ARBA MINCH UNIVERSITY
DEPARTMENT OF HYDRAULIC AND WATER RESOURCES ENGINEERING

Study Programme for the Degree of Master of Science in Hydraulic Engineering

Arba Minch University
Department of Hydraulic and Water Resources Engineering
Institute of Technology

July 2013
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Arba Minch University
AMiT
Department of Hydraulic and Water Resources Engineering

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1. Background

1.1 Introduction
Ethiopia is endowed with substantial amounts of water resources potential (122 and 2.6 million cubic meter surface and groundwater respectively). However, the contribution of these resources to socio-economic development of the country is very low. One of the main reasons is lack of capacity in terms of trained manpower. This called for the establishment of Arba Minch Water Technology Institute (AWTI) in September 1986. The main objectives of the institute were to promote the advancement of water resource development and environmental protection through provision of training, research and consultancy services in the water sector. The Institute, in its 18 years of service, has trained substantial number of professionals which are contributing significantly to the socio-economic development of the country in water and related sectors at different capacities. Up to its transformation to Arba Minch University, the Institute has graduated 1670 students (867, 670 and 136 students respectively at degree, advanced diploma and diploma level). Apart from the provision of education on regular basis the Institute has offered training opportunities to the wider community in its extension and weekend programs. To build its capacity, the institute has benefited from the strong link to some of the German Universities (Siegen and Dresden University as well as Free University of Berlin) which was supported by a long term project (1986-2007) called ‘GTZ support to AWTI’ funded by the German Government.

In 2002 the Institute has launched 2 M.Sc. programmes in Irrigation Engineering and Hydraulic and Hydropower Engineering. After 18 years of teaching and research experiences the Institute was transformed and officially inaugurated to full-fledged University in June 2004 which is the present Arba Minch University. In 2006 the program Hydrology and Water Resources Management and in 2007 Meteorology Science were launched at M.Sc. level.

The University aspires to be one of the leading Higher Educational Institutions in the country and a centre of excellence in the area of water resources in Eastern Africa by the year 2020. It has a mission of promoting democratic thinking, offering high quality education and training, conducting demand driven and problem solving research and consultancy, and rendering community service in order to contribute to the development endeavors of the country.
1.2 Background of School of Graduate Studies

Due to the recurrent food insecurity and increased magnitude and complexity of the poverty situation, there has been a long felt need of creating qualified manpower in the area of irrigation and hydraulics/hydropower, watershed management and hydrology so that the available water resources can be developed, managed and utilized without undue dependence on foreign expertise. Under such circumstances and as the pioneer of the Water Training Institute, AWTI has stepped into launching M.Sc. programs in the year 2002/2003. The school was initially established to run two specialized programs - Irrigation Engineering and Hydraulic and Hydropower Engineering. Currently four programs including Hydrology and Water Resources Management and Meteorology Science are running by the school. As the programs are designed to last for two years the school has graduated 5 batches in Irrigation Engineering and Hydraulics and Hydropower Engineering as well as 2 batches in Hydrology and Water Resources Management.

These programmes were designed to contribute to the skilled manpower demand of the country in the water sector. The objectives of launching M.Sc. program are

a) To assist the national capacity building endeavor in water sector area with the view to upgrade the skills of undergraduate level experts in selected fields of hydropower, irrigation, hydrology, environment and water resources management to expedite the countries development endeavors. This will help reduce dependency in foreign experts in planning, design and development of water resources projects.

b) To assist the regional capacity building endeavor with the view to promote regional cooperation and collaboration, knowledge and information sharing, create group of new generation with common attitudes and understanding towards solving common problems pertaining to the region, such as sustainable water sharing agreements, sustenance of trans-boundary ecological and environmental balance of the region

c) To reduce the brain drain of national and regional (African) professionals through at home training.

Considering the expansion of postgraduate studies in all the disciplines the necessity of changing the organizational structure of the school is being realized. Accordingly, faculties and
departments are responsible to run their respective programs both at M.Sc. and B.Sc. levels. In this case all the facilities and resources that are available in the department can be used for both programs. The school will have basically the responsibilities of overall coordination of the Masters Programs across the faculties.

2. Program Rationale

The Department of Hydraulic and Water Resources Engineering’s Master of Science in Hydraulic Engineering is a two-year program that provides practice oriented education with a focus on real-world engineering challenges. The program considers the physical processes associated with water and water motion that are essential to the understanding, development, protection, and improvement of the environment. It recognizes that tackling the complex environmental, economic and social dilemmas posed by water scarcity, pollution and other problems demands deep, comprehensive understanding of the earth’s water cycle and how it is stressed by the people who depend on it.

The program builds on the current Hydraulic and Hydropower Engineering program which was validated in 2002. The revised program aims to meet the current and future needs of the practitioners by focusing on specialist post graduate provision. The rationale for revisions is provided by a number of factors including professional requirements, changes in educational practices and limitations of the current program.

In recent years, the career opportunities for Hydraulic Engineers have expanded dramatically with the Ethiopian’s Growth and Transformation Plan that emphasizes the river basin, land and water developments. Our graduates teach and carry out research in universities, work for large firms, start their own businesses, and take positions in government and nonprofit organizations.

The distinctive elements of the programs are a professional practice experience comprising an individual, practice-oriented project work and thesis. The revised program recognizes the challenges of the current program associated with considerable time allotted to the research component of the master’s program.

The structure of the program has undergone some changes: the name of the exit words have been modified to exclude the term “hydropower” to indicate focus on specialist provision; the coursework has been streamlined from three semesters to two; the research component duration has been increased from one semester to one year.
3. Admission Requirements

The Master’s degree in Hydraulic Engineering is a highly competitive academic program. To be admitted to the program, candidates must have previously completed their undergraduate studies and been awarded a Bachelor degree in either Science (BSc) or Engineering (BEng) including courses in hydraulic, water resources, irrigation, and civil engineering. Candidates with other qualifications and achievements deemed to be suitably prepared for the program of study may also be considered. The selection is based on the prior academic and/or scientific achievement as documented by academic transcripts, a cover letter, references, and standardized test scores.

4. Objectives of M.Sc. Program

The mission of MSc in Hydraulic Engineering program is to use science, engineering, and policy to improve quality of life. This includes intelligent use of natural resources such as the raw materials, energy, and ecosystems as well as the design of functional and environmentally compatible facilities and infrastructure needed to sustain modern society. Therefore after successful completion of this specialization, the student is able to: plan, design and implement different scales (small, medium and large) of hydraulics projects without compromising the environmental compatibility and its economic viability.

The learning objectives include:

- offering range of courses for understanding of natural cycles, systems, and processes relevant to human activities
- advance understanding and gain deeper physical insight of how water quantity, quality and related earth system processes are affected by natural and human-induced environmental changes;
- enabling students be familiar with theories and quantitative methods for planning, designing and operation, analysing and management of large-scale water resources development projects;
- master the different hydraulics methodologies and application procedures that is helpful in planning, designing and operation of hydraulic structures;
- gain the necessary skill to evaluate critically the existing projects and systems
5. Resources

5.1 Staff
The department of Hydraulic and water resources engineering has adequate number of qualified staff to run the program. Those qualified staff with an academic rank of assistant professors and above are offering courses to M.Sc. programs and advise research projects. These staffs are also participating in various research and development projects. As there are common courses to all of the M.Sc. programmes in water resources engineering, staff are also shared among the programmes. They also participate in academic and project advisory activities of the undergraduate programmes. Table below summarizes the staff currently participating in the programmes.

<table>
<thead>
<tr>
<th>Specialization</th>
<th>Number of staff on duty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PhD and above.</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1 Hydraulic engineering</td>
<td>2</td>
</tr>
<tr>
<td>2 Irrigation/ Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
</tr>
</tbody>
</table>

5.2 Existing resources and facilities
The department has one large laboratory. PC computers and laptops are adequately available for staff to handle their duties. For students, resources such as library, computer labs etc are shared among with other departments.

There exists one irrigation laboratory, water supply and soil mechanics laboratory that serve undergraduate programmes. With some supplementary equipment, these laboratories can also be used for M.Sc. programmes. Relevant software and capable PCs are lacking. Class rooms and offices are also available since new post graduate building starts working. The MSc in Hydraulic Engineering is based in Graduate School building in the main campus. The school has also new post graduate library in the main campus provide access to over 1000 and more titles. In addition to borrowing books and browsing journals, the Graduate School library has reading area on the ground floor and first
floor. Within the main campus, MSc students have access to many dedicated computing labs with Internet connection. Students will also have access to further labs.

5.3 Quality assurance

Academic regulations are described in the University senate legislation. The university has Academic Development and Resources Center (ADRC) which has the following aims:

- to support the improvement of the quality of education (e.g. staff training on measurement and evaluation),
- to collaborate with the other units in the university in writing an overall (annual or biannual) quality status report that could help propose new policies or improve existing ones,
- to suggest Intervention measures (e.g. Staff training ) based on weakness and shortcomings identified in the annual /biannual report,
- to liaise with the Higher Education Relevance and Quality Agency (HERQA) through the Office of the Academic and Research Vice-president (AVP) regarding the assessment of academic programs,
- to provide support to the AVP's office in setting up institutional policies in line with HERQA's policies and guidelines,
- to provide quality and relevance assessment indicators, and
- to provide trainings on improved instructional and assessment methods.

The final M.Sc. thesis is evaluated by the examiners board that consists of chairman, external and internal examiners. They evaluate the thesis and examine the students during presentation or defense in terms of the quality of the material, its contribution to the science or socioeconomics, understanding and ability to answer questions etc.

6. Learning/Teaching Methods and Strategies

Delivery of modules is campus-based learning in reflective ways to enhance the student learning experience. Acquisition of knowledge and understanding is through a combination of lectures, group tutorials and lab practices. Knowledge and understanding are assessed through a combination of written assignments and exams. Practical skills (field Practice ) are developed through coursework, the research proposal and dissertation, tutorials and assignments. The
research dissertation provides students with the opportunity to contribute to the body of knowledge in their area of practice.
Throughout, the learner is encouraged to undertake independent study both to supplement and consolidate when is being taught/learnt and to broaden their individual knowledge and understanding of the subject.
Teaching and learning is supported by lecturing, holding tutorials, practical works and home studies. Instructions will be supported by LCD-projectors and other demonstration mechanisms. Students will be provided with hand-outs to guide them through specific courses. Assignments will be given to assist and encourage student to learn more.
The assessment and evaluation of students will be based on assignments, seminar presentation of projects and examinations (mid and final).

7. Graduation Requirements

There are two masters’ programs: Master of Engineering (MEng) in Hydraulic Engineering and Master of Science (MSc) in Hydraulic Engineering. To attain the MEng Hydraulic Engineering requires:

- Successful completion of 14 modules (39 credit hours). This should include the core modules, the research modules and the compulsory modules.
- Successful completion of graduate project work (2 credits).

To attain the MSc Hydraulic Engineering requires:

- Successful completion of 14 modules (39 credit hours). This should include the core modules, the research modules and the compulsory modules.
- Successful completion and defense of Masters’ thesis work (9 credits).

8. Degree Nomenclature

For the MSc program in Hydraulic Engineering Graduate Program the degree nomenclature should read:

English: THE DEGREE OF MASTER OF SCIENCE IN HYDRAULIC ENGINEERING
Amharic: የአርባ ምንክስ ለማህላዊ የከፋ/images/10.png
9. Module Listing and Description

Master of Science in Hydraulic Engineering is an intensive coursework program. While rooted on the fundamental analyses of hydraulic systems, the organization of modules include theoretical, numerical and field studies of hydraulic, hydrology and earth science disciplines. List of courses to be covered are given in Table 1.

9.1 Module Listing

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Course code</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Name</td>
<td></td>
<td>L  T/L C</td>
</tr>
<tr>
<td>1. Computer Programming and Numerical Methods</td>
<td>HE 611</td>
<td>02 03 03</td>
</tr>
<tr>
<td>2. Applied Hydrology</td>
<td>HE 612</td>
<td>02 03 03</td>
</tr>
<tr>
<td>3. River Engineering and Sediment Transport</td>
<td>HE 613</td>
<td>02 03 03</td>
</tr>
<tr>
<td>4. GIS and Remote Sensing</td>
<td>HE 614</td>
<td>02 03 03</td>
</tr>
<tr>
<td>5. Dams and Reservoirs</td>
<td>HE 615</td>
<td>02 03 03</td>
</tr>
<tr>
<td>6. Embankment dam</td>
<td>HE 621</td>
<td>02 03 03</td>
</tr>
<tr>
<td>7. Computational Hydraulics</td>
<td>HE 622</td>
<td>02 03 03</td>
</tr>
<tr>
<td>8. Groundwater Hydrology</td>
<td>HE 623</td>
<td>02 03 03</td>
</tr>
<tr>
<td>9. Hydropower Engineering</td>
<td>HE 624</td>
<td>02 03 03</td>
</tr>
<tr>
<td>10. Water Resources Systems: Planning and Design</td>
<td>HE 625</td>
<td>02 03 03</td>
</tr>
<tr>
<td>11. Dam Appurtenant structures</td>
<td>HE 731</td>
<td>02 03 03</td>
</tr>
<tr>
<td>12. Hydraulics Engineering Design</td>
<td>HE 732</td>
<td>02 03 03</td>
</tr>
<tr>
<td>13. Design of components of hydropower schemes</td>
<td>HE 733</td>
<td>02 03 03</td>
</tr>
<tr>
<td>14. Research Methods</td>
<td>HE 734</td>
<td>01 03 01</td>
</tr>
<tr>
<td>17. <strong>Practical Education (Field Visit)</strong> Ten – Days (visiting major Water Resources Development Project Sites and obtain relevant information to help them formulate the masters proposal)</td>
<td>HE-742</td>
<td>- - P/F</td>
</tr>
</tbody>
</table>

**Total Credit Hours** 49
### 9.2 Course Schedule

**MSc Hydraulic Engineering**

**Year: I**

**Semester: I**

<table>
<thead>
<tr>
<th>Module</th>
<th>Credit hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HE 611 - Computer Programming and Numerical Methods</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 612 - Applied Hydrology</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 613 - River Engineering and Sediment Transport</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 614 – GIS and Remote Sensing</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 615 - Dams and Reservoirs</td>
<td>02 03 03</td>
<td></td>
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</tbody>
</table>

**Semester Total credits** 10 15 15

**Semester: II**

<table>
<thead>
<tr>
<th>Module</th>
<th>Credit hours</th>
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</thead>
<tbody>
<tr>
<td>HE 621 - Embankment dam</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 622 - Computational Hydraulics</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 623 - Groundwater Hydrology</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 624 - Hydropower Engineering</td>
<td>02 03 03</td>
<td></td>
</tr>
<tr>
<td>HE 625 - Water Resources Systems: Planning and management</td>
<td>02 03 03</td>
<td></td>
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</table>

**Semester Total credits** 10 15 15
### MSc in Hydraulic Engineering

#### Year: II

<table>
<thead>
<tr>
<th>Module</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HE 731-Dam Appurtenant Structures</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 732-Hydraulics Engineering Design</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 733- Design of components of hydropower schemes</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 734-Research Methods</td>
<td>01 02 01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester Total Credits</th>
<th></th>
</tr>
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<tbody>
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<td></td>
<td>07 11 10</td>
</tr>
</tbody>
</table>

**Total Credits (without Research study)** 40

#### Semester: III

<table>
<thead>
<tr>
<th>Module</th>
<th>Credit hours</th>
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</thead>
<tbody>
<tr>
<td>HE 741 - Thesis: Research Work related to Investigation Planning, design and Management of Hydraulic engineering structures</td>
<td>- - 09</td>
</tr>
<tr>
<td>HY-742 : Practical Education (Field Visit)</td>
<td>- - P/F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester Total Credits</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>- - 09</td>
</tr>
</tbody>
</table>

**Total Credits (with Research study) 49**

#### Year: II

<table>
<thead>
<tr>
<th>Module</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HE 741 - Thesis: Research Work related to Investigation Planning, design and Management of Hydraulic engineering structures</td>
<td>- - 09</td>
</tr>
<tr>
<td>HY-742 : Practical Education (Field Visit)</td>
<td>- - P/F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester Total Credits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- - 09</td>
</tr>
</tbody>
</table>

**Total Credits (with Research study) 49**
### 9.3 DETAIL COURSE DESCRIPTION for MSC Hydraulic Engineering

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Programming &amp; Numerical methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>HE611</td>
</tr>
<tr>
<td>Credit Hours</td>
<td>3(L= 02  T= 03)</td>
</tr>
<tr>
<td>Aims and Objectives</td>
<td>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.</td>
</tr>
<tr>
<td>Outline Syllabus</td>
<td>• 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  &lt;br&gt;• 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</td>
</tr>
<tr>
<td>Assessment</td>
<td>40 % program writing assignments &lt;br&gt;20% numerical methods assignment &lt;br&gt;40% final Examination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Applied Hydrology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>HE 612(L= 02  T= 03)</td>
</tr>
<tr>
<td>Credit Hours</td>
<td>3</td>
</tr>
<tr>
<td>Aims and Objectives</td>
<td>The course is aimed at introducing process controlling water in the hydrological cycle; estimation of available runoff and expected flood; application of hydrological models in engineering context as well as planning and design of reservoirs.</td>
</tr>
<tr>
<td>Outline Syllabus</td>
<td>• Introduction to hydrologic cycle &lt;br&gt;• Measurement of Discharge and rating curve:  &lt;br&gt;- Site selection for discharge measurement &lt;br&gt;- Direct Measurement methods (Area-Velocity method, Dilution method, Electromagnetic method, Ultrasonic method)  &lt;br&gt;- Indirect Measurement methods (Using Measuring structures, Area-Slope method)  &lt;br&gt;- Stage-discharge relationship (Rating curve)  &lt;br&gt;• Time series analysis (testing for randomness and trend)  &lt;br&gt;• Methods of Runoff Computation  &lt;br&gt;- Empirical Methods</td>
</tr>
<tr>
<td>MSc in Hydraulic Engineering</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td></td>
</tr>
</tbody>
</table>

- Rational Formula
- Time-Area method
- Unit Hydrograph method (The Hydrograph, base flow Separation, unit hydrograph and its concepts, s-curve IUH, Synthetic UH, Geomorphological IUH)
- Hydrologic Models (Clark Model, Nash Model)
- Runoff estimation for ungauged catchments
- Design Storms: Design Precipitation Depth, Areal precipitation, Depth, Intensity-duration-frequency (IDF) relationship, IDF Curves
- Flood Frequency Analysis
- Channel flow Routing: Muskingum method, Muskingum-Cunge Method.
- Reservoir routing Method: Level Pool method, Modified Pulse Method
- Kinematic and diffusive wave routing method

Assessment
- 30% assignments and group work
- 20% mid-term test
- 50% final Examination

References

<table>
<thead>
<tr>
<th>Course Title</th>
<th>River Engineering and Sediment Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>HE 613</td>
</tr>
<tr>
<td>Credit Hours</td>
<td>3(L= 02 T= 03)</td>
</tr>
</tbody>
</table>

Aims and Objectives
To acquaint students with and provide and understanding of watershed erosion and delivery to rivers, sediment transport, etc

Outline Syllabus
- Watershed erosion and yield modeling concepts
- Hydraulics of loose boundary channels; sediment transport (suspended load, bed load and total load);
- Dispersion and diffusion in channels and fluid transport of contaminants
- Aggradations and degradation problems; local scour and its protection measures; special alluvial problems
- Design of stable channels
- River engineering: channel morphology, methods of river training

Assessment
- 20% assignments
- 30% mid-term exam
- 50% final Examination

References
### Course Title: GIS and Remote Sensing

<table>
<thead>
<tr>
<th>Course Code</th>
<th>HE 614</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours</td>
<td>3(L= 02 T= 03)</td>
</tr>
</tbody>
</table>

#### Aims & Objectives

The aim of the course is to familiarize the students with the emerging technologies and tools applicable in watershed and water resources management, hydrology, and satellite data gathering techniques.

#### Outline Syllabus

- Introduction to GIS
- Geographic Information and spatial data type
- Application of GIS in hydrologic/water resources
- Spatial data analysis
- Introduction to Remote Sensing; Electromagnetic Energy and Remote Sensing; Sensors and Platforms; Image Processing and digital image classification; Application of remote sensing to hydrology/water resources.

#### Assessment

- 30% assignments and fieldwork on GIS
- 30% assignments on Remote Sensing
- 40% final Examination

#### References


### Course Title: Dam and Reservoirs

<table>
<thead>
<tr>
<th>Course Code</th>
<th>HE 615</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Hours</td>
<td>3(L= 02 T= 03)</td>
</tr>
</tbody>
</table>

#### Aims and Objectives

To develop a basic understanding of the engineering behavior of types of dams through an appreciation of the geotechnical, geological, structural, hydraulic/hydrological and Environmental inputs to dam Planning and design in construction. Furthermore, it helps to appreciation problems of construction practice as well as to introduce surveillance and awareness of safety issues.

#### Outline Syllabus

- An overview of dam engineering
- Types and selection of dams
### Embankment dam

**Course Title:** Embankment dam  
**Course Code:** HE 621  
**Credit Hours:** 3(L= 02  T= 03)

**Aims and Objectives:** To develop a basic understanding of the engineering behavior of types of dams through an appreciation of the geotechnical, geological, structural and hydraulic/hydrological inputs to dam design and construction. Furthermore, it helps to appreciation problems of construction practice as well as introduces surveillance and an awareness of safety issues.

**Outline Syllabus**
- Types of embankment (rock fill and earth fill) dams
- Selection of type based on site investigation and assessment
- Foundation and reservoir site treatment for embankment dams
- Principles of embankment dam design and construction
- Hydraulic design for embankment dams (seepage, piping, filter,...)
- Stability analysis
- Overflow embankment dams
- Embankment dams for flood storage and dykes
- Dam safety, Instrumentation, Surveillance and risk analysis, etc.

**Assessment**
- 20% assignments
- 30% mid-term exam
- 50% final Examination

**References**
### Computational Hydraulics

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Hydraulics</td>
<td>HE622</td>
<td>3(L= 02  T= 03)</td>
</tr>
</tbody>
</table>

**Aims and Objectives**

To acquaint with the use of numerical models in free-surface hydraulics, numerical methods used for solution of flow phenomena and finally to acquire with skills necessary to write programs and models for hydraulics problems.

**Outline Syllabus**

- Basis of mathematical modeling in hydraulics
- Conservation laws describing free-surface flows
- Basic hydrodynamics; St. Venant’s equations & their solution
- Method of characteristics
- Method of finite differences: explicit and implicit schemes
- Development of numerical models for one dimensional free-surface flows
- Modeling of flow in open channel networks with inclusion of hydraulic structures and irregular cross-sections
- Numerical solution of two-dimensional nearly horizontal flows using method of finite differences and method of finite volumes
- Modeling of advection-diffusion in one and two dimensions
- Modeling sediment transport
- Introduction to problems of modeling short waves

**Assessment**

20% assignments  
30% mid-term exam  
50% final Examination

**References**

1. Computer Oriented Numerical Methods - V. Raja Raman  
2. Introduction to numerical methods for water resources – W.L. Wood

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### Ground Water Hydrology

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Water Hydrology</td>
<td>HE 623</td>
<td>3(L= 02  T= 03)</td>
</tr>
</tbody>
</table>

**Aims & Objectives**

After the completion of this course, the student will be able to understand the process and the problems associated with ground water resources development and its conservation, quality protection, monitoring and management. Apart from this they will also learn ground water modeling.

**Outline Syllabus**

- Ground water resources: Scope and occupancy
- Ground water in hydrologic cycle
- Hydro-geological aspects of ground water
- Aquifers: Characteristics and their types, porosity and permeability
- Ground water movement: Darcy’s law, hydraulic conductivity and its measurement, hydraulics of wells
- Steady and unsteady state of flow in confined and unconfined aquifer, unsteady flow in leaky aquifers
- Partially penetrating wells and multiple well system

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MSc in Hydraulic Engineering

MSc in Hydraulic Engineering

- Pumping tests, observation wells and piezometers
- Ground water quality and its monitoring
- Artificial recharge of ground water
- Ground water modeling e.g MODFLOW

Assessment

- 20% assignments
- 30% mid-term exam
- 50% final Examination

References


Course Title | Hydropower Engineering
---|---
Course Code | HE 624
Credit Hours | 3(L= 02  T= 03)

Aims and Objectives

The course goal is to cover key concepts in forms of energy, the status of global energy supply and sources as well as the situation in Ethiopia. It further enables student to grasp and understand planning criteria for energy demand coverage, types of hydropower plants and their classification, essential components of hydropower schemes as well as design of diversion structures usable in hydropower schemes.

Outline Syllabus

- Energy: Sources of energy, world energy balance, energy demand
- Significance of hydropower: Worldwide, Ethiopia, advantages and disadvantages, Comparison of Hydro power and Thermal power.
- Bases for water and energy management: Planning criteria for energy production; appraisal of catchment area and Water course; terms and parameters pertinent to hydropower schemes
- Types of hydropower plants: Various classifications; low head plants; medium head plants; high head plants; pumped storage schemes
- Classification of hydropower plants: low, medium, and high-head plants. Practical approach to the planning and design of hydroelectric power
### MSc in Hydraulic Engineering

| Installation: hydropower development cycle: pre-construction (planning), implementation (engineering, construction and supply) and operation (management and operation of hydropower installation). Fundamental theory of water availability and demand: flow, power and load duration curves. Design of hydropower plants: intakes, power canals, forbear, surge in power canals and penstocks, surges tanks, water hammer analysis, tunnels, power houses, draft tube, anchorage and supports. Characteristics and selection of valves, turbines, turbine location and cavitation’s problems. |
| Assessment | 20% assignments  
30% mid-term exam  
50% final Examination |

<table>
<thead>
<tr>
<th><strong>Course Title</strong></th>
<th>Water Resources Systems: Planning &amp; Management</th>
</tr>
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<tbody>
<tr>
<td><strong>Course Code</strong></td>
<td>HE 625</td>
</tr>
<tr>
<td><strong>Credit Hours</strong></td>
<td>3(L= 02  T= 03)</td>
</tr>
<tr>
<td><strong>Aims and Objectives</strong></td>
<td>To course is aimed at equipping students with system theories, linear and dynamic programming which are vital in engineering problems. This course covers the nature of water resources systems.</td>
</tr>
</tbody>
</table>
| **Outline Syllabus** | • water resources planning objectives, cost-benefit objectives, multi-objectives, plan formation, planning models and solution procedures, objective functions and constraint equation, optimizations methods; Water resources planning under uncertainty:  
• Objective functions, constraints and resources input with reference to operation model of hydropower systems  
• Simulation and search procedure  
• Linear programming and Dynamic programming  
• Probability concepts and their use in water resources planning. Application of systems analysis to water resources: deterministic river basin modeling: stream flow estimation, estimation reservoir storage requirement for water supply, flood control aspects, HP production, withdrawals and diversions; Synthetic Stream flow Generation: statistical stream flow generation models, ARMA models and their application in water resources management. Introduction to River basin modeling and management: river basins models, decision support system (DSS), and concepts of sustainability, environmental impacts and their assessment. |
| Assessment | 20% assignments  
30% mid-term exam  
50% final Examination |
### References

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<th>References</th>
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### Course Title: Dam Appurtenant Structures

<table>
<thead>
<tr>
<th>Course Code</th>
<th>HE 731</th>
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<tr>
<td>Credit Hours</td>
<td>3(L= 02  T= 03)</td>
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</table>

**Aims and Objectives:**

This course covers design of headwater control structures: spillway control structures, outlet structures; Design & analysis of overflow, chute, side channel, shaft, siphon, tunnel and culvert spillways; Crest gates: design and analysis; Design of outlet works: conveyance, intake structures, gates and valves, terminal structures, entrance and outlet channels; Scour protection and energy dissipation: hydraulic pump, stilling basins and stilling chambers.

**Outline Syllabus:**

- 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:**

- 20% assignments
- 30% mid-term exam
- 50% final Examination

**References**


### Course Title: Hydraulics Engineering Design

<table>
<thead>
<tr>
<th>Course Code</th>
<th>HE 732</th>
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<tbody>
<tr>
<td>Credit Hours</td>
<td>3(L= 02  T= 03)</td>
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</tbody>
</table>
Aims and Objectives

To provide an understanding of and ability in several aspects of advanced hydraulics and hydraulic engineering design. Among others this course enables the understanding of various advanced theories in hydraulic Engineering, design requirements of several specific hydraulic engineering applications, ability to apply design methods of specific hydraulic engineering problems at advanced level. Hydraulic design of certain structures, Some practical aspects of hydraulic performance and elements of structural design.

Outline Syllabus

- Unsteady flow problems in open channels
- Potential flow problems, water hammer in pipes systems
- Dam break problems
- Design of water tanks and water distribution systems
- Highway drainage; bridge and culvert hydraulics
- Physical Modeling in Hydraulic design

Assessment

20% assignments
30% mid-term exam
50% final Examination

References


Course Title

Design of components of hydropower schemes

Course Code

HE 733

Credit Hours

3(L= 02  T= 03)

Aims and Objectives

This course enables students to plan, design and analyze various components of hydropower schemes. It covers structural and mechanical components from water intake through water conveyances and powerhouse up to return flow to original river.

Outline Syllabus

- Water Intake: components, arrangements, construction and design
- Free surface conveyance: hydraulic design, sediment transport wave and oscillations, constructional details and stabilization
- Sedimentation trap: constructional arrangements and design
- Pressurized pipes conveyance (penstocks): types, water hammer analysis and dynamic loads pressure waves, bends, supports and expansion joints, design of anchor blocks
- Pressure tunnels and shafts: constructional details
- Manifolds: types and design
- Surge tanks and surge chambers: arrangements, purposes, types and constructional arrangements, surge analysis, special arrangements
- Gates and valves in conveyance systems: types, hydraulic characteristics, arrangements operation
- Power house: Types and layouts, design
### MSc in Hydraulic Engineering

| Assessment          | 20% assignments  
|                    | 30% mid-term exam  
|                    | 50% final Examination  

### References

### Course Title: Research Methods

<table>
<thead>
<tr>
<th>Course Title</th>
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<tbody>
<tr>
<td>Course Code</td>
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<tr>
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</table>

**Aims and Objectives**

The objective of the final 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.

**Outline Syllabus**

Furthermore it helps to develop provides knowledge of an appropriate standard to make a contribution to a particular field. Specifically the thesis work is aimed at:

- To develop an ability to undertake research, analysis or design given an appropriate level of supervision  
- To develop objectives and program of work  
- To collect information assess it and present it in an orderly and coherent form  
- To be able to write a document which presents clearly findings related to the study

**Assessment**

- 30% assignments  
- 70% Seminar work

**References**

### 3. Thesis: Research Work related to Investigation Planning, design and Management of Hydraulic Engineering

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Thesis: Research Work related to Investigation Planning, design and Management of Hydraulic Engineering</th>
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</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>HE741</td>
</tr>
<tr>
<td>Credit Hours</td>
<td>9</td>
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</tbody>
</table>
| Aims and Objectives | The objective of the final 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 provides knowledge of an appropriate standard to make a contribution to a particular field. Specifically the thesis work is aimed at:  
  - To develop an ability to undertake research, analysis or design given an appropriate level of supervision  
  - To develop objectives and program of work  
  - To collect information assess it and present it in an orderly and coherent form  
  - To be able to write a document which presents clearly findings related to the study |
| Outline Syllabus | Specific content to be agreed between student, supervisor & DGC  
  - Dissertation preparation |
| Assessment | Thesis evaluation by external, Internal examiners and Chair man  
  - Presentation and defense of the thesis |

### 10. MEng Hydraulic Engineering

For the MEng program in Hydraulic Engineering Graduate Program the degree nomenclature should read:

**English:**

THE DEGREE OF

Master of Engineering in Hydraulic Engineering

**Amharic:**

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Course Schedule and Course listing

**Year: 1**
### Semester: I

<table>
<thead>
<tr>
<th>Module</th>
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<tbody>
<tr>
<td>HE 611 - Computer Programming and Numerical Methods</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 612 - Applied Hydrology</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 613 - River Engineering and Sediment Transport</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 614 – GIS and Remote Sensing</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 615 - Dams and Reservoirs</td>
<td>02 03 03</td>
</tr>
<tr>
<td>HE 621 – Embankment dam</td>
<td>02 03 03</td>
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</table>

**Semester Total credits** 12 18 18
MSc in Hydraulic Engineering

Semester: II

<table>
<thead>
<tr>
<th>Module</th>
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<tbody>
<tr>
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<tr>
<td>HE 621 - Computational Hydraulics</td>
<td>02</td>
</tr>
<tr>
<td>HE 622 - Groundwater Hydrology</td>
<td>02</td>
</tr>
<tr>
<td>HE 623 - Hydropower Engineering</td>
<td>02</td>
</tr>
<tr>
<td>HE 624 - Water Resources Systems: Planning &amp; Management</td>
<td>02</td>
</tr>
<tr>
<td>HE 625 - Dam Appurtenant Structures</td>
<td>02</td>
</tr>
<tr>
<td>HE 626 - Hydraulics Engineering Design</td>
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**Semester Total credits** 12 18 18

Summer Session

<table>
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<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>HE 731 - Design of Components of hydropower schemes</td>
<td>02</td>
</tr>
<tr>
<td>HE 732 - Project Work</td>
<td>00</td>
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</tbody>
</table>

**Semester Total credits** 02 09 05

**Total Credits (without Research study)** 41