal degradation * Catalyst deactivation * Catalyst sintering and thermal degradation * Preparation of solid catalyst * Bulk catalyst * Impregnated / Supported catalyst * Final Activity of Catalyst preparation | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | 3 | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions and Presentation, Tutorial and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Final Exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |

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| Literature | 1. Harry M. Freeman (1995), Industrial Pollution Prevention Handbook, Second Edition, Tata McGraw-Hill, ISBN: 007-022-148-0 2. Noyes, R (1993), Pollution Prevention Handbook, First Edition, William Andrew, ISBN**:** 9780815513117 3. Robert U. Ayres (1994), Industrial Metabolism: Restructuring for Sustainable Development, United Nations University, ISBN: 978-9280808414 4. Clark. J.H. (1995), Chemistry of Waste Minimization, Springer, ISBN 978-94-011-0623-8 5. Mukesh Doble Ken Rollins and Anil Kumar (2007), Green Chemistry and Engineering, First Edition, Elsevier Science and Technology Books, ISBN: 9780123725325 |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | | | | |
| Course Number | | ChEg6133 | | | | | |
| Course Title | | Advanced Computational Fluid Dynamics | | | | | |
| PG Program | | MSc. in Chemical Engineering (Process Engineering) | | | | | |
| Module | | General Subject | | | | | |
| Course Coordinator | | Team | | | | | |
| Lecturer | | TBA | | | | | |
| ECTS | | 8 | | | | | |
| Credits | | 4 | | | | | |
| Course work load  distribution in hours (Semester basis (total)) | | Lecture | | Tutorial | Laboratory/Practice | Home-study | |
| 48 | | 32 | 32 | 128 | |
| Course Objectives | | To provide an understanding of physical models to study hydrodynamics in engineering systems. | | | | | |
| Learning Outcomes | | **After completing this Course, the student will be able to**   * + - understand the concepts, theories, and techniques of a variety of numerical methods     - develop ability and skills in solving industrial problems using quantitative and computational methods     - apply numerical methods for analyzing data to solve engineering problems     - use computational method in analyzing experimental data understand various computational techniques in modeling and solving engineeringproblems | | | | | |
| Course Description/  Content | | * Basic Concepts of Fluid Flow: Philosophy of computational fluid dynamics (CFD), review of equations of change for transfer processes, simplified flow models such as incompressible, inviscid, potential and creeping flow, flow classification. * Grid Generation: Structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems. * Finite Difference Method (FDM): Discretization of ODE and PDE, approximation for first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to engineering problems. * Finite Volume Method (FVM): Discretization methods, approximations of surface integrals and volume integrals, interpolation and differential practices, implementation of boundary conditions, application to engineering problems. * Special Topics: Case studies using FDM and FVM, flow and heat transfer in pipes and channels, square cavity flows, reactive flow, multiphase flow, rotary kiln reactors, packed and fluidized bed reactors, furnaces and fire systems. Overview of finite element method (FEM). | | | | | |
| Pre-requisites | | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | | | |
| Semester | | 1 | | | | | |
| Status of Course | | Compulsory | | | | | |
| Teaching & Learning  Methods | | Lectures, Seminars, Discussions, Tutorial and Assignments | | | |
| Assessment/Evaluation  & Grading System | | Course work assignments 25%  Seminars 15%  Discussion 10%  Final Exam. 50% | | | |
| Attendance  Requirements | | At least 75% of the Lecture | | | |
| Literature | | 1. Fletcher C.A.J. (1998), “Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques”, Springer-Verlag. 2. Fletcher C.A.J. (1998), “Computational Techniques for Fluid Dynamics, Vol. 2: Specific Techniques for Different Flow Categories”, Springer-Verlag. 3. Anderson J.D. (1995), “Computational Fluid Dynamics”, McGraw Hill. 4. Ghoshdastidar P.S. (2017), “Computer Simulation of Flow and Heat Transfer”, Cengage. 5. Ferziger J.H. and Peric M. (2002), “Computational Methods for Fluid Dynamics”, 3rd Ed., Springer. 6. Patankar S.V. (2004), “Numerical Heat Transfer and Fluid Flow”, Taylor and Francis. | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg 6135 | | | |
| Course Title | Advanced Chemical Engineering Thermodynamics | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | General Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 8 | | | |
| Credits | 4 | | | |
| Course work load  distribution in hours (Semester basis (total)) | Lecture | Tutorial | Laboratory/Practice | Self-study |
| 64 | 48 | - | 128 |
| Course Objectives | This course aims to provide graduate students with understanding on equilibrium and statistical thermodynamics and apply them to analyze chemical engineering problems. It will discuss topics of interest from viewpoint of statistical thermodynamics. It introduces the basic thermodynamic concepts of multiphase equilibrium and multi-component system. It also aims to connect the principles, concepts and laws/postulates of classical and statistical those dynamics to applications that require quantitative knowledge of thermodynamic properties from a macroscopic and molecular level as well as nano-scale. It introduces construction of partition functions and calculations of basic thermodynamic properties of several fundamental systems. The module provides fundamental insight into the underlying thermodynamic principles and practice of computation techniques to solve complex problems. | | | |
| Learning Outcomes | **After completing this course, the students will be able to**   * understand the fundamental concepts of chemical engineering thermodynamics and explain them to others * calculate thermodynamic properties through equation of state * differentiate between ideal and ideal thermodynamic behavior in both pure substances and mixtures * evaluate and apply different methods/assumptions to perform phase equilibrium calculations * relate intermolecular forces to macroscopic thermodynamic properties * solve complex chemical engineering problems using thermodynamic concepts data, and models * solve traditional closed ended and open-ended problems | | | |
| Course Description/  Content | * Mathematical development of fundamental laws of thermodynamics and their application to chemical engineering operations and processes * Fundamentals of equilibrium thermodynamics * Thermodynamic properties of fluids and fluid mixtures * Phase transition and critical phenomena * Legendre transformations * Equilibrium, Stability, Mixture Properties, Fugacity and Activities * Fundamentals of statistical mechanics * Partition functions * Statistical thermodynamic of fluids * Monte Carlo and dynamic simulations * Boltzmann Statistics and Ideal Mono-atomic gases * Virial Expansions, Distribution Functions; Monte Carlo methods * Phase Transitions, Monte Carlo for phase transitions, Phase Equilibrium and Chemical Equilibrium | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | 1 | | | |
| Status of course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Final exam 60% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. J. W. Tester and M. Modell (1997), Thermodynamics and its Applications, Third edition, Prentice-Hall, ISBN-13: 978-0139153563. 2. J.M. Prausnitz et al., (1998), Molecular Thermodynamics of Fluid-Phase Equilibria, Third edition, Prentice-Hall, ASIN: B018OEJ054. 3. D. Chandler (1987), Introduction to Modern Statistical Mechanics, First Edition, Oxford University Press, ISBN-13: 978-0195042771. 4. H.B. Callen (1985), Thermodynamics and an Introduction to Thermo-statistics, Second edition, Willey, ASIN: B01FEK33VI. 5. S.I. Sandler (1999), Chemical and Engineering   Thermodynamics, Third Edition, Willey, ASIN: B01FKTQSRY | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6142 | | | |
| Course Title | Advanced Separation Processes | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Specialization/core Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 8 | | | |
| Credits | 4 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 64 | 48 | - | 128 |
| Course Objectives | The aim of this course is to introduce the students to the theory and practices of modern separation techniques. It also provides the necessary background to allow students to select appropriate separation for the given analysis and also to equip them with the experts required in the selection, design, and evaluation of industrial separation processes. It introduces advanced knowledge of equilibrium stage concepts of various separation processes and unit operations. | | | |
| Learning Outcomes | **At the end of this course, it is expected that students will be able to**   * Understand thermodynamic and molecular basis for   equilibrium separation   * understand advanced/special separation techniques such as GC and MS etc. * describe and differentiate the various separation processes * classify different types of separation mechanisms * identify basic principles of separation mechanism * identify separation equipment’s of various type * perform calculation of the design parameters of the separation equipment * calculate the properties (e.g., composition and flow rates) product streams as well as energy requirements * design multistage separation system * analyze the performance of separation equipment * use computer modeling to design and simulate complex separation systems | | | |
| Course Description/  Content | * Introduction * VLE of multi-component mixtures * Approximate and rigorous methods for multi-component and multistage separations * Characterization, selection and design of equilibrium and rate-governed separation processes * Capacity and efficiency of multi-component, mass transfer equipment and process energy requirements * Distillation process * Elements of installation and operation cost estimation * Adsorption processes * Ion exchange * Chromatography design * Membrane processes * Adsorption process project, membrane characterization, membrane process classification, design parameters processes and membrane process design project * Lab practices/ exercises on extraction, binary and multi-component distillation, absorption, adsorption, vapor pressure determination; | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 20%  Seminars 10%  Project 20%  Final exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. J. D. Seader and E. J. Henley (2010), Separation process Principles, Third Edition, Wiley, ASIN: B004K3FB8Y. 2. Geankoplis C. J. (2007), Transport Processes and Separation Process Principles (Includes Unit Operations), Fourth Edition, Prentice Hall, ISBN-13: 978-8120326149. 3. King C. J. (2013), Separation Processes, Second Edition, Dover, ISBN-13: 978-0486491738. 4. Rousseau, R. W. (1987), Handbook of Separation Process Technology, Wiley, ISBN: [047189558X](http://gen.lib.rus.ec/book/index.php?md5=BD1D95D901B4B824F3EABEE48F84B379). | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6143 | | | |
| Course Title | Advanced Transport Phenomena | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Specialization/core Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 8 | | | |
| Credits | 4 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 64 | 48 | - | 128 |
| Course Objectives | The aim of this course is to provide students with tools and knowledge required to understand and analyze variety of problems involving heat and mass transfer and fluid flow, using analytical methods, numerical methods and commercial software. It is intended to develop students’ knowledge to:  Perform shell balances for conservation of momentum, energy, and mass;   * + - Understand and apply flux laws in balances     - Understand and apply inter-phase transport relationships     - Employ shell balance equations to obtain desired profile of velocity, temperature, and concentration     - Reduce and solve the appropriate macroscopic balances for conservation of momentum, energy and mass; recognize and apply analogies among momentum, energy and mass transfer     - Appreciate relevance of transport principles in diverse applications of chemical, biological, and material science and engineering. | | | |
| Learning Outcomes | **After completing this course, a learner should be able to demonstrate:**   * An understanding of the basic physical laws and equations governing transport phenomena (heat, and mass transfer and fluid flow) * The ability to analyze transport phenomena problems and identify major factors * The ability to make quantitative predictions about the physical behavior of the systems involving transport phenomena * An understanding of the basic principles of the numerical and analytical solutions of transport equations * An ability to use commercial software effectively to model reasonable complex transport phenomena problems | | | |
| Course Description/  Content | * Introduction to transport phenomena   + - Vector and tensor analysis     - Advanced momentum transport     - Advanced energy transport     - Advanced mass transport * Analogies in heat, mass and momentum transport | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | I | | | |
| Status of Module | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |

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| Assessment/Evaluation  & Grading System | Course work assignments 25%  Discussion 15%  Final exam 60% |
| Attendance  Requirements | At least 75% of the Lecture |
| Literature | 1. Bird R.B., Stewart W.E. and E.N. Lightfoot, (2001) Transport Phenomena, Second Edition, Wiley, ISBN: [9780471410775](http://gen.lib.rus.ec/book/index.php?md5=F69625143057EE93FE82FC56B35E354B). 2. J. R. Welty, et al., (2013), Fundamentals of Momentum, Heat and Mass Transfer, Wiley, ISBN: [9780470128688](http://gen.lib.rus.ec/book/index.php?md5=1C16F5652069010681CE67B239CAFB96). 3. Rosner R. and Daniel E. (2000) Transport Processes in Chemically Reacting Flow Systems, Dover, [978-1-62198-6119](http://gen.lib.rus.ec/book/index.php?md5=CCEF72852D25E768020AEA61B9077F4C) 4. Robert J. K., Michael E. C., and Peter G. (2003), Chemically Reacting Flow: Theory and Practice, Wiley, ASIN: B01JXTF6VG. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6144 | | | |
| Course Title | Advanced Process Dynamics and Control | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Specialization/core Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The aim of this course is to allow the learners to gain competence in advanced process control design and implementation issues, to acquaint them with principles and practice of non-linear analysis and control techniques, and also to familiarize them with the principles and practice of adaptive control techniques. It introduces advanced analog single loop control, digital (computer) control, and multivariable control analysis and design procedures. | | | |
| Learning Outcomes | **On completion of this course, the learner will be able to**   * + - design and implement multivariable control systems     - describe process monitoring and batch process control methods     - analyze the stability of nonlinear systems     - present the major issues associated with attuning     - describe adaptive controller methods and technologies | | | |
| Course Description/  Content | * + - Review of incentives for process control, control block diagrams, detailed comparisons of PID algorithms, and derivative action on process output vs. error     - Review of continuous-time Internal Model Control (IMC) and IMC-based PID     - Introduction to digital control and Implementation of digital PID algorithms     - Identification of discrete models for digital control     - Digital model-based controls - IMC and Dahlin’s method     - Introduction to model predictive control (MPC)     - Analysis of multivariable systems, review of RGA and introduction to singular value analysis     - The impact of process design on process control and reactor scale-up example.     - Frequency response techniques for control system design; Adaptive control, Lab practice/exercise on process control system design and analysis | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Final exam 60% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |

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| Literature | 1. George Stephanopoulos (2008), Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall of India, ISBN-13: 978-8230337950. 2. Luyben, W.L. (1999), Process Modeling, Simulation, and Control for Chemical Engineers, Second Edition, Mc-Graw-Hill, ISBN: [6-67-639159-9](http://gen.lib.rus.ec/book/index.php?md5=CD6485EBC5C5669BCE28ED7CE070401B). 3. Smith, C. A., and Armando, B. C., (1997), Principles and Practice of Automatic Process Control, Second Edition, Wiley,[ISBN: 9780471575887](http://gen.lib.rus.ec/book/index.php?md5=8F403AC3A6B18BC08CB358CEF2113EF6). 4. Nagy, I. (1992), Introduction to Chemical Process Instrumentation, Elsevier Science Ltd, ISBN-13: 978-0444987129. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg 6141 | | | |
| Course Title | Advanced Reaction Engineering | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Specialization/core Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 9 | | | |
| Credits | 4 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | 16 | 128 |
| Course Objectives | The intent of this course is to help students master several advanced concepts in reaction engineering such as advanced reactor design and stability including consideration of energy balance, chemical reaction mechanisms and rate theories, transport effects in reactive systems, and biological applications of chemical kinetics as well as other topics of interest. It provides profound knowledge in transport processes in heterogeneous catalytic systems, characterization of catalysts, and heterogeneous catalysis. | | | |
| Learning Outcomes | **On the completion of this course, the learner will be able to**   * examine the options and make judgment on the most feasible reactor system for a given duty * draw up an outline design for a range of chemical reactors and be aware of the required operating conditions * derive and apply the energy and material balances that are required to design isothermal and non-isothermal batch, plug flow, fixed bed, and continuous stirred tank reactors * solve problems of various complexity * apply problem solving skills to reactor design * solve problems of mass transfer with reaction in heterogeneous catalysts * perform modeling operation using modeling software | | | |
| Course Description/  Content | **Review** of design of ideal isothermal homogeneous reactors for single and multiple reactions, Adiabatic and non-adiabatic operations in batch and flow reactors, optimal temperature progression, hot spot in tubular reactor, autothermal operation and steady state multiplicity in continuously stirred tank reactor (CSTR), and tubular reactors.  **Rate equations for fluid solid catalytic reactions:** Rates of adsorption, desorption, surface reactions in terms of fluid phase concentration at the catalyst surface, qualitative analysis of rate equations, quantitative interpretation of kinetics data  **Diffusion and reaction**: External diffusion effects on heterogeneous reaction, diffusion and reaction in spherical pellets, internal effectiveness factor, falsified kinetics, overall effectiveness factor, estimation of diffusion and reaction limited regimes, Wisz-Prater criterion for internal diffusion, Mears criterion for external diffusion, inter pellet heat and mass transfer, mass and heat transfer with reaction in a packed bed Multiphase reactors: Gas-liquid-solid reactors, hydrodynamics and design of bubble column, slurry reactors, trickle bed reactors.  **Residence time distribution (RTD)** of ideal reactors, interpretation of RTD data, flow models for non-ideal reactors-Axial dispersion, N-tanks in series, and multiparameter models, diagnosing the ills of reactors, influence of RTD and micro mixing on conversion.  **Solid catalysis:** Introduction, Definitions, catalytic properties, classification of catalysts, steps in catalytic reaction, adsorption isotherm, chemisorption, synthesizing rate law, mechanism and rate limiting steps, deducing a rate law from the experimental data, finding a mechanism consistent with experimental observation, evaluation of rate law parameters | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | I | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, Laboratory practices, Seminars, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Discussion 15%  Final exam 60% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. Octave Levenspiel (1999), Chemical Reaction Engineering, Third Edition, Wiley, ISBN: [9780471254249](http://gen.lib.rus.ec/book/index.php?md5=A46B0F2CD94A6D1244821D5E72184601). 2. Fogler H. S. (2012) Elements of Chemical Reaction Engineering, Fourth Edition, ISBN: [0130473944](http://gen.lib.rus.ec/book/index.php?md5=88755150AA9AFAFC7F6CFDF725D7FD03). 3. Kulkarni Sulabha K. (2016), “Nanotechnology Principles and Practices”, 3rd Ed., Capital Publishing Company, New Delhi 4. Banwell Colin N., and McCash Elaine M. (2013), “Fundamentals of Molecular Spectroscopy”, 5th Ed., McGraw Hill Education (India) Pvt. Ltd, New Delhi | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg 6146 | | | |
| Course Title | Process Systems Engineering | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Specialization/core Subject | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The aim of this course is to introduce the students to systems thinking and creative problem-solving methodology and their application in fundamental process design, process identification, modeling, analysis, optimization, and control. It provides advanced knowledge in modeling, simulation, synthesis, analysis and screening of process alternatives. | | | |
| Learning Outcomes | **Upon completion of the course, students should be able to**   * recognize simple and complex systems, identify sub-systems and be familiar with fundamentals of systems design and architecture * understand basic methodology of creative problem solving using the systems approach * demonstrate knowledge of the interactions and integration management between manufacturing processes and systems, socio-economic enterprise systems, and environmental and bio-systems * identify flows, linear and non linear * describe the response of linear systems to simple periodic inputs * describe and use simple techniques to characterize complicated dynamics * distinguish chaotic from purely random systems * describe and use simple methods to determine fractal dimension * describe and give examples of the mathematical concept of complexity * use MathCad to manipulate simple equations, solve them numerically and plot the results | | | |
| Course Description/  Content | * Introduction: Process integration (PI) and its building blocks, available techniques for implementation of PI, application of PI. * Pinch Technology: Basic concepts, role of thermodynamics. Data extraction, targeting, designing, optimization-super targeting. Grid diagram, composite curve, problem table algorithm, grand composite curve. * Targeting of Heat Exchanger Network (HEN): Energy targeting, area targeting, number of units targeting, shell targeting, cost targeting. * Design of HEN: Pinch design methods, heuristic rules, stream splitting, design for maximum energy recovery (MER), multiple utilities and pinches, threshold problem, loops and paths, non-MER design, remaining problem analysis, driving force plot. * Heat Integration of Equipment: Heat engine, heat pump, distillation column, reactor, evaporator, drier, refrigeration system. * Heat and Power Integration: Co-generation, steam turbine, gas turbine. * Steady state simulation * Material and Energy balance for systems of process units * Optimization of Process systems * Application of optimization techniques to process design and operation * Multivariable search techniques * Leaner programming * Distribution and critical path networks * Nonlinear programming * Dynamic programming * Integer and mixed programming * Optimization in CAD programs | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | Lectures, seminars, discussions, tutorial, coursework assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. Glandt, E.D., M.T. Klein, & T.E Edgar (2001), Optimization of chemical processes, Second Edition, McGraw-Hill Companies, Inc, ISBN: [9780070393592](http://gen.lib.rus.ec/book/index.php?md5=20DD7BC5140B3F79E57A5241755F56D5). 2. Hangos, K. M., & L. T. Cameron, (2001) Process modeling and model analysis, Academic, ASIN: B008AU42UG. 3. Kemp I.C. (2007), “Pinch Analysis and Process Integration: A User Guide on Process Integration for the Efficient Use of Energy”, 2nd Ed., Butterworth- Heinemann. 4. Smith R. (2005), “Chemical Process Design and Integration”, 2nd Ed., Wiley. 5. Shenoy U.V. (1995), “Heat Exchanger Network Synthesis”, Gulf Publishing. 6. Edited by Klemes J., “Handbook of Process Integration (PI): Minimization of Energy and Water Use, Waste and Emissions”, 1st Ed., Woodhead Publishing. | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg7161 | | | |
| Course Title | M.Sc. Thesis Phase-I | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Thesis work | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| - | 48 | - | 160 |
| Course Objectives | The aim of this course is to give students the opportunity to display their expertise in reviewing modern scientific researches. The main purpose of Master Thesis Phase -I is to demonstrate that students are able to identify significant research gaps by critically reviewing theories and relevant literatures of his/her Master Thesis. | | | |
| Learning Outcomes | **On completion of a Master’s Thesis Phase-I a student should be able to demonstrate**   * a critical identification of the research topic resulting in to perform original research * an ability to undertake a critical literature review * an ability to plan and undertake research using appropriate concepts and methods and to adapt such methods to identify the gap for Master Thesis Phase-II. * writing Master Thesis Proposal based on the gap identified | | | |
| Course Description/  Content | None | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | Compulsory | | | |
| Status of Course | This course is student centered supported by one to one session with a supervisor; Supervision, discussion | | | |
| Teaching & Learning  Methods | Written Literature Review, Presentation, Defense | | | |
| Assessment/Evaluation  & Grading System | Not applicable | | | |
| Literature | 1. Recently Published Scientific Publications Relevant to Research Topic 2. Different Books Relevant to Research Topic | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg7162 | | | |
| Course Title | M.Sc. Thesis phase II | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Thesis Work | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 30 | | | |
| Credits | 6 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| - | 48 | 128 | 720 |
| Course Objectives | The aim of this course is to give students the opportunity to display their expertise in modern scientific researches. The main purpose of master thesis is to demonstrate that students are able to address significant research questions, to critically analyze theories and relevant literatures, to conduct independent empirical investigation using established quantitative and/or qualitative research methods and to present findings in an academic form. | | | |
| Learning Outcomes | **On completion of a thesis a student should be able to demonstrate**   * a critical investigation of the research topic resulting in the creation and interpretation of knowledge through original research * an ability to undertake a critical literature review * an ability to plan and undertake research using appropriate concepts and methods and to adapt such methods to deal with unforeseen issues * an ability to conceptualize, design and implement * an ability to relate theory and concepts to evidence in a systematic way and to draw appropriate conclusions based on the evidence * evidence competence related to issues pertinent to the master thesis * show competence in the selection and use of data * an ability to write clearly and precisely complying with the established criteria for formal presentation of a written thesis * produce a substantial piece of advanced independent work related to the theories, concepts, and practical issues the research work | | | |
| Course Description/  Content |  | | | |
| Pre-requisites | Coursework completion | | | |
| Semester | IV | | | |
| Status of Course | Compulsory | | | |
| Teaching & Learning  Methods | This course is student centered supported by one to one session with a supervisor; Supervision, and discussion | | | |
| Assessment/Evaluation  & Grading System | Written Thesis Review, Research Process, Presentation, Defense | | | |
| Literature | Not applicable | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6152 | | | |
| Course Title | Quality Control and Assurance | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The aim of this course is to provide students with the basic understanding of concepts and application of quality assurance and quality control as a part of complete management system for the processing industry. It introduces the practices of quality assurance, quality control and total quality management; standardization, ISO 9000 and ISO 14000, as well as case studies. | | | |
| Learning Outcomes | **It is expected that after completion of this course, students will be able to**   * + - demonstrate thorough understanding of fundamental principles of quality assurance and quality control as well as international standard for quality management system     - comprehend the concept of quality, the various means to achieve it, its costs and benefits     - understand the importance of quality in modern business scenarios     - develop a new or evaluate an existing quality management system     - apply approaches, systems, and tools used to assure quality control     - design systems of quality control and assurance within a team environment     - integrate methods, skills and tools necessary for quality control applications     - conduct quality audit in various industry settings     - understand and apply various standards and quality management systems such as ISO 9000 and ISO 1400 | | | |
| Course Description/  Content | * Introduction and background to quality assurance and quality control * Achieving, sustaining and improving quality * Nature of quality management * Quality management principles * Quality planning (QP) * Quality control (QC) * Quality improvement (QI) * Quality assurance (QA) * Fundamentals of total quality management * Quality management systems and standardization * Methods of total quality management * Tools for quality * Measurement of quality * Quality checkpoints and quality control points * Quality measurement in product development * Quality costing * Benchmarking * Managing quality using ISO 9000 * Managing quality using the process approach * Other relevant issues | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Elective | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. Sara M. and Carol W. (2015), HACCP: A Practical Approach, Third Edition, Springer, ASIN: B01F82GPTO. 2. Chapmann and Hall (1998), Functional Properties of Food Macromolecules, Second Edition, Springer; ASIN: B01A64H5WK. 3. Merton R. and Hubbard (2003), Statistical Quality Control for the Food Industry, Third Edition, Springer, ISBN: [9780306477287](http://gen.lib.rus.ec/book/index.php?md5=A6F74C50F32010A33611C664D13AEF09). | | | |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6155 | | | |
| Course Title | Biochemical Engineering | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The aim of this course is to provide the students with the fundamental understanding of biochemical engineering. It provides an understanding of biotechnology/biochemical processes, biological constituents and basic metabolic pathways, purification strategies, and principles and applications of molecular biotechnology relevant to biochemical engineering process design. | | | |
| Learning Outcomes | **On completion of this course, students should be able to**   * identify industrial applications of biology, biochemical and bioprocess knowledge * describe the approach of a process engineer to describe the inner workings of biochemical and biotechnological applications as industrial systems * recognize the role of biochemical constituents and metabolic pathways relevant to biochemical engineering process design * determine the crucial factors that affect the biological and biochemical processes of the main classes of biochemical components * develop technical and transferable skills (gather, analyze, and communicate information effectively) | | | |
| Course Description/  Content | * Course overview and introduction to biochemical engineering   + - Metabolism     - Enzyme technology and kinetics     - Immobilized enzymes     - Application of enzyme kinetics     - Microbial growth and growth kinetics     - Fermentation     - Scale up in fermentation systems     - Microbial culture     - Bioreactor design and, heat and mass transfer consideration | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | III | | | |
| Status of Course | Elective | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |

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| Literature | 1. Lee. J. M. (1991), Biochemical Engineering, First Edition, prentice hall Inc, ISBN-13: 978-0130853172. 2. Baily James E & Olli’s David F; Biochemical Engineering Fundamentals, Second Edition, TMH, ASIN: B010FR8VNU. 3. Blanch, H.W. & Clark, D.S (1997). Biochemical Engineering, Second Edition, CRC Press, ISBN-13: 978-0824700997. 4. Clarke, K. G. (2013), Bioprocess engineering: An introductory Engineering and life science approach, First Edition, Woodhead Publishing, ISBN: [9781782421672](http://gen.lib.rus.ec/book/index.php?md5=8AF1715E1965CF78C59D01BEB6D7B163). 5. Doran. P.M. (2012), Bioprocess Engineering Principles, Second Edition, Academic Press, ISBN: [9780122208515](http://gen.lib.rus.ec/book/index.php?md5=15405736B6C94C18A67CC25C47F3363E). |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg7153 | | | |
| Course Title | Petro and Bio-Refinery Technology | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | **The course objectives are to:**   * provide the students with the knowledge of crude oil, Biomass, and natural gas * provide students an overview of status quo and future direction of the engineering bio-products from renewable resources. Topics are selected to cover the fundamental understanding, conversion technologies, and practical applications from renewable biomass to energy, fuel, materials, and chemicals. * define bioprocessing, bio-refinery and bio-manufacturing as the production of biomaterials or performing industrial bioprocesses, using enzymes and biological cells (microorganisms, plant and animal cells) or their physiological bioprocesses. * discuss the physical and chemical properties of crude petroleum and natural gas * describe methods used in preparation of intermediates for petrochemicals processing * test and analyze samples of petroleum and petrochemical products * discuss processes of petrochemicals and related intermediates * sketch and explain process flow diagrams of petrochemical products | | | |
| Learning Outcomes | **On successful completion of the course, the students should be able to demonstrate an ability to**   * understand fundamental principles of bioproducts from renewable resources and also gain basic skills to further work on the biorefinery and bioproducts areas. * describe composition and types of crude oil, biomass and natural gas * understand physical and chemical properties of oil and natural gas as, specific gravity, flash point, and carbon residue * describe methods used in preparation of intermediates from methane, ethane, and ethylene * test and analysis specific samples of petroleum and petrochemical products * describe the production processes of ethanol, energy, biomaterial from biomass * describe the production processes of synthesis gas, urea, and ammonia * sketch and explain process flow diagrams polyethylene, ethylene glycol on industrial scale | | | |

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| Course Description/  Content | The course includes petrochemical, the fundamental principles and practical applications from renewable materials to bio-based materials:   * Raw materials for petrochemical * Bio-refinery and bio-based products overview * Fundamental Concepts in understanding bio-refinery * Energy and fuels from biomass: bioethanol, biodiesel, bio hydrocarbon * Energy and fuels from biomass: thermochemical conversion * Energy and fuels from biomass: others * Materials from biomass: overview and fundamentals * Materials from biomass: natural fibers, cellulose, lignin and others * Chemical platforms from biomass; * Pilot-plant and process design. * Hydrocarbon and non-hydrocarbon petrochemical processing * Refinery processes * Petrochemical from basic raw materials * Reactors and their application in petrochemical industry * Natural gas and coal processing principles * Synthesis gas * Ammonia and urea |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) |
| Semester | III |
| Status of course | Elective |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments |

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| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% |
| Attendance  Requirements | At least 75% of the Lecture |
| Literatures | 1. Junyong (J.Y.) Zhu, Xiao Zhang, and Xuejun (Jun) Pan (Editors(s)) (2011), Sustainable Production of Fuels, Chemicals and Fibers from Forest Biomass, American Chemical Society, First Edition, ISBN: 978-0-8412-2643-2. 2. Birgit Kamm, Patrick R. Gruber, Michael Kamm (Editor(s)) (2006), Bio-refineries-Industrial Processes and Products, First Edition, Wiley-VCH Verlag Gmbh & Co. KGaA, ISBN: 3-527-31194-7. 3. W.L. Nelson, (1949), Petroleum Refining Engineering, Third Edition, McGraw-Hill, ASIN: B0007E3ACY. 4. R. N. Watkins, (1979), Petroleum Refinery distillation, Second Edition, Gulf Pub Co, ISBN-13: 978-0872016729. 5. Robert A Mayers, (2016), Hand book of petroleum refining process, Fourth Edition, McGraw-Hill Education, ISBN-13: 978-0071850490. 6. [Robert E. Maples](https://www.amazon.com/Robert-E.-Maples/e/B001KIX7WY/ref=dp_byline_cont_book_1)  (2000), Petroleum Refinery Process Economics, Second Edition, PennWell Corp, ISBN-10: 0878147799. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6234 | | | |
| Course Title | Polymer Science and Engineering | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 32 | - | 112 |
| Course Objectives | The aim of this course is to give students broad based information in modern aspects of polymer science and engineering. It provides students with firm understanding and practical knowledge of polymer science and engineering ranging from synthesis, through characterization and properties to behavior and applications. It will also equip the students with experience and knowledge to make distinctive contribution in future careers in emerging areas of polymer science and engineering, whether in industry or academia. | | | |
| Learning Outcomes | **After completing the course, students will be able to**   * acquire sound knowledge and understanding of the important, physical and engineering principles that underpin the synthesis, properties, behavior and application of polymers * understand the relationship between polymer properties, and structure and molecular weight * understand methods of determining structure and molecular weight of polymers, and describe the significance of polymer solubility, melting point and glass transition temperature * describe different types of polymerization processes * determine the data required for the design of polymerization reactors * select polymeric materials for specific application | | | |
| Course Description/  Content | * Introduction to polymers and classification of polymers * Chemical structures * Polymer properties and polymerization mechanisms * Polymer solution, glassy state and aging * Mechanical properties, fracture mechanics, viscous elasticity and dielectric properties * Polymer liquid crystals * Semi crystalline polymers * Polymer melts, Rheology and processing | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Elective | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |

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| Literature | 1. Robert O. Ebewele (2000), Polymer science and technology, First Edition, CRC Press, ISBN-13: 978-0849389399. 2. Grulke, E.A. (1994), Polymer Process Engineering, Updated Edition, Prentice Hall, ISBN-13: 978-0130153975. 3. Kwang Soo Cho, (2016), Viscoelasticity of Polymers: Theory and Numerical Algorithms, First Edition, Springer, ISBN-13: 978-9401775625. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6232 | | | |
| Course Title | Membrane Technology | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Elective | | | |
| Module Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 7 | | | |
| Credits | 3 | | | |
| Course work load  distribution in hours  (Semester basis(total)) | Lecture | Tutorial | Laboratory/Practice | Home-study |
| 48 | 48 | - | 112 |
| Course Objectives | The objective of this course is to provide students with a broad spectrum of knowledge in fundamentals of membrane science and engineering, as well as in membrane applications for chemical, environmental and biomedical engineering. | | | |
| Learning Outcomes | **On completion of this course, students should be able to**   * define different membrane characteristics, configurations, and operating conditions * understand the application of membrane technology in a wide range of industrial applications * understand the advantages and limitations of membrane systems for a given application * use basic theoretical equations and correlations to define the mass transfer occurring in such processes | | | |

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| Module Description/  Content | The module starts with the introduction of various membranes and their applications. It provides general theory of membrane transport for pressure, concentration and electric field driven separation and purification processes. A basic principle of membrane fabrication for symmetric, asymmetric and composite membranes will be studied. Other focuses will be given to membrane fouling, liquid membranes, and facilitated transport in order to broaden students’ knowledge in membrane usage and functional membranes. In order to inspire student interests in membrane applications for life science, the module will also include membranes for controlled release devices, bio-mimetic and biological membranes for life science. |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) |
| Semester | II |
| Status of Course | Elective |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial, and Assignments |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Seminars 15%  Discussion 10%  Final exam 50% |
| Attendance  Requirements | At least 75% of the Lecture |

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| Literature | 1. Heinrich Strathmann (2011), Introduction to Membrane Science and Technology, First Edition, Wiley-VCH, ISBN-13: 978-3527324514. 2. Richard W. Baker (2012), Membrane Technology and Applications, Third Edition, Wiley, ISBN-13: 978-0470743720. 3. H Strathmann, (2004), Ion-Exchange Membrane Separation Processes, (Membrane Science and Technology), First Edition, Elsevier Science, ISBN-13: 978-0444502360. |

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| DEPARTMENT OF CHEMICAL ENGINEERING  HARAMAYA INSTITUTE OF TECHNOLOGY  HARAMAYA UNIVERSITY | | | | |
| Course Number | ChEg6148 | | | |
| Course Title | Characterization of Material | | | |
| PG Program | M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Module | Core | | | |
| Course Coordinator | Team | | | |
| Lecturer | TBA | | | |
| ECTS | 8 | | | |
| Credits | 3 | | | |
| Module work load  distribution in hours  (Semester basis (total)) | Lecture | Tutorial | Laboratory/Practical | Home -study |
| 48 | - | 48 | 144 |
| Course Objectives | To familiarize the students with the basic principles related to materials characterization methods. | | | |
| Learning Outcomes | **At the end of the course, a learner should be able to**   * + - discuss the relative advantages and disadvantages for the techniques     - be able to identify and justify the selection of at least 3 techniques to evaluate a particular sample     - be given an unknown sample (or have one from own research) and collect a targeted dataset on it using an instrument available on campus | | | |
| Course Description/  Content | * X-ray Diffraction and Diffractometry: Stereographic projection, Laue’s equation, Bragg’s condition of diffraction, structure factor rules, single phase analysis, multi-phase analysis, estimation of particle size and strain, orientation and texture, residual stress. * Light Microscopy: Basic principles, estimation of grain size, grain boundary area, volume fraction of second phase. * Transmission Electron Microscopy (TEM): Reciprocal space and lattice, Ewald sphere, diffraction from finite crystal, bright and dark field imaging, selected area diffraction, indexing of diffraction patterns, contrast from precipitates, dislocations, and stacking faults. * Scanning Electron Microscopy (SEM): Basic principles of scanning electron microscopy, energy dispersive spectroscopy (EDS), wavelength dispersive spectroscopy (WDS), electron backscattered diffraction (EBSD). * Thermal analyses techniques: Principles of differential scanning calorimetry (DSC), differential thermal analysis (DTA), Dilatometry, Thermogravimetric analysis (TGA). * Spectroscopy Methods: Emission spectroscopy, Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS). | | | |
| Pre-requisites | Admission to M.Sc. in Chemical Engineering (Process Engineering) | | | |
| Semester | II | | | |
| Status of Course | Core | | | |
| Teaching & Learning  Methods | Lectures, Seminars, Discussions, Tutorial and Assignments | | | |
| Assessment/Evaluation  & Grading System | Course work assignments 25%  Laboratory 25%  Exam 50% | | | |
| Attendance  Requirements | At least 75% of the Lecture | | | |
| Literature | 1. Goodhew, P.J. (2001), Humphreys, J. and Beanland, R., “Electron Microscopy and Analysis”, 3rd Edition, Taylor and Francis 2. Cullity, B.D. and Stock, S.R. (2001), “Elements of X-Ray Diffraction”, 3rd Edition, Printice Hall 3. Williams, D. B. and Carter, C. B. (2009), “Transmission Electron Microscopy: A Textbook for Materials Science”, 2nd Edition, Springer 4. Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L. and Michael, J.R. (2003), “Scanning Electron Microscopy and X-ray Microanalysis”, 3rd Edition, Springer 5. Speyer, R. (1993), “Thermal Analysis of Materials”, CRC Press 6. Dehoff, R.T. and Rhines, F.N. (1968), “Quantitaive Microscopy”, McGraw Hill | | | |

**Program Name: Master of Science in Food Science and Technology**

1. **Course Breakdown**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Course Title** | **Course**  **Code** | **Cr. Hr** | |
| **Sem. I** | **Sem. II** |
| 1 | Fundamentals of Food Processing Technology | FSTE 511 | 3 | 0 |
| 2 | Experimental Design and Analysis in Food  Science and Technology | FSTE 521 | 2 | 0 |
| 3 | Graduate Seminar on Current Topics in the  Field of Specialization | FSTE 531 | 1 | 0 |
| 4 | Computer Modelling and Risk assessment | FSTE 551 | 3 | 0 |
| 5 | Food Packaging | FSTE 512 | 0 | 2 |
| 6 | Food Waste Management | FSTE592 | 0 | 2 |
|  |  |  |  |  |

**Courses for Food Science and Technology Program**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Course Title** | **Course Code** | **Cr. Hr** | |
| **Sem I** | **Sem II** |
| **Required courses** | | | | |
| 1 | Advanced Food Chemistry | FSTC 511 | 3 | 0 |
| 2 | Advanced Food Microbiology | FSTC 521 | 3 | 0 |
| 3 | Advanced Food Analysis | FSTC 531 | 3 | 0 |
| 4 | Grain Science and Technology\* | FSTC 512 | 0 | 3 |
| 5 | Fruit and Vegetable Science and  Technology\* | FSTC 522 | 0 | 3 |
| 6 | Dairy Science and Technology\*\* | FSTC 532 | 0 | 3 |
| 7 | Meat Science and Technology\*\* | FSTC 542 | 0 | 2 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Total** | |  | **15** | **13** |
| 8 | Thesis | FSTC 611 | **6** |  |
| **Elective Courses** | | | | |
| 1 | Coffee, Tea and Species Processing  Technology | FSTC 552 | 0 | 2 |
| 2 | Human Nutrition | FSTC 562 | 0 | 3 |
| 3 | Beverage Science and Technology | FSTC 572 | 0 | 2 |
| 4 | Food Biotechnology | FSTC 582 | 0 | 2 |

**\*** Students doing thesis research on animal products may not be required to take these courses

**\* \***Students doing thesis research on plant products may not be required to take these courses

**Courses for Food Engineering Program**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Course Title** | **Course**  **Code** | **Cr. Hr** | |
| **Sem I** | **Sem II** |
| **Required courses** | | | | |
| 1 | Advanced Food Engineering Operations | FOEN 511 | 3 | 0 |
| 2 | Transport Phenomena | FOEN 521 | 2 | 0 |
| 3 | Design of Food Processing Machinery | FOEN 531 | 3 | 0 |
| 4 | Engineering Properties of Food Materials | FOEN 541 | 2 | 0 |
| 5 | Food Engineering Laboratory | FOEN 522 | 0 | 2 |
| 6 | Engineering of Food Storage Facilities | FOEN 532 | 0 | 3 |
| 7 | Engineering Design For Food Quality and  Safety | FOEN 542 | 0 | 2 |
| 8 | Food Process Instrumentation and Control | FOEN 552 | 0 | 2 |
| **Total** | | | **19** | **13** |
| 9 | Thesis | FOEN 611 | **6** |  |
| **Elective courses** | | | | |
| 10 | Reaction Kinetics and Bioreactor Design | FOEN 582 | 0 | 2 |

1. **Course Description**

***Common courses for both programs***

***Fundamentals of Food Processing Technology (FSTE 511) Lec. 3 hrs/week Tut./Lab: --***

*Quality factors in foods, causes and control of food deterioration. Fundamental processes: cleaning, size reduction, mixing and forming, separation and drying. Scientific principles of food processing and preservation: Heat addition processes, heat removal processes, Special preservation methods (irradiation, Radio frequency, sugar and salt, acids, oil and spices, smoking etc.). Low cost preservation for developing countries.*

***Experimental Design and Analysis in Food Science and Technology (FSTE 521) Lec. 2 hrs/week Tut./Lab: --***

*Principles of experimental design. Problems of food product design: production process problem and recipe problem. Single and multi-factor (factorial) experiments: experimental designs (CRD, RCBD, LD, mixture experimental design), analysis and interpretation using one-way and multi-way ANOVA. Simple and multiple linear regression, nonlinear regression analysis. Food process modeling and optimization, food recipe modeling and optimization. Selecting research topics; formulation of a specific research problem; research project proposal writing.*

***Graduate Seminar (FSTE 531)***

***Lec. 1 hrs/week Tut./Lab: --***

*Review and discussion of current literature and research findings in the field of Food Science and Technology or Food Engineering. With this, it is intended to acquaint the students to the methodology for preparation and presentation of scientific papers.*

***Food Packaging (FSTE 512)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Principles food packaging. Packaging materials: physical and chemical properties; Production and possibility of reuse; recycling. Forms and application of packages; storage of packaging materials. Food packaging systems and their relation ship to specific products and processes. Active food packaging systems: overview of active food packaging; design of modified atmosphere packaging; active packaging in polymer films; edible films and coatings as active layers. Safety issues in food packaging. Food packaging legislation (labeling and packaging closures). Regulations and equipment analysis of various existing packaging systems.*

***Food Science and Technology Program***

***Advanced Food Chemistry (FSTC 511)***

***Lec. 2 hrs/week Tut./Lab: 3hrs/week***

*Survey on chemical structure, reaction and stability of food major (water, carbohydrates, lipids, amino acids, proteins and enzymes) and minor (vitamins, minerals, food colorants, food flavors, food additives, toxic substances) chemical components with emphasis on changes during food production, processing, storage and handling of foods or the methods used in analyzing them. Selected topics on chemical composition, functionality and physicochemical properties of common plant food (cereal grains, legumes, oilseeds, fruits and vegetables, sugar cane, sugar alcohols, honey, beverages, coffee, tea spices, salt, vinegar, gums); and common animal (dairy, meat, egg, fish) food products. Water treatments and quality features in food processing. Literature survey on topics of food chemistry, foods chemical technology and physico-chemical properties changes.*

***Advanced Food Microbiology (FSTC 521)***

***Lec. 2 hrs/week Tut./Lab: 3hrs/week***

*Review of basic food microbiology. Beneficial uses of micro-organisms (starter cultures, probiotics, etc.). Problems and solutions for emerging spoilage and pathogenic bacteria associated with intoxication, infection and toxicoinfection. Different methods used to control undesirable micro organisms for the safety and stability of foods with special emphasis on the new non thermal methods and the hurdle concept in food preservation. Hygienic food production systems with special emphasis on the principles of HACCP. New techniques used to identify and characterize micro organisms in food.*

***Advanced Food Analysis (FSTC 531)***

***Lec. 2 hrs/week Tut./Lab: 3hrs/week***

*Sampling and sample treatments for analyte analysis in foods. Selected theory, instrumentation and practice on instrumental methods of food analysis: spectroscopic (colorimetric, atomic absorption, infrared, NIR, mass spectrometry, nuclear magnetic resonance spectroscopy, x-ray diffraction), separation (solvent extraction, chromatography and electrophoresis), enzymes based analysis, refractometry, viscometery, rheology and thermal analysis. Topics on various methods and techniques used on proximate, amino acids, enzymes, fatty acids, flavors, microelement, vitamins, undesirables (microbial metabolites, pesticide residues) analysis in foods. Literature survey on food analysis or food analysis instrumentation.*

***Grain Science and Technology (FSTC 512)***

***Lec. 2 hrs/week Tut./Lab: 3 rs/week***

*Review of grain (cereals, oil seeds and legumes) anatomy, composition and physico  chemical properties. Science and technology of grain cleaning, grading, drying, storage, milling (wet and dry) and milling products (flour, fiber, starch, protein and oil). Quality evaluation of cereal grains (composition, physico-chemical properties, rheology, etc) and their products. Science and technology of cereal food products: malted cereals and alcoholic beverages, baked products (bread, injera and soft wheat products), extruded products (pasta and macaroni), breakfast cereals and snack foods. Quality analysis in legume seeds and its products. Science and technology of legume foods processing. Quality analysis in edible oil seeds and its products. Science and technology of edible oil extraction. Analysis and prevention of mycotoxines. Literature discussion in cereal, legume and oil seeds science and technology.*

***Dairy Science and Technology (FSTC 522)***

***Lec. 2 hrs/week Tut./Lab: 3 hrs/week***

*The chemistry of milk and its components, the microbiology of milk and milk products. Processing of common dairy products. Organization of the dairy industry, the economic significance, environmental impact and safety considerations of dairy products*

***Meat Science and Technology (FSTC 532)***

***Lec. 2 hrs/week Tut./Lab: 3 hrs/week***

*Animal pre-handling, stunning and bleeding, Dressing and skin removal, evisceration and carcass storage, use of High and low Temperature, Chilling, Freezing and Drying: Use of Preservative Heavy Salt, C02 or Ozone, use of Salt combined with Curing and Smoking; Canning, and Aseptic processing, Meat processing for Sausage and Salami. Dressing and Processing pork, poultry and wild fowl. Processing of Sea foods cold storage of processed foods.*

***Fruit and Vegetable Science and Technology (FSTC 542)***

***Lec. 2 hrs/week Tut./Lab: 3 hrs/week***

*Structure and composition. Physiology and Biochemistry: changes during maturation, maturity indices, Physiology of ripening, chemical and biochemical changes during ripening, biosyntheses of ethylene, mode of action of ethylene. Classification of fruits based on respiration rate. Postharvest handling: pre-cooling; pre-packaging treatments; packaging. Fruit and vegetables Microbiology: Microflora, microbiological changes. Storage methods. Processing of selected fruit and vegetable products. Physiological, biochemical and microbiological changes after minimal processing; Modified and controlled atmosphere storage and packaging; vacuum packaging.*

***Coffee, Tea and Species Processing Technology (FSTC 552)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Coffee, tea and spices post harvest physiology and handling. Processing of coffee, tea, and spices. Classification and grading of coffee, tea and spices. Storage and marketing of coffee, tea and spices.*

***Human Nutrition (FSTC 562)***

***Lec.2 hrs/week Lab/Tut hrs/week***

*Review of nutrients and their roles. Nutritive values of common foods. Planning of balanced diet. Process of digestion and absorption. Digestion and absorption of major nutrients and their metabolism. Energy balance. Evaluation of daily energy requirement. Vitamins: water-soluble vitamins, fat-soluble vitamins. Minerals: macro minerals, micro minerals. Water. Nutritional deficiency disorders and their prevention. Protein-energy malnutrition (caloric requirements in growth and development). Iron, Iodine, vitamin-A deficiency etc. Dietary and anthropometrics assessment of nutritional status. Nutrition education and the nutrition policy including Ethiopian nutrition policy.*

***Beverage Science and Technology (FSTC 572)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Alcoholic beverages: concept of fermentation for production of beer, wine and distilled beverages. Non alcoholic beverages: carbonated and non- carbonated. Raw materials, equipment; quality and legislation of these products. Literature survey on recent developments in beverage technology.*

***Food Biotechnology (FSTC 582)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Review of cell structures, composition and cellular component fractionation. DNA and enzyme biosynthesis. Production of microbial enzymes of food processing importance. Energy and metabolism pathways important in food ingredients (products) making. Cellular genetics, control systems, gene cloning, mutation in industrial micro organisms. Topics on the production of selected biotechnological products to the food industry: alcohol, lactic acids, vinegar, maltodextrines, sweeteners, glucose syrups, amino acids, flavors, bakery yeast, yogurt, beer and cheese. Industrial application of genetic engineering techniques for improvement of food micro organisms of interest - starter cultures (probiotics, bacteriocins). Biosensors and bio -safety regulatory issues. Topics in biotechnology and fermented products.*

***Food Engineering Program***

***Food Engineering Operations (FOEN 511)***

***Lec. 3 hrs/week Tut./Lab: -----***

*Review of engineering calculations. Steady and unsteady state mass and energy balances. Quantitative characterization of different unit operations: thermal process calculations, pasteurisation, sterilization, drying and dehydration, evaporation, distillation, leaching, extraction, absorption and adsorption, Engineering aspects of physical separations: cleaning, grading and sorting, size reduction, size separation, mixing, membrane separation, filtration, homogenization, centrifugation, crystallization; emulsion.*

***Transport Phenomena (FOEN 521)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Modes of heat transfer. Basic concepts of heat transfer: steady and unsteady state conduction in one and multi-dimension. Principles of convection; Empirical and practical relations for Forced convection heat transfer; Natural convection systems; Radiation heat transfer; Boiling and condensation; Heat exchanger types. Mass transfer by molecular diffusion, diffusion in gases; diffusion in liquids and solids; the mass transfer coefficient; convective mass transfers, evaporation process in the atmosphere; Simultaneous heat and mass transfer. Momentum transfer.*

***Design of Food Processing Machinery (FOEN 531)***

***Lec. 3 hrs/week Tut./Lab: -----***

*Materials of construction. Design of separating machines: filters, cleaning machines, centrifugal separators, cyclones extractors, sorters and graders. Extruders, mixers and homogenizes. Design of transporting machines: pumps and fans, belt conveyors, augers, chain and sprockets. Size reducers; evaporators and dryers. Fundamentals of machine maintenance and maintenance schedule.*

***Engineering Properties of Food Materials (FOEN 541)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Relation between engineering properties of food materials and food quality. Physical properties and their measurement: density, shape, size, porosity sphericity. Thermal, electrical and dielectric properties. Color and measurement of color. Measurement of rheological properties of foods. Reheology of liquid, semi-solid and solid foods. Air flow through granular materials, flow properties of granular materials.*

***Food Engineering Laboratory (FOEN 522)***

***Lec. 1 hrs/week Tut./Lab:3 hrs/week***

*Planning experiments. Selected food processing experiments (determination of physical and engineering properties, fluid flow, thermal process, determination of thermal properties and characterization of heat exchangers, drying characteristics of food materials, physical separation etc.) will be conducted accompanied by data collection and analysis. At the end of each experiment a complete report following a scientific approach should be prepared.*

***Engineering of Food Storage Facilities (FOEN 532) Lec. 3 hrs/week***

*Course Objectives & Competences to be Acquired*

*The course is designed to impart functional and environmental design requirements, and management of food storage facilities.*

*The students will*

* Understand functional and environmental design requirements of food storage facilities*

* Be able to prepare specifications of such facilities*

*Be able to strategically manage storage facilities*

*Course Description/Course Contents*

* Physiology and environmental requirements of food raw materials and processed products.*

* Space design and layouts; design and operation of ventilation systems for storage of non-perishable foods.*

* Cold storage; modified atmosphere storage and other storage facilities for perishable foods. Design, construction and management of storage houses, silos and bins design; Building heat loss and gain*

***Engineering Design for Food Quality and Safety (FOEN 542) Lec. 2 hrs/week***

*Course Objectives & Competences to be Acquired*

*The course is designed to impart standard design codes, and safety and quality requirements processing plants.*

*The students will:*

* Understand design requirements for safety and quality of food processing plants*

* Be able to analyze risks associated with safety and quality of processed foods*

* Implement quality assurance methods*

*Course Description/Course Contents*

* Standards, codes of practice and design techniques relating to quality and safety assurance in food and bioprocessing industries.*

* Topics covered include ethical and safe food processing, quality systems standards, hygiene regulations, risk analysis, HACCP, traceability, design and layout of food and bioprocessing plant facilities, principles of cleaning*

***Food Packaging (FSTE 512)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Principles food packaging. Packaging materials: physical and chemical properties; Production and possibility of reuse; recycling. Forms and application of packages; storage of packaging materials. Food packaging systems and their relat ion ship to specific products and processes. Active food packaging systems: overview of active food packaging; design of modified atmosphere packaging; active packaging in polymer films; edible films and coatings as active layers. Safety issues in food packaging. Food packaging legislation (labeling and packaging closures). Regulations and equipment analysis of various existing packaging systems.*

***Food Process Instrumentation and Control (FOEN* 572)**

***Lec. 2 hrs/week Tut./Lab: -----***

*Sensors and transducers & their characteristics; Signals and their analyses; system modeling and response; Analogue and digital signal processing circuits; Computer interfacing; overall system design and timing; Bus systems.*

***Reaction Kinetics and Bioreactor Design (FOEN 582)***

***Lec. 2 hrs/week Tut./Lab: -----***

*Theory and types of reactions: reactions in foods. Homogeneous reactions, heterogeneous reactions. Theory of reaction rates, the reaction rate constant, temperature dependence of reaction rates. Kinetics of microbial growth and destruction, kinetics of quality changes in foods during processing and preservation. Bioreactors in food processing, bioreactor construction and configuration. Ideal reactor operations: analysis of batch and continuous reactors. Monitoring and control of bioreactors.*

**Program Name: Master of Science in Irrigation Engineering**

1. **Course Breakdown**

**Year I Semester I**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| WREE-6051 | Research Methods | 2 | 1 | 3 | 5 | 4 |  |
| EngH-6021 | Advanced Applied Hydrology | 3 | 2 | 3 | 7 | 6 |  |
| WREE-6011 | GIS and Remote Sensing Application in Soil & Water Engineering | 3 | 1 | 3 | 7 | 5 |  |
| IENG-6033 | Advanced Surface Irrigation System Design | 3 | 2 | 3 | 7 | 6 |  |
| ENGH-6022 | Water Resource Systems Analysis and Planning | 2 | 1 | 3 | 5 | 4 |  |
| IENG-6031 | Soil – Plant – Water – Atmosphere Relations | 2 | 1 | 3 | 5 | 4 |  |
| WREE-6061 | Numerical Methods and Computer Programming (E) | 2 | 1 | 3 | 5 | 4 |  |
| IENG-6062 | Advanced Software Applications in Irrigation Engineering (E) | 2 | 1 | 3 | 5 | 4 |  |
| **Semester Total** | | **17** | 10 | 24 | 46 | 37 |  |

**Year I Semester II**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| IENG-6032 | Advanced Drainage Engineering | 3 | 2 | 3 | 7 | 6 |  |
| IENG-6041 | Dam Engineering & Appurtenant Structures | 4 | 3 | 3 | 7 | 7 |  |
| IENG-6034 | Pressurized Irrigation system Design | 3 | 2 | 3 | 7 | 6 |  |
| IENG-6042 | Design of Diversion and Irrigation Structures | 3 | 2 | 3 | 7 | 6 |  |
| IENG-6052 | Graduate Seminar in Irrigation Engineering | 1 | 0 | 0 | 8 | 2 |  |
| IENG-6063 | Management of Irrigation Systems (E) | 2 | 1 | 3 | 5 | 4 |  |
| IENG-7054 | **Practical Education (Field Visit**) Ten – Days (visiting major Water Resources Development Project Sites and obtain relevant information to help them formulate the masters proposal | P/F |  |  |  |  |  |
| **Semester Total** | | **16** | **11** | **15** | **41** | **31** |  |

**Year II Semester III & IV**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| IENG-7054 | **Research Thesis:** Research Work related to Investigation Planning, Design and Management of Irrigation and Drainage engineering | 6 |  |  | 90 | 30 | ALL Courses |
| **Semester Total** | | **6** |  |  | **90** | **30** |  |

1. **Course Description**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Title** | **Soil-Water-Plant-Atmosphere Relationship** | | | |
| Course Code | IENG-6031 | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No & Name | Mod. 3,Irrigation & Drainage Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | After completion of this course, the student shall learn:   1. How water moves through porous media and plant system. 2. The detail about the soil and water system that is needed to plant growth. 3. Soil-water constants and their significance. 4. Concept and measurement of soil water potential. 5. Water exchange in plant cells and tissues as well as metabolic and other characteristics for efficient water use. 6. Better understanding about the transpiration and evapotranspiration that indicates the keen relationships between soil water-plant and atmosphere. 7. Response of salinity on internal water deficit and response of plant to water deficit. | | | |
| Outline Syllabus | Soil water retention, infiltration and water uptake, measurement of soil water content, concept and measurement of soil water potential, matric potential and solute potential, water exchange in plant cells and tissues, water movement of transpiration and evapotranspiration, energy and water balance, Factor affecting plant water states, metabolic and other characterstis for eficient water use, Availability of soil water for plant growth, Response of plant to water deficit, Effect of salinity on internal water defecit and plant growth. | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Irrigation Engineering Principles. Soil-Water-Plant Relationships. Module 3- Version 2 CE IIT, Kharagpur, India 2. Israelsen, O.W. and Hansen, V. E. (3rd Edition). 1990. Irrigation Principles and Practices. John Wiley and Sons, Inc. New York, USA. 3. Kirkham, M. B.(2nd Edition) 2014. Principles of Soil and Plant Water Relationships. Academic Press, Oxford, U. K. 4. Mark Behan. 1992. Lessons in Soil-Plant-Water Relationships, Pakistan Forest Institute, Peshawar, Pakistan. 5. Michael, A. M. 1990. Irrigation Theory and Practices. Vani Educational Books, Vikas Publishing House Pvt. Ltd. New Delhi, India. 6. Murthy, V. V. N. 1998.Land and Water Management Engineering, Kalyani Publishers, India. 7. Soil Conservation Service (SCS) Engineering Division. 1964. Irrigation Soil-Plant-Water Relationships. Soil Conservation Service, Washington DC, USA. | | | |

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| --- | --- | --- | --- | --- |
| **Course Title** | **Advanced Surface Irrigation System Design** | | | |
| Course Code | IENG-6033 | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No & Name | Mod. 3, Irrigation & Drainage Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Aims and Objectives | This course is designed to acquaint students with insight into the design, construction and operation of gravity irrigation systems. | | | |
| Outline Syllabus | * Introduction: types and required design variables. * Hydraulics of surface irrigation: basic concepts of surface irrigation; flow equations; surface irrigation models. * Design and operation of gravity or surface systems: basic considerations; contour ditch irrigation; basin irrigation; border irrigation; contour level irrigation; furrow and corrugation irrigation; wild flooding; reuse systems. * Farm water distribution Systems: unlined and lined ditches; low pressure pipe systems; operation and maintenance. | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Irrigation Engineering and Hydraulic Structures Santhsh   Kumar GargNaisark 2003   1. Irrigation, Water Power and Water Resources Engineering, Arora. K.R, Delhi 2002 2. Irrigation Water Management Principles and Practices   MasumdarDilipRumar, New Delhi 2002   1. Irrigation System Design: An Engineering Approach Cuenca, Richard 1989 | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Title** | **Pressurized Irrigation Systems Design** | | | |
| Course Code | **IENG-6034** | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No & Name | Mod. 3,Irrigation & Drainage Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course objectives and  competences to be  acquired | This course is designed to acquaint students withthe key requirements in pump selection and design of pump systems for typical irrigation installation. To understand the performance characteristics of different types of pumps and describe procedures to match pump performance characteristics with system requirements. Further, this course is designed to acquaint students with planning and design procedures for sprinkler and drip irrigation systems. | | | |
| Outline Syllabus | * Pumping systems: study of indigenous water lifts, opertating principles of hydraulic ram, principles of positive displacements, Jet and air lift pumps, Design of recprocating pumps, design of centrifigal pumps, impeller and casing, pump characterstics, selection of size and types of pumps, optimization of pump efficiencies, pump testing and modifications, pump installation, operation and maintenance, pump troubles and remedies, pump in service and parallel, special operating condition, design of farm irrigation system networks * Introductions: Sprinkler system components; general, technical and economic features of set-move, solid-set and continuous-move systems; criteria for system selection. * Hydraulics of sprinklers: water distribution to the soil under a static single sprinkler, a moving sprinkler and moving multiple sprinklers; sprinkler selection. * Sprinkler design: field layout; sprinkler spacing; operating pressure; sizing laterals, mains and pumping plant. * Trickle irrigation: trickle irrigation methods; components and equipment; system layout; emission devices; lateral lines; submain lines; mainlines. * Hydraulics of trickle irrigation systems: hydraulics of emitters and trickle irrigation lines; emitter flow variation and uniformity of trickle systems. * Crop water requirements under trickle irrigation: influence of ground cover; water distribution to plants; net irrigation amount; irrigation interval. * The design of trickle irrigation Systems: emitter selection; lateral line design; submain design; mainline design. * Trickle irrigation installation and maintenance: fittings and connection procedures; maintenance, filtration and flushing; fertilizing through trickle Systems and weed control. | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Irrigation Engineering and Hydraulic Structures Santhsh   Kumar GargNaisark 2003   1. Irrigation, Water Power and Water Resources Engineering, Arora. K.R, Delhi 2002 2. Irrigation Water Management Principles and Practices   MasumdarDilipRumar, New Delhi 2002   1. Irrigation System Design: An Engineering Approach Cuenca, Richard 1989 | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Title** | **Design of Diversion and Irrigation Structures** | | | |
| Course Code | **IENG-6042** | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No & Name | Mod. 4, Dam Engineering and Diversion Structures | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course objectives and  competences to be  acquired | The course aims at imparting highly technical knowledge and skill intheory and design aspects of various diversion structures includingcanal design by tractive force approach. It enables students to designdifferent types of diversion and control structures. In addition, this course is designed to acquaint students with theoretical and practical understanding of design procedures for structures used in water supply and conveyance systems for irrigated Agriculture. | | | |
| Outline Syllabus | * Different stages of rivers and their flow characteristics * A critical review of silt theories for canal design * Tractive force approach for canal design * Schwarz- Christoffel transformation and Khosla*et al.* theory * Stability analysis, hydraulic and structural design of headworkcomponents weir and barrage * Design of gates, head regulator, divide wall, fish ladder, undersluices, silt excluder * Design of canal regulating structures, distributary head regulator,cross regulator, escapes & outlets * Design of silt control structures; silt ejectors, * Design of cross-drainage works | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | * Basak N.N., (1999). Irrigation Engineering, Tata McGraw-Hill,New Delhi. * Garg, S. Kumar. (2004). Irrigation Engineering and HydraulicStructures, Khanna Publishers, India. * Sahasrabudhe, S.R. (1994). Irrigation Engineering and Hydraulic Structures, Sanjeev Kumar Kataria Publishing, India. * Novak, P. et.al. (1997). Hydraulic Structures, E & F.N. Spon, nc., London, UK. * Lal, Pande B.B et.al. (1987), Irrigation and Water Power Engineering, Standard Publishers Distribution, NaiSarak, India. * Depweg, H.W.Th (2001). Structures in Irrigation Networks: Hydraulic Aspects, IHE, The Netherlands. | | | |

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| Course Title | **Advance Drainage Engineering** | | | |
| Course Number | **IENG-6032** | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No. & Name | Mod 03, Soil Physics and Drainage | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Pre-requisites | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course Objectives & Competences to be Acquired | * Able to derive equation for different flow and understand their approaches in drainage channels. * To develop the common understanding of physics of land drainage, forces and energy form in soil water and their effect on surface tension of soil and its criteria. | | | |
| Course Description/ Course Content | Drainage in agriculture: Needs, Design considerations of agricultural drainage, Drainage-related problems in Ethiopia. Saturated and Unsaturated Flow: Unsaturated hydraulic conductivity, Steady and unsteady flow, Steady flow towards well. Field drains and field laterals: Surface drainage systems for sloping areas, Cross slope drainage system, Water disposal in sloppy areas. Types of sub-surface drainage system: Design of drainage canals and related structures, Installation of pipe drains, Hydraulics of drainage pipes. Composition of pipe sections of differing diameter, Hydraulic gradient and slope. Reuse of Drainage water. Concepts of vertical and bio-drainage. Drainage for salinity control: Measurement of salinity, Salinity in relation to irrigation and drainage, salinization and management options, Salinaization due to inadequate leaching and capillary rise. Drainage of heavy clay soil. Application of simulation models for drainage systems. | | | |
| Practical Work | Measurement of in-situ hydraulic conductivity, estimation of drainage coefficient and leaching requirements, Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems, design of filter and envelop materials. | | | |
| Semester | Year 1, Semester 2 | | | |
| Teaching & Learning Methods | Lectures, Laboratory, Projects, Home study | | | |
| Assessment/Evaluation & Grading System | Assignments 30%, Project 30%, Final Exam, 40% | | | |
| Attendance Requirements | A student must attend at least 75% ofthe classes during lectures and 100% during practical if registered for the course. | | | |
| Literature | 1. Bhattacharya A.K. and Michael A.M. 2009. Land Drainage: Principles, Methods and Applications. Vikas Publication House Pvt Ltd. 2. Ritzema H.P. 1994. Drainage Principles and Applications. 2nd Edition. ILRI Publication 16. Wageningen, The Netherlands. 3. Kirkham D. and Powers, W.L. 1972. Advanced Soil Physics. John Wiley and Sons. 4. Schilfgaarde J.V. 1974. Drainage for Agriculture. Monograph No. 17. American Society of Agronomy, Madison, Wisconsin, USA. 5. De Zeeuw J.W. 1973. Theories of Field Drainage and Watershed Runoff. Vol 2. Publication No. 16, International Institute of Land Reclamation and Improvement. Wageningen, The Netherlands. 6. Singh R.V. 1991. Drainage and Salinity Control. Himanshu Publication, Udaipur. 7. Roe H.B. and Ayers Q.C. 1954. Engineering for Agricultural Drainage. McGraw Hill. | | | |

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| Course Title | | **Management of Irrigation Systems** | | | |
| Course Code | **IEng-6063** | | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | | |
| Module No & Name | Mod 06, Elective Courses | | | | |
| Module Coordinator | To be decided | | | | |
| Lecturer | To be decided | | | | |
| Credit Hours/ECTS | 2/4 | | | | |
| Prerequisite | Irrigation & Drainage Engineering Module (Mod. 3) | | | | |
| Contact hours (per week) | Lecture | | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | | 3 | 5 | 4 |
| Aims and Objectives | Equip students with the concepts & frameworks to implementing equitable, efficient, and sustainable irrigation system management. The course raises salient issues in managing both small and large scale irrigation systems in order to highlight important tools for achieving equitable distribution and of irrigation water, institutional & organizational imperatives of irrigation system management, and basic criteria for evaluating the efficiency and effectiveness of the services rendered by a certain irrigation project.  At the end of the course, students must be able to assess the performance of irrigation systems based on multiple set of objectives, including technical, economic, and social criteria. An essential requirement for a successful completion of the course is that, students must be able to relate the methodologies they learn from it and apply effectively to the contexts of irrigation management in Ethiopia. | | | | |
| Outline Syllabus | Overview of irrigation networks and water distribution: operational objectives; irrigation scheduling; water distribution methods; design of on farm water distribution networks. Irrigation water management: multi objective command area planning and analysis; conjunctive use of canal and groundwater, water rights and allocation. Financial policy: irrigation development cost; operational cost; maintenance costs; cost sharing and recovery, water pricing. Organizational management for irrigation: operational and maintenance policy (main and tertiary unit operation, maintenance & management); water users; irrigation agencies, structures of organization; manpower planning & recruitment; management techniques; large and small scale irrigation projects case studies. Evaluation criteria of irrigation systems: assessment of service delivery and customer satisfaction, physical performance measures and evaluation, socioeconomic evaluation, Case studies. | | | | |
| Assessment | * 20% two irrigation projects case studies (groups of students will study actual irrigation projects: one foreign and another Ethiopian report their findings and conduct presentations. The focus of the projects is water rights, water allocation, equity and participation in irrigation water management) * 20% two irrigation project case studies (groups of students will study actual irrigation projects: one foreign and another Ethiopian, report their findings and conduct presentations. The focus is irrigation operation, water distribution & use, water pricing and maintenance) * 20% two irrigation management institutions case studies (groups of students will study actual irrigation system management including one foreign and one Ethiopian, report their findings and conduct presentations. The focus is the study of institutional and organizational aspects of irrigation systems, including irrigation agencies and water users) * 10%: individual assignment * 30% final examination (closed book) | | | | |
| References | Malano, H. M., & Hofwegen, P. J. (2006). Management of Irrigation and drainage systems: A service approach. Delft: Taylor & Francis .  Hofwegen, P., & Jaspers, F. (2006). Analytical framework for integrated water resources management: guideline for assessment of Instritutional Frameworks. Delft: Taylor & Francis .  Any relevant literature on irrigation system & water management, and irrigation institutions | | | | |

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| Course Title | | **Research Methods** | | | | | | |
| Course Number | | WREE-6051 | | | | | | |
| Degree Program | | Irrigation Engineering, MSc Program | | | | | | |
| Module No. & Name | | Mod 05, Project and Research | | | | | | |
| Module Coordinator | | To be decided | | | | | | |
| Lecturer | | To be decided | | | | | | |
| Credit Hours /ECTS | | 2/4 | | | | | | |
| Prerequisite | Irrigation & Drainage Engineering Module (Mod. 3) | | | | | | | |
| Contact hours (per week) | Lecture | | Tutorials& Seminar/ Lab.,Workshop Practice | | Home Study | | Total Contact Hours | |
|  | | 1 | | 3 | | 5 | | 4 |
| Course Objectives & Competences to be Acquired | | * To gain an increased understanding of the application of scientific methods to the field. * To provide knowledge on application of statistical design and Analysis. * To enlighten the students about the research ethics. * Further the student shall be able to prepare a well-structured scientific proposal and apply experimental design methods for his/her M.Sc. | | | | | | |
| Course Description/ Course Content | | Introduction to research and experiments; procedure of research (the scientific method); research planning; steps in experimentation; research proposal writing; review of the relevant statistical concepts; design and analysis of experiments - principle of experimental design, design and analysis of comparative experiments (Completely Randomized Design, Randomized Complete Block Design and Latin Square Design), Factorial, Split Plot Design; Research proposal and report writing. | | | | | | |
| Teaching & Learning Methods | | Lectures, Projects, Home study | | | | | | |
| Assessment/Evaluation & Grading System | | Assignments 20%, Project 30%, Final Exam, 50% | | | | | | |
| Attendance Requirements | | A student must attend at least 80% ofthe classes during lectures. | | | | | | |
| Literature | | 1. Gomez K.A. and Gomez A.A. 1984. Statistical Procedures for Agricultural Research. 2nd Edition. John Wiley & Sons. New York. 2. Montgomery, D.C., 2012. Design and Analysis of Experiments. 8th Edition. Arizona State University. John Wiley & Sons. 3. Bajpai, A.C., Claus, I.M. and Fairly, J.A., 1978. Statistical Methods for Engineers and Scientists. John Wiley & Sons. 4. Bethea R.M. 1995. Statistical Methods for Engineers and Scientists. 3rd Edition. CRC Press, Taylor & Francis Group. 5. DestaHamito, 2001. Research Methods in Forestry: Principles and Practices with Particular Reference to Ethiopia. Larenstein University Professional Education, Deventer, the Netherlands. | | | | | | |

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| Course Title | **GIS and Remote Sensing Application in Water Recourse Engineering** | | | | | | |
| Course Number | WREE-6011 | | | | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | | | | |
| Module No. & Name | Mod 01, Computational Techniques and Modeling | | | | | | |
| Module Coordinator | To be decided | | | | | | |
| Lecturer | To be decided | | | | | | |
| CreditHours/ECTS | 3/5 | | | | | | |
| Prerequisite | Irrigation & Drainage Engineering Module (Mod. 3) | | | | | | |
| Contact hours (per week) | Lecture | | Tutorials& Seminar/ Lab.,Workshop Practice | | Home Study | | Total Contact Hours |
| 1 | 1 | 3 | | 7 | | 5 | |
| Course Objectives & Competences to be Acquired | * Understanding of aerial photography and interpretation. * Able to use satellite remote sensing to perform image analysis and classification for developing thematic maps. * Able to integrate satellite data with GIS to undertake recourse mapping and planning studies. | | | | | | |
| Course Description/ Course Content | Basic principles of remote sensing and sensors, Elements of photogrammetry, Electromagnetic spectrum, Energy interaction with surface features, Aerial photo and satellite imagery, Photo and image interpretation, Principles of Geographical Information System tools, their varieties and capabilities, Advantages of GIS over conventional methods, Importance of ground truth establishment, GIS and remote sensing for land and water resources data collection, analysis and interpretation, Application of GIS in water and land resource development and management. Digital Image Processing. Practice on ArcGIS add-ins such as SWAT, ArcHydro, … Use of GIS and remote sensing tools in watershed management. | | | | | | |
| Practical Work | Familiarization with remote sensing and GIS hardware and their principle of working, Methods of establishing ground truth, Comparison between truth and remotely sensed data, Application of GIS packages. Practical based on digital image processing. | | | | | | |
| Teaching & Learning Methods | Lectures, Laboratory, Projects, Home Study | | | | | | |
| Assessment/Evaluation & Grading System | Assignments 30%, Project 30%, Final Exam, 40% | | | | | | |
| Attendance Requirements | A student must attend at least 75% ofthe classes during lectures and 100% during practical if registered for the course. | | | | | | |
| Literature | 1. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation, Waveland Pr Inc. 2. Burrough, P.A. 1986. Principles of GIS for Land Resource Assessment. Oxford University Press. 3. Heywood I., Cornelius S. and Carver S. 2011. An Introduction to Geographic Information Systems. Prentice Hall. 4. Lillesand T., Kiefer R.W. and Chipman J. 2015. Remote Sensing and Image Interpretation. 7th Edition. John Wiley and Sons. 5. Chrisman Nicholas. 2001. Exploring Geographic Information Systems. 2nd. John Wiley and Sons. 6. Shultz, G.A. and Engman, E.T. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York. 7. Victor Raizer. 2017. Advances in Passive Microwave Remote Sensing of Oceans. CRC Press, Taylor & Francis Group. | | | | | | |

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| Course Title | **Numerical Methods and Computer Programming** | | | |
| Course Code | WREE-6061 | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module Number & name | 06, Elective Course | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course Objectives &  Competences to be  Acquired | * This course is aimed at teaching student on relevant numerical techniques useful in hydraulic computations. * This course will also introduce programming languages. * The student should be able to program numerical methods applicable to water resources problems. | | | |
| Outline syllabus/ course description | Computer Programming with Fortran or, C++, or Matlab: learning Programming logic, syntax, I/O and File processing, data structures; arrays, selection statements, looping, pointers (optional), subprograms and modules. Numerical techniques: linear systems (matrix, Gauss elimination, LU decomposition), Ordinary differential equations, Partial differential equations; numerical differentiation and integration, solution of non- linear equations (bracketing methods, open methods), finite difference methods, Direct search methods (Nealder Mead method, Rosenbrock method), Applications to water resources. | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Fortran 90/95 - S.T.Chapman 2. Computer Oriented Numerical Methods - V. Raja Raman 3. Introduction to numerical methods for water resources – W.L. Wood | | | |

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| **Course Title** | **Advanced Software Aplications in Irrigation Engineeering** |
| **Course Code** | IENG-6062 |
| **Program** | Irrigation Engineering, MSc Program |
| Module Number & name | 06, Elective Course |
| Module Coordinator | To be decided |
| Lecturer | To be decided |
| Credit Hours/ECTS | 2/4 |
| Prerequisite | None |

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| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |

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| Aims and Objectives | The aim of the course is to introduce students with software applications of irrigation engineering and water resources project design. At the end of the course students will able to use appropriate software for the designing and management purpose of water resources and related projects. |
| Outline Syllabus | * Land leveling software for irrigation area (command) preparation: Introducing the latest version of Surfer software * Field irrigation methods design software: SURDEV developed to solve problems in the design, operation, and evaluation of surface irrigation systems (Basin, border and furrow irrigation methods). * Soil and Crop water requirements and irrigation scheduling software: CROPWAT and SWAP * Water Conveyance structure design software * WinFlume: water flow measurement with Flumes and Weirs * FlowMaster: for design and analyzes pipes, ditches and open channels * CulvertMaster: for design and analyzes culvert hydraulics * Introduce water allocation and planning models: WEAPWater Evaluation and Planning System * Hydrological Modelling HEC-HMS * Model the hydraulic characteristic of rivers for various hydrological phenomenons using HEC – RAS. * Applications of CAD for design and layout of irrigation projects as drawing and map tool * Introducing ground water flow models - Visual ModFLOW-FEFLOW * Introduction to CADAM for design and analyze of concrete gravity dam |
| Teaching & Learning  Methods | Lectures, Computer lab. exercise |
| Assessment |  |
| References | 1. Lecture Note  2. Software’s manual if  3. Any reference material related to the topics |

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| Course Title | **Graduate Seminar in Irrigation Engineering** |
| Course Code | IENG-6052 |
| Degree Program | Irrigation Engineering, MSc Program |

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| Module Number & name | 05, Project and Research |
| Module Coordinator | To be decided |
| Lecturer | To be decided |

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| Credit Hours/ECTS | 1/2 | | | |
| Prerequisite | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 0 | 0 | 8 | 2 |
| Course Objectives &  Competences to be  Acquired | * Intended to acquaint the students to the methodology of preparation and presentation of scientific papers. | | | |
| Outline syllabus/ course description | Presentation of seminar by students on advanced topics in the area of irrigation engineering that is not covered in other courses, the selected topic must be related to his/her field specialization sought and should not be related to his/her thesis research. | | | |
| Assessment | * presentation * preparation | | | |

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| Course Title | **Water Resource Systems Planning and Analysis** |
| Course Code | EngH-6022 |
| Degree Program | Irrigation Engineering, MSc Program |

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| Module Number & name | 02, Hydrology & Water Resources Engineering |
| Module Coordinator | To be decided |
| Lecturer | To be decided |

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| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course Objectives &  Competences to be  Acquired | * Introduce the application of systems concept to water resources planning and management * Acquaint with optimization technique for modeling water resources systems and economic aspects of water resource projects | | | |
| Outline syllabus/ course description | Applications of systems analysis, simulation and optimization techniques in water resources planning and management.  Economic evaluation, and Water Resources project Planning,   * Introduction to water resources management: Need for planning, stages of planning, data requirements etc. * Principles of Integrated Water Resources Management (IWRM). * Tools of water resources system analysis: linear programming, non- linear programming and dynamic programming. * Optimal sizing of reservoirs: Deterministic approach using the critical low flow period and stochastic approach using Monte Carlo simulation. * Optimal operation of multipurpose reservoirs: Determination of the optimal reservoir operating rule, determination of optimal releases from reservoirs in series and parallel. * Determination of catchment yield as a function of storage using mass balance approach, water use coefficients, conjunctive use of surface water and ground water: determination of amount from both surface and ground water. * Methods of engineering economic analysis: the annual uniform method, present worth method, rate of return method, benefit cost ratio etc. | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. David C. Major and Roberto L. Leuton, (1979), Applied Water Resources Systems Planning, Prentice Hall, New Jersey. 2. Louchs D. P, Jerry, R. Water Resources Systems Planning and Analysis Prentice Hall N.J 3. Mohammad Karamouz, FerencSzidarovszky, BanafshehZahraie, (2003), Water Resource System Analysis, LEWIS PUBLISHERS 4. S.K. Jain, V.P. Singh, (2003),Water Resource systems planning and management, ELSEVIER. 5. Ronald C. Grifﬁn, Water Resource Economics: The Analysis of Scarcity, Policies, and Projects, (2006), The MIT Press, Cambridge, Massachusetts London, England. | | | |

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| Course Title | **Advanced Applied Hydrology** | | | |
| Course Code | EngH-6021 | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module Number & name | 02, Hydrology & Water Resources Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Prerequisite | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course Objectives &  Competences to be  Acquired | * Introduce the knowledge for analysis and management of surface water in rural and urban catchments. | | | |
| Outline syllabus/ course description | Hydrologic principles:-Hydrological cycle and water balance, evapotranspiration processes,Infiltration. Runoff and River Flow: - Stream flow, rainfall-runoff relationships, hydrograph analysis, unit hydrograph, and application of unit hydrograph, synthetic unit hydrograph development, hydrologic and hydraulic routing. Hydrologic design. Reservoir routing. Hydrologic simulation models and reservoir yield.  Groundwater hydrology:- an introduction, general flow equations, Darcy’s Law ,groundwater equation, analytical and numerical solutions, ground water modeling techniques | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Dingman, 2002, Physical Hydrology, Prentice-Hall, Inc. 2. Chow, V.T., D.R. Maidment, and L.W. Mays, 1988, Applied Hydrology, McGraw-Hill Book Company. 3. Linsley, RK; Franzini, JB; Freyberg, DL; Tchobanoglous, G., "Water Resources Engineering", 4th edition, McGraw-Hill, 1992.​ | | | |

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| Course Title | **Dam Engineering and Appartenant Structures** | | | |
| Course Code | **IENG-6041** | | | |
| Degree Program | Irrigation Engineering, MSc Program | | | |
| Module No & Name | Mod. 4: Dam Engineering and Diversion Structures | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 4/7 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 3 | 3 | 7 | 7 |
| Course objectives and  competences to be  acquired | To develop a basic understanding of the engineering behavior of Earth and concrete dams through an appreciation of the geotechnical,geological, structural, hydraulic /hydrological and Environmentalinputs to dam Planning and design in construction.  Furthermore, ithelps to comprehend problems of construction practice as well as tointroduce surveillance and awareness of safety issues.The student should develop the requiredcompetence to provide the dam safety inspections and suggest theremedial measures for assuring the dam safety.  This course provides an understanding of the design of hydraulicstructures associated to dam and other appurtenant structures. Thecandidate should be able to design the spillway, energy dissipationdevices, dam outlets, gates and sills, fish ladders, fish screens. Thecandidate should also be aware of design of cofferdams and tunnels. | | | |
| Outline Syllabus | * An overview of dam engineering * Types and selection of dams * Site selection and investigation for dams and reservoirs * Principles of concrete dam design and construction. * Design and analysis of Gravity, Arch and Buttress dams * Advanced methods of design * Roller compacted concrete dam. * Types of embankment ( rock fill and earth fill) dams Selection of type based on site investigation and assessment * Foundation and reservoir site treatment for embankmentdams * Principles of embankment dam design and construction * Hydraulic design for embankment dams (seepage, piping,filter,..) * Stability analysis * Dam safety, instrumentation, Surveillance and risk analysis * Spillways classification and choice for various types of dams * Design of spillways * Energy dissipation structures * Stilling basin and plunge pools * Dam outlets, gates and sills, fish ladders, fish screens * River diversion during construction (Cofferdams, Tunnels) | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | * Arora, K., (2002). Irrigation, Water power and WaterResources Engineering, 4th Edition, A.K. Jain, New Delhi. * Novak, P., et al. (2007). Hydraulic structures, 4th Edition, * Taylor and Francis, London. * USBR, (1973). Design of Small Dams, 2nd Edition, US gov’tPrinting Office, Washington D.C. * Creager, W.P., J.D., Justin, and J. Hinds, (1945). Engineeringfor Dams (VOL I,II and III). * Bhart Singh, R.S. Varshney (1995). Engineering forembankment dams, A.A.Balkema publishers, USA. * Vischer, D.L & W.H. Hager, (1997). Dam Hydraulics, JohnWiley & Sons, New York. | | | |

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| Course Title | **Practical Education (Field Visit)** |
| Course Number | **IENG-7054** |
| Program | Irrigation Engineering, MSc Program |
| Module | Mod. 5,Project and Research |
| Module Coordinator | To be decided |
| Lecturer | To be decided |
| Credit Points/ECTS | P/F |

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| Prerequisite: | All First Semester Courses |

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| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
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| Course Objectives &  Competences to be  Acquired | This course made students capable of conducting a well-organized field work or laboratory based scientific research focusing on their field of Specialization.  On completion of this course, the student will be able to:   * solve a practical Irrigation water management and drainage system problem using scientific knowledge, * use computer packages to write technical reports, create spreadsheets, * use IT skills and software for learning, sourcing and presentation of material, * demonstrate ability to plan and complete a project on time, * explore and verify through experimentation, problem solutions in the area of water management, * present experimental procedures, results, observations and conclusions in a clear and concise manner * determine experimentally the characteristics and parameters of a given research problem in the area of agricultural water management, * present experimental procedures, results, observations and conclusions in a clear and concise manner | | | |
| Course Description/Course  Contents | An individual and non-strictly supervised research based project, where consultative help is offered by the *project advisor****.*** The project is assigned based on individuals interest and can be connected to any of the major subjects already taught. The subject of the assignment preferably considers the needs of the country. | | | |
| Pre-requisites | All First Semester Courses | | | |
| Teaching & Learning  Methods | Fieldwork/ Project Work | | | |
| Assessment/Evaluation  & Grading System | Assessment of the project work will be based on the following criteria.  Assessment by advisor 40%  Quality and originality of work as  assessed by others during final 30%  presentation  Question-Answers/Defense of your  work during final presentation, and 10%  Presentation quality  Project report 10% | | | |
| Attendance Requirements | Class attendance is 100 % since the course is Fieldwork or laboratory works. | | | |
| Literature | * Gomez K.A. and Gomez A.A. 1984. Statistical Procedures for Agricultural Research. II edition. John Wiley & Sons. * Bender E.F, Douglass L.W., Kramer, A. 1982. Statistical Methods for Food & Agriculture. Avi publishers. * Petersen, R. G. 1994. Agricultural Field Experiments: Design & Analysis, Marcel Decker. * Lipson, C. &Sheth N. J. 1973. Statistical Design & Analysis of Engineering Experiments. McGraw-Hill Book Company. | | | |

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| **Course Title** | **MSc Thesis** |
| Course Code | IEng-7054 |
| Degree Program | Irrigation Engineering, MSc Program |
| Module No & Name | 05, Project and Research |
| Module Coordinator | To be decided |
| Lecturer | To be decided |
| Credit Hours/ECTS | 6/30 |
| Prerequisite: | All Courses |

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| --- | --- | --- | --- | --- |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
|  |  | 90 | 30 |

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| --- | --- |
| Course objectives and  competences to be  acquired | The objective of the final MSc thesis is to develop students capacity and ability to undertake and disseminate original information obtained through literature searches, discussions with academic staff and professional engineers, and other related professionals to obtain a deeper understanding of a subject than made possible by following a taught Program of study. Furthermore it helps to develop knowledge of an appropriate standard to make a contribution to the field. |
| Outline Syllabus | * Specific content to be agreed between student, supervisor and IGC * Thesis preparation |
| Assessment | * Thesis evaluation should be made by External and Internal examiners, and Chairman |
| References | Haramaya University Thesis or Dissertation Guideline |

**Program Name: Soil and Water ConservationEngineering**

1. **Course Breakdown by Semester**

**Year I Semester I**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| WREE-6011 | GIS and Remote Sensing Application in WR Engineering | 3 | 1 | 3 | 7 | 5 |  |
| EngH-6021 | Advanced Applied Hydrology | 3 | 2 | 3 | 7 | 6 |  |
| IEng-6031 | Soil – Plant – Water – Atmosphere Relations | 2 | 1 | 3 | 5 | 4 |  |
| SWCE-6041 | Advanced Soil and Water Conservation Engineering | 3 | 2 | 3 | 7 | 6 |  |
| WREE-6051 | Research Methods | 2 | 1 | 3 | 5 | 4 |  |
| SWCE-6071 | Waste Land Development & Management | 2 | 1 | 3 | 5 | 4 |  |
| WREE-6061 | Numerical Methods and Computer Programming (E) | 2 | 1 | 3 | 5 | 4 |  |
| SWCE-6062 | Socio Economic aspect of Soil and Water Conservation (E) | 2 | 1 | 3 | 5 | 4 |  |
| **Semester Total** | | **17** | **10** | **24** | **46** | **37** |  |

**Year I Semester II**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| SWCE-6012 | Erosion Assessment and Experimentation | 2 | 1 | 3 | 5 | 4 |  |
| SWCE-6013 | Hydrological Modeling | 3 | 2 | 3 | 7 | 6 |  |
| IEng-6032 | Advanced Drainage Engineering | 3 | 2 | 3 | 7 | 6 |  |
| SWCE-6042 | Design of Small Dams and Hydraulic Structures | 3 | 2 | 3 | 7 | 6 |  |
| SWCE-6052 | Graduate Seminar in Soil and Water Conservation Engineering | 1 | 0 | 0 | 8 | 2 |  |
| SWCE-6053 | Field Work/lab based project work | P/F |  |  |  |  |  |
| SWCE-6072 | Watershed Development & Management | 3 | 2 | 3 | 7 | 6 |  |
| SWCE-6063 | Forest Watershed Management (E) | 2 | 1 | 3 | 5 | 4 |  |
| SWCE-6064 | Watershed Planning and Management(E) | 2 | 1 | 3 | 5 | 4 |  |
| **Semester Total** | | **17** | **10** | **18** | **46** | **34** |  |

**Year II Semester III & IV**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Cr.Hr** | **L** | **L/P** | **HS** | **CP** | **Prerequisite** |
| SWCE-7054 | MSc Thesis Research | 6 |  |  | 90 | 30 | ALL Courses |
| **Semester Total** | | **6** |  |  | **90** | **30** |  |

1. **Course Description**
2. **Detail Course Description**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Course Title | **GIS and Remote Sensing Application in Water Recourse Engineering** | | | |
| Course Number | WREE-6011 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No. & Name | 01, Computational Techniques and Modeling | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| CreditHours & ECTS | 3 | | | |
| Pre-requisites | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 7 | 5 |
| Course Objectives & Competences to be Acquired | * Understanding of aerial photography and interpretation. * Able to use satellite remote sensing to perform image analysis and classification for developing thematic maps. * Able to integrate satellite data with GIS to undertake recourse mapping and planning studies. | | | |
| Course Description/ Course Content | Basic principles of remote sensing and sensors, Elements of photogrammetry, Electromagnetic spectrum, Energy interaction with surface features, Aerial photo and satellite imagery, Photo and image interpretation, Principles of Geographical Information System tools, their varieties and capabilities, Advantages of GIS over conventional methods, Importance of ground truth establishment, GIS and remote sensing for land and water resources data collection, analysis and interpretation, Application of GIS in water and land resource development and management. Digital Image Processing. Practice on ArcGIS add-ins such as SWAT, ArcHydro, Use of GIS and remote sensing tools in watershed management. | | | |
| Practical Work | Familiarization with remote sensing and GIS hardware and their principle of working, Methods of establishing ground truth, Comparison between truth and remotely sensed data, Application of GIS packages. Practical based on digital image processing. | | | |
| Teaching & Learning Methods | Lectures, Laboratory, Projects, Home Study | | | |
| Assessment/Evaluation & Grading System | Assignments 30%, Project 30%, Final Exam, 40% | | | |
| Attendance Requirements | A student must attend at least 75% ofthe classes during lectures and 100% during practical if registered for the course. | | | |
| Literature | 1. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation, Waveland Pr Inc. 2. Burrough, P.A. 1986. Principles of GIS for Land Resource Assessment. Oxford University Press. 3. Heywood I., Cornelius S. and Carver S. 2011. An Introduction to Geographic Information Systems. Prentice Hall. 4. Lillesand T., Kiefer R.W. and Chipman J. 2015. Remote Sensing and Image Interpretation. 7th Edition. John Wiley and Sons. 5. Chrisman Nicholas. 2001. Exploring Geographic Information Systems. 2nd. John Wiley and Sons. 6. Shultz, G.A. and Engman, E.T. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York. 7. Victor Raizer. 2017. Advances in Passive Microwave Remote Sensing of Oceans. CRC Press, Taylor & Francis Group. | | | |

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| Course Title | **Advanced Applied Hydrology** | | | |
| Course Code | EngH-6021 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module Number & name | 02, Hydrology and Water Resources Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/5 | | | |
| Prerequisite |  | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course Objectives &  Competences to be  Acquired | * Introduce the knowledge for analysis and management of surface water in rural and urban catchments. | | | |
| Outline syllabus/ course description | Hydrologic principles:-Hydrological cycle and water balance, evapotranspiration processes,Infiltration. Runoff and River Flow: - Stream flow, rainfall-runoff relationships, hydrograph analysis, unit hydrograph, and application of unit hydrograph, synthetic unit hydrograph development, hydrologic and hydraulic routing. Hydrologic design. Reservoir routing. Hydrologic simulation models and reservoir yield.  Groundwater hydrology:- an introduction, general flow equations, Darcy’s Law ,groundwater equation, analytical and numerical solutions, ground water modeling techniques | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Dingman, 2002, Physical Hydrology, Prentice-Hall, Inc. 2. Chow, V.T., D.R. Maidment, and L.W. Mays, 1988, Applied Hydrology, McGraw-Hill Book Company. 3. Linsley, RK; Franzini, JB; Freyberg, DL; Tchobanoglous, G., "Water Resources Engineering", 4th edition, McGraw-Hill, 1992.​ | | | |

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| **Course Title** | **Soil-Water-Plant-Atmosphere Relationship** | | | |
| Course Code | IENG-6031 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No & Name | 03, Soil Physics & Drainage | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | After completion of this course, the student shall learn:   1. How water moves through porous media and plant system. 2. The detail about the soil and water system that is needed to plant growth. 3. Soil-water constants and their significance. 4. Concept and measurement of soil water potential. 5. Water exchange in plant cells and tissues as well as metabolic and other characteristics for efficient water use. 6. Better understanding about the transpiration and evapotranspiration that indicates the keen relationships between soil water-plant and atmosphere. 7. Response of salinity on internal water deficit and response of plant to water deficit. | | | |
| Outline Syllabus | Soil water retention, infiltration and water uptake, measurement of soil water content, concept and measurement of soil water potential, matric potential and solute potential, water exchange in plant cells and tissues, water movement of transpiration and evapotranspiration, energy and water balance, Factor affecting plant water states, metabolic and other characterstis for eficient water use, Availability of soil water for plant growth, Response of plant to water deficit, Effect of salinity on internal water defecit and plant growth. | | | |
| Assessment | * 40% term paper (group work) and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Irrigation Engineering Principles. Soil-Water-Plant Relationships. Module 3- Version 2 CE IIT, Kharagpur, India 2. Israelsen, O.W. and Hansen, V. E. (3rd Edition). 1990. Irrigation Principles and Practices. John Wiley and Sons, Inc. New York, USA. 3. Kirkham, M. B.(2nd Edition) 2014. Principles of Soil and Plant Water Relationships. Academic Press, Oxford, U. K. 4. Mark Behan. 1992. Lessons in Soil-Plant-Water Relationships, Pakistan Forest Institute, Peshawar, Pakistan. 5. Michael, A. M. 1990. Irrigation Theory and Practices. Vani Educational Books, Vikas Publishing House Pvt. Ltd. New Delhi, India. 6. Murthy, V. V. N. 1998.Land and Water Management Engineering, Kalyani Publishers, India. 7. Soil Conservation Service (SCS) Engineering Division. 1964. Irrigation Soil-Plant-Water Relationships. Soil Conservation Service, Washington DC, USA. | | | |

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| **Course Title** | **Advanced Soil and Water Conservation Engineering** | | | |
| Course Code | SWCE-6041 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No & Name | 04, Soil and Water Conservation Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 3/6 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course objectives and  competences to be  acquired | This course is designed to give students advanced understanding of Soil and Water Conservation Engineering. Thus students shall learn:   * the concepts of mechanics and processes of soil erosion by water and wind. * To identify the need, design, layout, construction, and maintenance of biological and engineering soil and water conservation measures. * To design and operate of temporary and permanent gully control structures including check dams and various spillways for gully control. | | | |
| Outline Syllabus | Overview of soil erosion mechanics/ effects and soil erosion problem in Ethiopia. Soil erosion by water and wind: Processes, forms/type, factors affecting (Energy, resistive, and protective), and principle of control measures and control methods; Design, planning and layout of soil and water conservation measures: Biological measures - contour farming, strip cropping, tillage practices, mulching, and soil management practices. Physical /structural measures - design and construction of contour bunds, graded bunds and different type of terraces, computation of earth works, economic analysis of different bunds and terraces; design, construction and maintenance of excess runoff disposal structures such as diversion ditch and grassed waterway; Design and operation of temporary and permanent gully erosion control structures such as check dams and energy dissipation structures (chute spillway, drop spillway and drop inlet spillway) at different flow conditions; Measures for wind erosion control: vegetative measures, wind breaks and shelter belts, tillage practices and structural measures. Mechanized construction techniques for soil and water conservation structures. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. FAO57,1987.SoilandWaterConservationinSemi- arid Areas. Roma Italia 2. Garg, S.K. 1987. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, New Delhi 3. Hudson, N. 1981. Soil Conservation. BastfordAcademicand EducationalLtd.London 4. Humberto Blanco and Rattan Lal. 2008. Principles of Soil Conservation and Management. Springer publisher, The Ohio State University, Columbus, OH, USA 5. Kirkby, M.J. and Morgan, P.P.C. (Eds). 1980. Soil Erosion. John Wiley and Sons. New York, USA 6. Morgan, R. P. C. 2005. Soil Erosion and Conservation, 3rd ed., Blackwell Publisher, Maldea, USA 7. Schwab, G.O., Frangmier DD, Elliot M.J., and Frevert R.K., 1995, Soil and Water Conservation and Engineering, Fourth edition, John Villey& Sons Inc. 8. Suresh, R. 2002. Soil and Water Conservation Engineering, Fourth Edition Standard Publishers and Distributors, Delhi. 9. Tripathi, R. P. and Singh, H. P. Soil Erosion and Conservation. New Age International (P) Limited Publisher, New Delhi, India. | | | |

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| Course Title | **Research Methods** | | | |
| Course Number | WREE-6051 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No. & Name | 05, Project and Research | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Pre-requisites | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course Objectives & Competences to be Acquired | * To gain an increased understanding of the application of scientific methods to the field. * To provide knowledge on application of statistical design and Analysis. * To enlighten the students about the research ethics. * Further the student shall be able to prepare a well-structured scientific proposal and apply experimental design methods for his/her M.Sc. | | | |
| Course Description/ Course Content | Introduction to research and experiments; procedure of research (the scientific method); research planning; steps in experimentation; research proposal writing; review of the relevant statistical concepts; design and analysis of experiments - principle of experimental design, design and analysis of comparative experiments (Completely Randomized Design, Randomized Complete Block Design and Latin Square Design), Factorial, Split Plot Design; Research proposal and report writing. | | | |
| Practical Work |  | | | |
| Teaching & Learning Methods | Lectures, Projects, Home study | | | |
| Assessment/Evaluation & Grading System | Assignments 20%, Project 30%, Final Exam, 50% | | | |
| Attendance Requirements | A student must attend at least 80% ofthe classes during lectures. | | | |
| Literature | 1. Gomez K.A. and Gomez A.A. 1984. Statistical Procedures for Agricultural Research. 2nd Edition. John Wiley & Sons. New York. 2. Montgomery, D.C., 2012. Design and Analysis of Experiments. 8th Edition. Arizona State University. John Wiley & Sons. 3. Bajpai, A.C., Claus, I.M. and Fairly, J.A., 1978. Statistical Methods for Engineers and Scientists. John Wiley & Sons. 4. Bethea R.M. 1995. Statistical Methods for Engineers and Scientists. 3rd Edition. CRC Press, Taylor & Francis Group. 5. DestaHamito, 2001. Research Methods in Forestry: Principles and Practices with Particular Reference to Ethiopia. Larenstein University Professional Education, Deventer, the Netherlands. | | | |

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| **Course Title** | **Waste land Development Management** | | | |
| Course Code | SWCE-6071 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No & Name | 07, Watershed and Natural Resource Management | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 2 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | After completion of this course, student shall learn:   * Land Evaluation and land suitability classifications according to FAO and USBR framework. * Land degradation due to erosion in arid and semi-arid regions and their management by conservation practices. * Causes, reclamation and management of water logged soils. * Rehabilitation and management of ravine lands. * Design and management of irrigation and drainage systems in waste land. * Socio-economic evaluation of waste land development projects. | | | |
| Outline Syllabus | Land suitability; Classification according to USBR; Land suitability categories according to FAO frame work; Land evaluation, Mapping of degraded soil survey; Land degradation management by conservation practices; causes, reclamation and management of water logged and salt affected soils; Rehabilitation and management of ravine land; Selection, design and management of irrigation and drainage systems in watershed. Economic evaluation of waste land development projects. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. Blaikie, P. and Brookfield, H. C. 1987. Land Degradation and Society. Methuen, UK. 2. Clark, R. 1996. Methodologies for the Economic Analysis of Soil Erosion and Conservation. CSERGE Working Paper, Norwich, UK. 3. Dent, D. and Young, A. T. 1981. Soil Survey and Land Evaluation. George Allen and Unwin, London, UK. 4. FAO.1973. Frame Work for Land Evaluation. Draft Edition. AGL/MISC/73/14. FAO, Rome. 5. FAO. 1974. Approaches to Land Classification. Soils Bulletin 22. FAO, Rome. 6. Hudson, N. W. 1987. Soil and Water Conservation in Semi-arid Areas. FAO Soils Bulletin No. 57. 7. Lal, R., Blum W. H., Valentine, C. and Stewart, B. A. (eds). 1997. Methods for Assessment of Soil Degradation, CRC Press, Boca Raton, USA. 8. Proceedings of the Development Centre on Watershed Management for Asia and the Far East. The Challenges of Our Watersheds. Soil Conservation Society of India, Hazaribagh, India. 9. Singh G.D. and Poonia, T.C. 2003. Fundamentals of Watershed Management Technology, Yash Publishing House, India. 10. Singh, G. Venkataramanan, Shastry, G. and Joshi, B. P. 1991. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. 11. Tideman, E. M. 1996. Watershed Management. Omega Scientific Publishers, New Delhi, India. | | | |

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| Course Title | **Numerical Methods and Computer Programming** | | | |
| Course Code | WREE-6061 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module Number & name | 06, Elective Courses | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course Objectives &  Competences to be  Acquired | * This course is aimed at teaching student on relevant numerical techniques useful in hydraulic computations. * This course will also introduce programming languages. * The student should be able to program numerical methods applicable to water resources problems. | | | |
| Outline syllabus/ course description | Computer Programming with Fortran or, C++, or Matlab: learning Programming logic, syntax, I/O and File processing, data structures; arrays, selection statements, looping, pointers (optional), subprograms and modules. Numerical techniques: linear systems (matrix, Gauss elimination, LU decomposition), Ordinary differential equations, Partial differential equations; numerical differentiation and integration, solution of non- linear equations (bracketing methods, open methods), finite difference methods, Direct search methods (Nealder Mead method, Rosenbrock method), Applications to water resources. | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Fortran 90/95 - S.T.Chapman 2. Computer Oriented Numerical Methods - V. Raja Raman 3. Introduction to numerical methods for water resources – W.L. Wood | | | |

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| **Course Title** | **Socio-Economic Aspects of Soil and WaterConservation** | | | |
| Course Code | SWCE-6062 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No & Name | 06, Elective Course | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 2 | | | |
| Prerequisite: | Applied Hydrology and Soil and Water Conservation Engineering | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | The objective of this course is to make students acquainted with:   * the socio-economic aspects of SWC measures and programs; * interrelationship between poverty, forest/pasture degradation and soil erosion * the impact of the socio-economic situation of the farmers / herders on the feasibility / acceptability of soil conservation measures on agricultural land * The assessment of on-site and downstream impacts of soil and water conservation activities | | | |
| Outline Syllabus | Review of soil and water conservation activities in Ethiopia; analysis of project successes and failures. Economics of soil and water conservation (basin scale and farmer’s scale). Soil conservation as an investment. Economic costs / labor input of soil conservation measures on farmers’ fields. Cost benefits analysis of SWC measures; multi-criteria analysis. Analyzing the economic impacts of the proposed technical interventions on small farms; Social and economic situation of farmers in erosion prone areas. Feasibility / acceptability of soil conservation measures on agricultural land in correlation to socio-economic situation of the farmers / herders. Farmers’ perception of soil degradation.  Use of indigenous knowledge The role of the extension service. Peoples' participation on SWC programs. Incentives in soil and water conservation. Farmers decision behaviors under subsistence agriculture. Evaluation techniques for conservation projects: Onsite and offsite impacts of conservation on water and soil fertility. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. Graff, J. de, 1996. The price of soil erosion; an economic evaluation of soil conservation and watershed development. Doctoral thesis,Wageningen University. 2. Walker, D. J., & Young, D. L., 1986. The effect of technical progress on erosion damage and economic incentives for soil conservation.Land Economics 62(1), 83-93. 3. Anderson, J. R. and Thampapillai, J., 1990. Soil Conservation in Developing Countries: Project and Policy Intervention. Agriculture and Rural Development Department, The 64 World Bank, Washington, D.C. 4. Bishop, J., & Allen, J., 1989. The on-site costs of soil erosion in Mali. The World Bank, Environment Working Paper No. 21. | | | |

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| **Course Title** | **Erosion Assessment and Experimentation** | | | |
| Course Code | SWCE-6012 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No & Name | 01-Computational Techniques and Modeling | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 2/4 | | | |
| Prerequisite: | Applied Hydrology and Soil and Water Conservation Engineering | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | * To apply the different erosion assessment methods and models * To understand the requirements and tests for model development and to apply | | | |
| Outline Syllabus | The purpose of erosion research, the need of research, objectives and experimental methods of soil erosion research: review of basic statistical concepts in experimentation ; reconnaissance studies on erosion; prepare, plan and conduct erosion research on small plots, large plots and on watershed basis in the field under natural rains and conduct experiments in laboratory and field erosion plots using rainfall simulators; types of rainfall simulators; modeling soil erosion processes; determination of sediment yield; stream flow and sediment transport; fluvial monitoring, reservoir survey, and select appropriate model type and their applications; model development; conceptual, physical process based and empirical models for quantifying sedimentation; strategy for data analysis, calibration, validation and evaluation; Use of Universal Soil Loss Equation (USLE) and similar models in erosion assessment and conservation design; wind erosion models; Application of erosion prediction models in Ethiopia. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. FAO, 1993**.** Field measurement of soil erosion and runoff. Soil Bulletin, no 68. Roma Italia 2. Garde, R. J. and RangaRaju, K. G. (1995). Mechanics of Sediment Transportation and Alluvial Stream Problems. 2nd Ed. Willey Eastern Ltd. New Delhi. 3. Hudson, N. 1981. Soil Conservation. Bastford Academicand EducationalLtd.London 4. Humberto Blanco and Rattan Lal. 2008. Principles of Soil Conservation and Management. Springer publisher, The Ohio State University, Columbus, OH, USA 5. Kirkby, M.J. and Morgan, P.P.C. (Eds). 1980. Soil Erosion. John Wiley and Sons. New York, USA 6. Lal, R. 1994. Soil Erosion Research Methods. Soil and Water Conservation Society, Ankeny, IA 7. Mason, R. L., Gunst, R. F., and Hess, J. 2003. Statistical Design and Analysis of Experiments: with Applications to Engineering and Science. 2nd ed. Wiley Intersciences, Hoboken, NJ. 8. Montgomery, D. C., 2001. Design and Analysis of Experiments. 5thedt. Arizona State University. John Wiley & Sons. 9. Morgan, R. P. C. 2005. Soil Erosion and Conservation, 3rd ed., Blackwell Publisher, Maldea, USA 10. Schwab, G.O., Frangmier DD, Elliot M.J., and Frevert R.K., 1995, Soil and Water Conservation and Engineering, Fourth edition, John Villey& Sons Inc. 11. Suresh, R. 2002. Soil and Water Conservation Engineering, Fourth Edition Standard Publishers and Distributors, Delhi. 12. Tripathi, R. P. and Singh, H. P. Soil Erosion and Conservation. New Age International (P) Limited Publisher, New Delhi, India. | | | |

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| Course Title | **Hydrological Modeling** | | | |
| Course Code | SWCE-6013 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module Number & name | 01-Computational Techniques and Modelling | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/5 | | | |
| Prerequisite | Advanced Applied Hydrology | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course Objectives &  Competences to be  Acquired | * Introduce the classification and evaluation of hydrological models * Familiarize on process and prepare data files for different models * To help on using well-known models in water resources assessment, in impact estimation of climate change and land-use change, * To interpret, analyze and understand the model outputs | | | |
| Outline syllabus/ course description | Mathematical models and simulation of hydrologic problems; introduction, fundamentals of hydrologic modeling; probabilities and statistical analysis, introduction to optimization of hydrological problems; classification of optimization methods, analytical optimization, reliability tests of prediction models; univariate estimation; methods of estimation of model parameters, data transformation; statistical optimization, numerical optimization, subjective optimization, provide useful skills using well-known hydrological models in simulating hydrological processes, calibration and evaluation of hydrologic models. | | | |
| Assessment | * 40% term paper, group work and presentation * 10% assignment (individual work) * 50% final examination | | | |
| References | 1. Keith J Beven, (2001), Rainfall –Runoff Modeling-The Primer, J. WILEY & SONS 2. Thorsten Wagener, Howard S. Wheater, Hoshin V. Gupta, (2004). Rainfall-Runoff Modelling in Gauged and Ungauged Catchments, Imperial College Press 3. Richard H. McCuen, (2003) Modelling Hydrologic Change -Statistical Methods, A CRC Press Company | | | |

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| Course Title | **Advance Drainage Engineering** | | | |
| Course Number | IENG-6032 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No. & Name | 03, Soil Physics and Drainage | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Pre-requisites | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course Objectives & Competences to be Acquired | * Able to derive equation for different flow and understand their approaches in drainage channels. * To develop the common understanding of physics of land drainage, forces and energy form in soil water and their effect on surface tension of soil and its criteria. | | | |
| Course Description/ Course Content | Drainage in agriculture: Needs, Design considerations of agricultural drainage, Drainage-related problems in Ethiopia. Saturated and Unsaturated Flow: Unsaturated hydraulic conductivity, Steady and unsteady flow, Steady flow towards well. Field drains and field laterals: Surface drainage systems for sloping areas, Cross slope drainage system, Water disposal in sloppy areas. Types of sub-surface drainage system: Design of drainage canals and related structures, Installation of pipe drains, Hydraulics of drainage pipes. Composition of pipe sections of differing diameter, Hydraulic gradient and slope. Reuse of Drainage water. Concepts of vertical and bio-drainage. Drainage for salinity control: Measurement of salinity, Salinity in relation to irrigation and drainage, salinization and management options, Salinaization due to inadequate leaching and capillary rise. Drainage of heavy clay soil. Application of simulation models for drainage systems. | | | |
| Practical Work | Measurement of in-situ hydraulic conductivity, estimation of drainage coefficient and leaching requirements, Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems, design of filter and envelop materials. | | | |
| Teaching & Learning Methods | Lectures, Laboratory, Projects, Home study | | | |
| Assessment/Evaluation & Grading System | Assignments 30%, Project 30%, Final Exam, 40% | | | |
| Attendance Requirements | A student must attend at least 75% ofthe classes during lectures and 100% during practical if registered for the course. | | | |
| Literature | 1. Bhattacharya A.K. and Michael A.M. 2009. Land Drainage: Principles, Methods and Applications. Vikas Publication House Pvt Ltd. 2. Ritzema H.P. 1994. Drainage Principles and Applications. 2nd Edition. ILRI Publication 16. Wageningen, The Netherlands. 3. Kirkham D. and Powers, W.L. 1972. Advanced Soil Physics. John Wiley and Sons. 4. Schilfgaarde J.V. 1974. Drainage for Agriculture. Monograph No. 17. American Society of Agronomy, Madison, Wisconsin, USA. 5. De Zeeuw J.W. 1973. Theories of Field Drainage and Watershed Runoff. Vol 2. Publication No. 16, International Institute of Land Reclamation and Improvement. Wageningen, The Netherlands. 6. Singh R.V. 1991. Drainage and Salinity Control. Himanshu Publication, Udaipur. 7. Roe H.B. and Ayers Q.C. 1954. Engineering for Agricultural Drainage. McGraw Hill. | | | |

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| **Course Title** | **Design of Small Dams and HydraulicStructures** | | | |
| Course Code | SWCE-6042 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No & Name | Mod. 4: Soil and Water Conservation Engineering | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 3/6 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course objectives and  competences to be  acquired | * This course will make students know the various kinds of barriers that can be built across streams and their appropriate site selections for the purpose of impoundment of water by which regulated use of water can be achieved effectively. * The students shall learn and understand the fundamental theories of design and analysis of small dams such as embankment and concrete dams. * The students shall learn and understand the fundamental theories of design and analysis of hydraulic structures such as spillways, inlet/outlet structures, and intake structures. * The students shall learn and understand the fundamental theories of stream diversion works as well as reservoir engineering. * Students at the end of the semester shall be equipped with the fundamental knowledge of design of small dams & reservoirs. | | | |
| Outline Syllabus | Selection of type of dam; foundation and construction materials; soil and rock classification; surface and sub-surface exploration methods; field and laboratory tests; design principles of earth fill dams and concrete dams; Introduction to rock fill , arch and buttress dams; spillways: hydraulic design of different types of spillways; outlet works; inlet structures; stream diversion works; reservoir engineering: reservoir versus dams; classification and capacity of reservoirs; sediment yield of reservoirs; reservoir losses. | | | |
| Assessment | * 30 Project group work) and presentation * 20 assignment (individual work) * 50% final examination | | | |
| References | **Reference Books:**   1. K.Garg, Irrigation Engineering and Hydraulic structures, 29th edition Khanna publishers, 2014 2. Dr. B.C Punmia, Irrigation and water power engineering, 16th edition , Laxmi Publications , 2009 3. Dr P.N Modi Irrigation water resource and water power engineering, 8th edition standard Book House, New Delhi, 2012 4. Dr. K.R. Arora, Irrigation and water power and water resource engineering, 1st edition, New age international, 2009 5. SatyaNarayanaMurtyChalla, Water Resources Engineering principle and practice, New age International Publisher, reprint 2009. 6. Bureau of reclamation, Design of small dams, 3 edition, a water resources technical publication, reprint 2012 | | | |

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| Course Title | **Graduate Seminar in Soil and Water Conservation Engineering** | | | |
| Course Code | SWCE-6052 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No & Name | 05-Project and Research | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 1/2 | | | |
| Prerequisite | Second Year Semester I | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 0 | 0 | 8 | 2 |
| Course Objectives &  Competences to be  Acquired | * Intended to acquaint the students to the methodology of preparation and presentation of scientific papers. | | | |
| Outline syllabus/ course description | Presentation of seminar by students on advanced topics in the area of SWC engineering that is not covered in other courses, the selected topic must be related to his/her field specialization sought and should not be related to his/her thesis research. | | | |
| Assessment | * presentation * preparation | | | |

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| Course Title | **Field Work/Lab Based Project Work** | | | |
| Course Number | SWCE-6053 | | | |
| Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module | Mod. 4: Project and Research | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Points/ECTS | P/F | | | |
| Pre-requisites | All First Semester Courses | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
|  |  |  |  |
| Course Objectives &  Competences to be  Acquired | This course made students capable of conducting a well-organized field work or laboratory based scientific research focusing on their field of Specialization.  On completion of this course, the student will be able to:   * solve a practical soil and water management problem using scientific knowledge, * use computer packages to write technical reports, create spreadsheets, * use IT skills and software for learning, sourcing and presentation of material, * demonstrate ability to plan and complete a project on time, * explore and verify through experimentation, problem solutions in the area of water management, * present experimental procedures, results, observations and conclusions in a clear and concise manner * determine experimentally the characteristics and parameters of a given research problem in the area of agricultural water management, * present experimental procedures, results, observations and conclusions in a clear and concise manner | | | |
| Course Description/Course  Contents | An individual and non-strictly supervised research based project, where consultative help is offered by the **project advisor.** The project is assigned based on individuals interest and can be connected to any of the major subjects already taught. The subject of the assignment preferably considers the needs of the country. | | | |
| Teaching & Learning  Methods | Fieldwork/ Project Work | | | |
| Assessment/Evaluation  & Grading System | Assessment of the project work will be based on the following criteria.  Assessment by advisor 40%  Quality and originality of work as  assessed by others during final 30%  presentation  Question-Answers/Defense of your  work during final presentation, and 10%  Presentation quality  Project report 10% | | | |
| Attendance Requirements | Class attendance is 100 % since the course is Fieldwork or laboratory works. | | | |
| Literature | * Gomez K.A. and Gomez A.A. 1984. Statistical Procedures for Agricultural Research. II edition. John Wiley & Sons. * Bender E.F, Douglass L.W., Kramer, A. 1982. Statistical Methods for Food & Agriculture. Avi publishers. * Petersen, R. G. 1994. Agricultural Field Experiments: Design & Analysis, Marcel Decker. * Lipson, C. &Sheth N. J. 1973. Statistical Design & Analysis of Engineering Experiments. McGraw-Hill Book Company. | | | |

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| **Course Title** | **Watershed Development and Management** | | | |
| Course Code | SWCE-6072 | | | |
| Degree Program | Soil and Water Conservation Engineering, MSc Program | | | |
| Module No & Name | 07-Watershed and Natural Resource Management | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 3 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 2 | 3 | 7 | 6 |
| Course objectives and  competences to be  acquired | After completion of this course, the student shall learn about the:   * Basic concept, principles and objectives of watershed management. * Concept of hydrologic cycle and estimation of amount and peak design runoff rate. * Land use capability classification and topographical characteristics of watershed. * Application of appropriate soil and water conservation measures for agricultural and non-agricultural lands. * Learn about grassland development and management. * Techniques for dry land farming and rainwater harvesting. * Planning, management and socio-economic evaluation of watershed development projects. | | | |
| Outline Syllabus | Concept of watershed development and management; collection of hydrological data; watershed characteristics and hydrologic cycle; problems of land degradation; land rise capability; classification and topographical characteristics of watershed; Appropriate soil and water conservation measures for agriculture and non-agricultural lands; Grass land development and management; Techniques for dry land farming based on watershed characteristics; Water harvesting techniques for hilly and arid regions; Hydrological and sediment monitoring of watershed. Estimation of peak design runoff rate; Planning management and economic evaluation of watershed development projects; case studies. Economic and financial analysis of soil and water conservation projects; Project Evaluation. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. Blaikie, P. and Brookfield, H. C. 1987. Land Degradation and Society. Methuen, UK. 2. Clark, R. 1996. Methodologies for the Economic Analysis of Soil Erosion and Conservation. CSERGE Working Paper, Norwich, UK. 3. DhruvNarayana, V. V., Shastry, G. and Patnaik, U. S. 1990. Watershed Management. Indian Council of Agricultural Research, New Delhi, India. 4. Hudson, N. W. 1987. Soil and Water Conservation in Semi-arid Areas. FAO Soils Bulletin No. 57. 5. Murty, V. V. N. 1998. Land and Water Management Engineering, Kalyani Publishers, India. 6. Lal, R., Blum W. H., Valentine, C. and Stewart, B. A. (eds). 1997. Methods for Assessment of Soil Degradation, CRC Press, Boca Raton, USA. 7. Proceedings of the Development Centre on Watershed Management for Asia and the Far East. The Challenges of Our Watersheds. Soil Conservation Society of India, Hazaribagh, India. 8. Singh G.D. and Poonia, T.C. 2003. Fundamentals of Watershed Management Technology, Yash Publishing House, India. 9. Singh, G. Venkataramanan, Shastry, G. and Joshi, B. P. 1991. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. 10. Suresh, R. 1997. Soil and Water Conservation Engineering. Standard Publishers Distributors, Delhi, India. 11. Tideman, E. M. 1996. Watershed Management. Omega Scientific Publishers, New Delhi, India. | | | |

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| **Course Title** | **Forest watershed Management** | | | |
| Course Code | SWCE-6063 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No & Name | 06, Elective | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours | 2/4 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | After completion of this course, student shall learn:   1. Hydrological behavior and characteristics of forest watershed. 2. Impact assessment of stream flow due to change in land use land cover in a forest watershed. 3. Runoff estimation and peak flow estimation in a forest watershed. 4. Erosion assessment and soil conservation measures for a forest watershed along with design of soil and water conservation structures in a forest watershed. 5. Simulation of hydrological processes in forest watershed. | | | |
| Outline Syllabus | Concepts; Characteristics and hydrology of forest watershed; Investigation of streams; Impact of land use changes; Deforestation; Road building and other forest uses on forest stream quality and quantity; Radiation energy and water balance; Interception process and estimation; Precipitation and runoff estimation; Soil erosion in forest watershed; Selection and design of soil and water conservation strictures; Simulation of hydrological processes in forest watershed. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. DhruvNarayana, V. V., Shastry, G. and Patnaik, U. S. 1990. Watershed Management. Indian Council of Agricultural Research, New Delhi, India. 2. Hudson, N. W. 1987. Soil and Water Conservation in Semi-arid Areas. FAO Soils Bulletin No. 57. 3. Murty, V. V. N. 1998. Land and Water Management Engineering, Kalyani Publishers, India. 4. Lal, R., Blum W. H., Valentine, C. and Stewart, B. A. (eds). 1997. Methods for Assessment of Soil Degradation, CRC Press, Boca Raton, USA. 5. Proceedings of the Development Centre on Watershed Management for Asia and the Far East. The Challenges of Our Watersheds. Soil Conservation Society of India, Hazaribagh, India. 6. Singh G.D. and Poonia, T.C. 2003. Fundamentals of Watershed Management Technology, Yash Publishing House, India. 7. Singh, G. Venkataramanan, Shastry, G. and Joshi, B. P. 1991. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. 8. Suresh, R. 1997. Soil and Water Conservation Engineering. Standard Publishers Distributors, Delhi, India. 9. Tideman, E. M. 1996. Watershed Management. Omega Scientific Publishers, New Delhi, India. | | | |

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| **Course Title** | **Watershed Planning and Management** | | | |
| Course Code | SWCE-6071 | | | |
| Degree Program | Soil and Water Conservation Engineering MSc Program | | | |
| Module No & Name | 06, Elective | | | |
| Module Coordinator | To be decided | | | |
| Lecturer | To be decided | | | |
| Credit Hours/ECTS | 2/4 | | | |
| Prerequisite: | None | | | |
| Contact hours (per week) | Lecture | Tutorials& Seminar/ Lab.,Workshop Practice | Home Study | Total Contact Hours |
| 1 | 3 | 5 | 4 |
| Course objectives and  competences to be  acquired | * To identify watershed problemson the basis of the need of the people * to encourage people to be a part of the management programs * to provide a sincere soil conservation measures to be adopted while planning a watershed project * to prepare watershed projects taking accounts all aspects of watershed problems, the people need and the economeics of the program | | | |
| Outline Syllabus | Problem of land degradation; Identification of watershed problems peoples; Peoples participation in watershed management; Socio-economic survey of watershed; Land use capability classification; Appropriate soil and water conservation measures for watershed management; Integrated multi-disciplinary approach for watershed; Concept of watershed planning; Analysis of data and preparation of layout;Development of master plan; Rain water harvesting;Selecting crops; Horticulture; Tree cultivation and deforestation; National land use policy; Legal and social aspects. | | | |
| Assessment | * 50% continuous assessment * 50% final examination | | | |
| References | 1. DhruvNarayana, V. V., Shastry, G. and Patnaik, U. S. 1990. Watershed Management. Indian Council of Agricultural Research, New Delhi, India. 2. Hudson, N. W. 1987. Soil and Water Conservation in Semi-arid Areas. FAO Soils Bulletin No. 57. 3. Murty, V. V. N. 1998. Land and Water Management Engineering, Kalyani Publishers, India. 4. Lal, R., Blum W. H., Valentine, C. and Stewart, B. A. (eds). 1997. Methods for Assessment of Soil Degradation, CRC Press, Boca Raton, USA. 5. Proceedings of the Development Centre on Watershed Management for Asia and the Far East. The Challenges of Our Watersheds. Soil Conservation Society of India, Hazaribagh, India. 6. Singh G.D. and Poonia, T.C. 2003. Fundamentals of Watershed Management Technology, Yash Publishing House, India. 7. Singh, G. Venkataramanan, Shastry, G. and Joshi, B. P. 1991. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. 8. Suresh, R. 1997. Soil and Water Conservation Engineering. Standard Publishers Distributors, Delhi, India. 9. Tideman, E. M. 1996. Watershed Management. Omega Scientific Publishers, New Delhi, India. | | | |

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| **Course Title** | **MSc Thesis** |
| Course Code | SWCE-7054 |
| Degree Program | Soil and Water Conservation Engineering MSc Program |
| Module No & Name | 05, Project and Research |
| Module Coordinator |  |
| Lecturer |  |
| Credit Hours/ECTS | 6/30 |
| Prerequisite: | All Courses |
| Course objectives and  competences to be  acquired | The objective of the final MSc thesis is to develop students capacity and ability to undertake and disseminate original information obtained through literature searches, discussions with academic staff and professional engineers, and other related professionals to obtain a deeper understanding of a subject than made possible by following a taught Program of study. Furthermore it helps to develop knowledge of an appropriate standard to make a contribution to the field. |
| Outline Syllabus | * Specific content to be agreed between student, supervisor and IGC * Thesis preparation |
| Assessment | * Thesis evaluation should be made by External and Internal examiners, and Chairman |
| References | Haramaya University Thesis or Dissertation Guideline |

**Program Name: Master of Science in Postharverst Technology**

1. **Course Breakdown By Semester**

**Year** I

|  |  |  |
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| **Course Code** | **Course Title** | **Cr.hr.** |
| AGEN 611 | Experimental Design and Analysis | 3 |
| AGEC 621 | Computer Applications (E) | 2 |
| AGEN 631 | Engineering Properties of Biological Materials | 3 |
| PHTC 641 | Advanced Agricultural Process Engineering | 3 |
| PHTC 612 | Design & Management of Storage Structures | 3 |
| PHTC 621 | Engineering Instrumentation and Data Handling | 2 |
| PHTC 622 | Post harvest Technology of Durable crops | 2 |
| PHTC 632 | Post harvest Technology of Perishable crops | 2 |
| PHTC 642 | Animal Products Processing | 2 |
| PHTC 652 | Design of Agricultural Processing Equipment | 3 |
| PHTC 662 | Graduate Seminar | 1 |
| PHTC 672 | Bio-process Engineering | 2 |
|  | **Total** | **26/28** |
|  | **Year II** |  |
| PHTC 711 | M.Sc. Thesis Research | 6 |
| **Additional Courses for Non-Thesis Option** | | |
| AGEN 711 | Master’s Project | 3 |
| PHTC 721 | Packaging Technology | 3 |
| PHTC 731 | Advanced food Engineering | 3 |
| PHTC 741 | Processing of industrial Crops | 3 |
| **12** | | |

**VII. COURSE BREAKDOWN PER-SEMESTER**

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|  | **Year I Semester-I** |  |
| **Course Code** | **Course Title** | **Cr.hr.** |
| AGEN 611 | Experimental Design and Analysis | 3 |
| AGEC 621 | Computer Applications (E) | 2 |
| AGEN 631 | Engineering Properties of Biological Materials | 3 |
| PHTC 641 | Advanced Agricultural Process Engineering | 3 |
| PHTC 621 | Engineering Instrumentation and Data Handling | 2 |
|  |  | 11/13 |
|  | **Year I Semester-II** |  |
| PHTC 612 | Design & Management of Storage Structures | 3 |
| PHTC 622 | Post harvest Technology of Durable crops | 2 |
| PHTC 632 | Post harvest Technology of Perishable crops | 2 |
| PHTC 642 | Animal Products Processing | 2 |
| PHTC 652 | Design of Agricultural Processing Equipment | 3 |
| PHTC 662 | Graduate Seminar | 1 |
| PHTC 672 | Bio-process Engineering | 2 |
|  | **Total** | **15** |
|  | **Year II** |  |
| PHTC 711 | M.Sc. Thesis Research | 6 |
| **Additional Courses for Non-Thesis Option** | | |
| AGEN 711 | Master’s Project | 3 |
| PHTC 721 | Packaging Technology | 3 |
| PHTC 731 | Advanced food Engineering | 3 |
| PHTC 741 | Processing of industrial Crops | 3 |
| **12** | | |

1. **Course Description**

**AGEN 611 Experimental Design and Analysis (3 cr. hr.).**

Review of relevant probability distributions, principles of experimental design, design, layout and analysis of experiments, some useful experimental designs, analysis of variance and covariance, regression and correlation in experimentation. Modeling and simulation in agricultural engineering; Introduction to optimization techniques.

**AGEC 621 Computer Applications (2 cr. hr.)**

Introduction to computer use, application of software, statistical package, and computer graphics.

**AGEN 631 Engineering Properties of Biological Materials (3 cr.hr.)**

Rheology. Contact stress between bodies in compression. Aerodynamic and hydrodynamic properties. Mechanical damage, Optical properties. Friction. Electrical, Physical and Thermal properties.

**PHTC 672 Bio-process Engineering (2cr.hr.)**

Thermal processing of foods, micro-biological inactivation rates, quality factor degradation. Water activity and the role of water in food processing. Kinetics of biological reactions; general principles of reactor design, classification of reactors; fermentation

**PHTC 641 Advanced Agricultural Process Engineering (3 cr. hr.).**

Cleaning, sorting and grading, mechanical separator. Drying, methods of drying, types of dryers. Size reduction of solids and liquids (Emulsification and homogenization), Extraction. Mixing and Forming. Material handling and process control, elevators, sensors, and controllers. Thermal treatment using hot air, baking and roasting, steam sterilization, pasteurization. Removal of heat, freezing and freeze drying. Microwave heating,. Packaging. Methods of Post harvest loss assessment and prevention.

**PHTC 612 Design and Management of Storage Structures (3 cr. hr.)**

Enterprise analysis, activity analysis of an enterprise, space/room analysis Environmental requirement of stored durable and perishable products. Durable and perishable crops characteristics, storage methods. Physiological disorders, chemical and integrated pest control methods. Design and operation of ventilation systems. Building heat loss and gain. Design, construction and management of silos and bins. Cold storage. Modified atmospheric storage. Legislation on chemical use, quality and information sources, inspection procedures.

**AGEN 621 Engineering Instrumentation and Data handling (2 cr. hr.)**

Introduction to sensors and transducers and their characteristics; Signals and their analyses; System modeling and response; Analogue and digital signal processing circuits; Computer interfacing; Overall system design and timing; Bus systems.

**PHTC 622 Post harvest Technology of Durable Crops (2 cr. hr.)**

Types of durable crops and their uses, characteristics and properties. Processing technology associated with cereals and legumes and its theoretical background. Oil extraction. Baking technology. Quality parameters and nutritional value of processed products.

**PHTC 632 Post harvest Technology of Perishable Crops (2 cr. hr.)**

Compositional properties of fruits, vegetables and industrial crops. Preparation of fruits and vegetables for processing. Raw material quality requirements and assessment. Canning, freezing, drying and dehydration of fruits and vegetables. Processing of juices, concentrates squashes and related products from fruits and vegetables. Sugar technology. Coffee and tea processing. Quality assessment of processed products. Nutritional losses during processing and storage. Ethiopian standards and international standards organizations (ISO) standards

**PHTC 642 Animal Products Processing (2 cr. hr.)**

Poultry products technology. Dairy technology. Meat processing; processing of hides and skins. Fish technology; storage and processing. Methods of preservation; canning, drying and chemical application. Quality parameters of raw and processed products.

**PHTC 652 Design of Agricultural Processing Equipment. (3 cr. hr.).**

Design and performance evaluation of de-hulling and milling machines, mixers, elevators conveyors, centrifuges, filtration and mechanisms, fans and pumps.

**PHTC 662 Graduate Seminar (1 cr. hr.)**

Review and discussion of current literature and research findings in the field of Post harvest Technology. With this it is also intended to acquaint the student to the methodology for preparation and presentation of scientific papers.

**PHTC 711 M.Sc. Thesis. Research (6 cr. hr.)**

Independent research work in Post harvest Technology to be conducted by candidates in national priority area under the supervision of advisor(s) as a partial requirement for the Master of Science degree in Post harvest Technology.

**PHTC 721 Packaging Technology (3 cr. hr.)**

Types of packaging materials and their physical and chemical properties. Food packaging systems and their relation to specific products, processes, regulation and equipment. Analysis of various existing packaging systems. Relations between properties of materials and performance of packages

**PHTC 731 Advanced Food Engineering (3 cr. hr.)**

Application of heat and mass transfer, fluid flow, food properties and food processing constraints in the design and selection of food processing equipment.

**PHTC 741 Processing of Industrial Crops (3cr.hr.)**

Types of industrial crops. Oil seeds and their physical and chemical properties. Oil extraction. Processing of cotton and tobacco. Quality assessment of raw industrial crops quality parameters of final product such as oil.

**AGEN 711 Master’s Project (3 cr. hr.)**

An individual study which involves the careful definition of problems, research methods, and the application of appropriate knowledge and skill. The entire project work shall be based on literature review or a case study. The Master’s Project should be in a manner suitable for evaluation by a committee consisting of three to four persons.