DEBRE BRIHAN UNIVERSITY

DEPARTMENT OF MATHEMATICS

POST GRADUATE STUDIES

CURRICULUM FOR M.Sc. IN MATHEMATICAL MODELING

January 2012

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Background

DEBRE BRIHAN UNIVERSITY (DBU) is one of the 31 Universities which was established in 1999 E.C by the Government of Federal Democratic Republic of Ethiopia. DBU is located in Central part of Ethiopia, Amhara Region, and North Shoa zone in Debre Berhan town which is 130 km far from the capital city, Addis Ababa. In the last few years from its establishment DBU university has launched different schools and faculties namely, college of Natural and Computational Science, school of Engineering, School of computing Science, School of Health Science, College of Agriculture, college of Humanities, college of Business and Economics and Institute of Education, based on its mission and vision in particular and the mission and vision of the country in general. The department of Mathematics is also established in 1999 E.C under the college of Natural and computational sciences and has run undergraduate program for the last six years. Besides trained major mathematics undergraduate program, the department also offers different mathematics courses for various departments of Natural sciences, Computational sciences and technology faculties.

Currently Ethiopia has designed and implemented a strategic plan to produce 70% of man power will trained in natural sciences, technology and health care sciences annually. To train such man power in the fields of natural sciences, technology and health care sciences Mathematics is a fundamental subject and will play a pivotal role for their development. Especially applied mathematics is very essential for the development of all these sciences but we observe that almost all Mathematics teachers in the university and colleges are a pure mathematics teachers. Therefore there is a shortage of applied mathematics teachers in almost all Universities and Colleges through out the country. For this the department of Mathematics in DBU obliged to design a post graduate program in applied stream especially "Mathematical Modeling". For detail see the "Rational of the program" and "Graduate profile" in the subsequent pages.

Rational

Currently the Government of the Federal Democratic Republic of Ethiopia has given a firm attention on producing a man power trained in science and technology. To implement this, all the universities around the nation have expanded their capacity to accept this huge man power in their campuses. To train this man power in science and technology, universities need trained and efficient teachers for their respective disciplines. Here the role of Mathematics teachers for all science and technology departments is unavoidable. It is obvious that the universities mostly need applied Mathematics teachers who are capable of teaching Mathematics practically related to the subject matter of different departments in different colleges, schools and faculties. For this application of Mathematics, a teacher who teaches "**Mathematical Modeling"** is very essential. Mathematical modeling is the branch of mathematics which helps individuals, governments, businesses (organizations), researchers of all physical and social sciences to get insight into problem situations which are arise in our real world. Formulating and building mathematical models require study real life cases, work on practical applications and give mathematical interpretations and analyze the solutions of the real world problems which are actually not covered in the current post graduate curriculum for almost all Mathematics departments of the universities across the nation. This curriculum is expected to fill this gap. To fill this gap Mathematics department of DBU has designed this curriculum and decided to open Post Graduate program in applied Mathematics stream for a specialization of Mathematical Modeling. To implement this regular, summer and night extension programs break downs are designed appropriately based on the need assessment of the stakeholders.

Philosophy

This curriculum is designed based on two philosophies

1. ***"****You learn Mathematics by doing Mathematics****":***

   Athletes do not train for sports by watching games on TV but they must exercise and practice. Similarly you can not learn Mathematics by only listening to the lecture; you must actively and consistently participate in the learning process, both in and out of the classroom.

2. *"The answer is not the goal":*

   Mathematics is not just getting an answer that matches what's in the back of the textbook. Mathematics is about:

   - Investigating meaningful and practical problems chosen from common experiences encompassing many academic disciplines, including the mathematical sciences, operations research, engineering, and the management and life sciences.
   - Collect a set of information, identify and understand the real world problems based on your information and convert this information into Mathematical model.
   - Applying different techniques of Mathematics to analyze your information and create precise deductions.
   - Give the Mathematical interpretation of your results, that is what actually mean by your numbers, variables, equations, tables, diagrams, graphs and charts.
   - Give the real world interpretation of your Mathematical model and communicating the entire processes: abstraction, hypothesis, analysis and conclusion to your intended audience or the problem stakeholders.

Policies for the post graduate candidate

This curriculum has the following policies:

1. **Assignments**: It is strongly recommended that you may work together, while completing your assignment each of you should write up and hand in your own document.
2. **Project:** There will be project proposal and final written project on your selected topic
3. **E-mail account:** Each of you will open e-mail account for easy transportation of the necessary materials from your teacher to you and any quest if you have to your teacher.
4. **Class Attendance:** Expecting you to attend every class.
5. Meet all policies under DBU Legislation.

Objectives:

At the successful completion of the course in **Mathematical modeling** the student will be able to:

- Teach mathematical modeling for under graduate students.
- Do research which will be published in reputable journals.
- Build mathematical models of real world problems using ODE and PDE.
- Give scientific advice to the managers of governmental and nongovernmental organizations, industries and the concerned stake holders based on the research results.

Graduate Profile

After completing the M.Sc. degree in Mathematical Modeling the graduates are able to:

- Teach practical applications of Mathematics by building a model for some phenomenon of different disciplines in physical sciences, life sciences, health care sciences and technology of undergraduate programs.
- Develop and prepare some Mathematical Modeling teaching and learning materials for under graduate programs of different departments in physical sciences, life sciences, health care sciences and technology.
- Conduct a group research with different departments in physical sciences , life sciences, technology and health care sciences
- Develop mathematical models that help individuals, government policy makers, researchers, engineers, businesses (organizations) to solve real world problems.
- Produce papers, journals and articles in the national and international publishers and give some contribution to the world of science.

Admission requirements

A candidate of the program must

- Has a B.Sc. or B. Ed. degree in Mathematics or an equivalent degree in mathematics from recognized institution with GPA 2.0 and above.
- Meet the general University graduate admission requirements.
- Have sponsor or self support to cover her/his tuition fees.

Applicants who fulfill the admission requirements are required to pass an entrance examination in

- Ordinary differential equations, Partial differential equations and Numerical Analysis for *"Mathematical Modeling"* stream.

  Given and evaluated by the department of Mathematics. The maximum mark has taken out of 100% of which 70% counts for entrance examination and 30% counts for undergraduate CGPA. The pass mark is 50% out of the maximum 100%.

Graduation Requirements

Eligible candidates are required to complete a minimum of 32 credit hours in all regular, summer and night extension programs

- With a minimum of CGPA 3.00.
- With No 'F' nor 'D' grade in any one of the courses have taken
- For any delay at the time of graduation, not to fulfill the minimum CGPA, she /he will has a permission to take course once to clear her /his 'F', 'D' or 'C' grades.

Staff Profile

The following table shows the Department's overall staff profile.

(Those who are currently on duty in 2011/2012 A.Y):

s/No	NAME	SEX	Qualification	Rank	Nationality	Remarks
1	**Dr. Temesgen Tibebu**	M	PhD	Assistant professor	Ethiopian	
2	Ato Genanaw Timerga	M	MSc	Lecturer	Ethiopian	
3	Ato Tibebu Tullu	M	Msc.	Lecturer	Ethiopian	
4	Ato Tadesse Ayele	M	M.Sc	Lecturer	Ethiopian	
5	Ato Dereje Tarekegn	M	Msc.	Lecturer	Ethiopian	
6	Ato Abushet Hayalu	M	Msc.	Lecturer	Ethiopian	
7	Ato Gebrehiwot Mehari	M	Msc.	Lecturer	Ethiopian	
8	Ato Ibrahim Zerga	M	Msc.	Lecturer	Ethiopian	
9	Ato Yohannes Berhie	M	Msc.	Lecturer	Ethiopian	
10	Ato Bogale Asefa	M	Msc.	Lecturer	Ethiopian	
11	Ato Atilie Nega	M	Msc.	Lecturer	Ethiopian	
12	Ato Shewakena Mersha	M	Msc.	Lecturer	Ethiopian	
13	Ato Tesfaye tefera	M	Msc.	Lecturer	Ethiopian	
14	Ato Kibru Teka	M	MSc	Lecturer	Ethiopian	
15	Ato Nigussie Chane	M	Msc.	Lecturer	Ethiopian	
16	Ato Dejene Shewakena	M	Msc.	Lecturer	Ethiopian	
17	Ato Zeleke Amare	M	Msc.	Lecturer	Ethiopian	
18	Ato Kidus Hunegnaw	M	Msc.	Lecturer	Ethiopian	
19	Ato Seid Ali	M	Msc.	Lecturer	Ethiopian	
20	Ato Legesse Abebe	M	Msc.	Lecturer	Ethiopian	
21	Ato Kumlachew Tadesse	M	Msc.	Lecturer	Ethiopian	UNISA
22	Ato Molla Mengesha	M	Msc.	Lecturer	Ethiopian	
23	Ato Biniam Zgta	M	Msc.	Lecturer	Ethiopian	
24	Ato Gebrehiwot H/mariam	M	Msc.	Lecturer	Ethiopian	
25	Ato Habte Tadesse	M	Msc.	Lecturer	Ethiopian	
26	Ato Kidanie Hailu	M	BSc	Ass. Lecturer	Ethiopian	
27	Ato Sleshi Dabi	M	Bed	Ass. Lecturer	Ethiopian	

/Those who are currently on study leave for PhD or MSc

Sno	NAME	SEX	Qualification	Rank	Nationality	remark
1	Ato Nohe Syoum	M	M.Sc/ On PhD study leave	Lecturer	Ethiopian	
2	W/t Yegbtsehiwot Zerihun	F	M.Sc/ On PhD study leave	Lecturer	Ethiopian	
6	Ato Abrham Fente	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
7	Ato Kindie Fentahun	M	B.Sc/ On MSc study leave	GAII	Ethiopian	
8	Ato Seife Endiris	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
9	Ato Alene Tefera	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
10	Ato Tsigie Bayrou	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
11	Ato Nigussie Dedefi	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
12	Ato Mengistu Chalchisa	M	B.Sc/ On MSc study leave	ASS. Lec.	Ethiopian	
13	W/t Haymanot Zeleke	F	B.Sc/ On MSc study leave	GAII	Ethiopian	

Those who will be a block staff

S.No	Name	sex	rank	Specialization	Address
1	Dr. Tsegaye Gedif	M	Assistant Professor	Differential	AAU
2	Dr. Tadesse Abdi	M	Assistant Professor	Differential	AAU
3	Dr. Semu Mitiku	M	Assistant Professor	Optimization	AAU
4	Dr. Berhanu Guta	M	Assistant Professor	Optimization	AAU
5	Dr. Mengistu Goa	M	Assistant Professor	Functional Analysis	AAU
6	Dr. Genanaw Gofe	M	Assistant Professor	Numerical Analysis	JMU

Current facilities for undergraduate program

The Mathematics program currently has the following facilities:

1. Four Class rooms
2. Eleven Offices for teachers
3. Twelve Computers
4. One Printers
5. Computer laboratory

Required additional facilities for the post graduate program

1. Seminar library
2. Computer laboratory with a minimum of 20 PCs and Internet connection.
3. Software
4. LCD projectors
5. Text Books

Required nonacademic staff for the department

1. One secretary
2. One lab technician

Duration of the program

Duration of the program is designed for:

1. Two years breaking into four semesters for Regular programs.
2. Three years breaking into six semesters for Evening Extension program.
3. Four years or Four summers for summer program.

Degree Nomenclature

After completion of the program successfully, the degree would be awarded as follows:

English: **Degree of Master of Science in Mathematical Modeling.**

Amharic: የሳይንስ ማስተርስ ዲግሪ በሒሳብ

(በሞዴሊንግ)

Course Requirements

Mathematical Modeling Stream

1. List of compulsory courses

SN	Course Code Number	Course Title	Credit Hours
1	Math 5511	Ordinary Differential Equations	3
2	Math 5411	Numerical Analysis	3
3	Math 5711	Mathematical Modeling	3
4	Math 5811	Applied Research Methodology	2
5	Math 5522	Partial Differential Equations	3
6	Math 5722	Mathematical Biology	3
7	Math 5612	Optimization and theory of Approximations	3
8	Math 6621	Optimal Control	3
9	Math 67---1	Elective/Concentration Course	3
10	Math 6822	Thesis	6
Total Credit Hours			32

2. List of Elective Courses: A candidate should elect only one of the following

SN	Course Code Number	Course Title	Credit Hours
1	Math 6731	Mathematical Bio Economics	3
2	Math 6741	Mathematical Epidemiology	3

9.3 Course Break down

Regular Mathematical Modeling Stream

Year	Semester I			Semester II		
	Course Title	**Codes**	**Credits**	**Course Title**	**Codes**	**Credits**
I	Ordinary Differential Equations	Math 5511	3	Partial Differential Equations	Math 5522	3
	Numerical Analysis	Math 6411	3	Mathematical Biology	Math 6721	3
	Mathematical Modeling	Math 5711	3	Optimization	Math 5612	3
	Applied Research Methodology	Math 5811	2			
	Total		**11**	**Total**		**9**
	Optimal Control	Math 6621	3	Thesis		
	Elective/Concentration Course	Math 67--1	3			
	Total		**6**	**Total**		**6**

Summer Mathematical Modeling Stream

	Year I / Summer I			Year II / Summer II		
	Ordinary Differential Equations	Math 5511	3	Partial Differential Equations	Math 5522	3
	Numerical Analysis	Math 5411	3	Mathematical Biology	Math 5722	3
	Mathematical Modeling	Math 5711	3	Optimization	Math 5612	3
	Applied Research Methodology	Math 5811	2			
	Total		**11**	**Total**		**9**
	Year III / Summer III			**Year IV / Summer IV**		
	Optimal Control	Math 6621	3	Thesis		**6**
	Elective/Concentration Course	Math 67--1	3			
	Total		**6**	**Total**		**6**

Evening Extension Mathematical Modeling Stream

Year	Semester I			Semester II		
	Course Title	**Codes**	**Credits**	**Course Title**	**Codes**	**Credits**
I	Ordinary Differential Equations	Math 5511	3	Numerical Analysis	Math 5411	3
	Mathematical Modeling	Math 5711	3	Applied Research Methodology	Math 5811	2
	Total		**6**	**Total**		**5**
II	Partial Differential Equations	Math 5522	3	Optimization	Math 5612	3
	Mathematical Biology	Math 5722	3	Optimal Control	Math 6621	3
	Total		**6**	**Total**		**6**
	Elective/Concentration Course	Math 67--1	3	Thesis		**6**
	Total		**3**	**Total**		**6**

9.4 Course Break down

Regular Mathematical Modeling Stream

Year	Semester I			Semester II		
	Course Title	**Codes**	**Credits**	**Course Title**	**Codes**	**Credits**
I	Ordinary Differential Equations	Math 5511	3	Partial Differential Equations	Math 5522	3
	Functional Analysis	Math 54A2	3	Mathematical Modeling	Math 5711	3
	Optimization	Math 5612	3	Mathematical Biology	Math 6721	3
	Applied Research Methodology	Math 5811	2			
	Total		**11**	**Total**		**9**
	Numerical Analysis	Math 6411	3	Thesis		
	Elective/Concentration Course	Math 67--1	3			
	Total		**6**	**Total**		**6**

Summer Mathematical Modeling Stream

	Year I / Summer I			Year II / Summer II		
	Ordinary Differential Equations	Math 5511	3	Partial Differential Equations	Math 5522	3
	Numerical Analysis	Math 5411	3	Mathematical Biology	Math 5722	3
	Mathematical Modeling	Math 5711	3	Optimization	Math 5612	3
	Applied Research Methodology	Math 5811	2			
	Total		**11**	**Total**		**9**
	Year III / Summer III			**Year IV / Summer IV**		
	Optimal Control	Math 6621	3	Thesis		**6**
	Elective/Concentration Course	Math 67--1	3			
	Total		**6**	**Total**		**6**

Evening Extension Mathematical Modeling Stream

Year	Semester I			Semester II		
	Course Title	**Codes**	**Credits**	**Course Title**	**Codes**	**Credits**
I	Ordinary Differential Equations	Math 5511	3	Numerical Analysis	Math 5411	3
	Mathematical Modeling	Math 5711	3	Applied Research Methodology	Math 5811	2
	Total		**6**	**Total**		**5**
II	Partial Differential Equations	Math 5522	3	Optimization	Math 5612	3
	Mathematical Biology	Math 5722	3	Optimal Control	Math 6621	3
	Total		**6**	**Total**		**6**
	Elective/Concentration Course	Math 67--1	3	Thesis		**6**
	Total		**3**	**Total**		**6**

Course Descripitions

Course Name…….. Ordinary Differential Equations (ODE)

Course Code…… Math 5511

Course Prerequisite…….. None

Credit Hours + Tutorial Hours……...3 Hrs + 2Hr

Text Book……..Ordinary Differential equations, Wolfgang Walter.

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Prove and recognize existence and uniqueness theorems..
- Find the solutions of linear and non linear ODE.
- Give a mathematical analysis for ODE model.

Course Description

Existence and Uniqueness Theorems: General Theory of Linear Systems of Differential Equations: Sturm-liouville Theory: Oscillation and Companion Theorems for Second Order Linear Equations: Self-Adjoint Eigenvalues Problems; Regular Singular Boundary Value Problems; Non-Self Adjoint Boundary Value Problems; Green's Function.Fundamental Solution and Cauchy Problems; Elements of Potential Theory; Maximum Principle; Boundary Value Problems for Equations of Elliptic Parabolic type.

Course Name…….. Partial Differential Equations (PDE)

Course Code…… Math 5522

Course Prerequisite…….. Math 55A1

Credit Hours + Tutorial Hours……...3 Hrs + 2Hr

Text Book……..Partial differential equations, Beny Neta

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Derive the representations of heat, transport and wave equations.
- Find the solutions of linear and non linear PDE.
- Give a mathematical analysis for PDE model.

Course Description

Introduction to Partial differential equations, Transport equation, Initial value problem, Non homogeneous problem, Laplace‘s equation, Heat equation, wave equations: Physical interpretations and Solution by spherical means, Nonlinear first order Partial differential equation – Complete integrals, Examples for liner, quasilinear, fully nonlinear equations, Second order Elliptic equations and linear evolution equations.

Course Name…….. Mathematical Modeling

Course Code…… Math 5711

Course Prerequisite…….. No

Credit Hours + Tutorial Hours……...3 Hrs + 2Hrs

Text Book……..Mathematical Modeling, Nicola Bellomo.

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Build a model in real world problems.
- Find the solutions of a model and analyze them
- Recognize the dimensional analysis for mathematical modeling

Course Description: An Intuitive Introduction to Modeling, Elementary Examples and Definitions, Modeling Scales and Representation, Dimensional Analysis for Mathematical Models, Traffic Flow Modeling, Classification of Models and Problems, Critical Analysis, Microscopic Scale Models and Ordinary Differential Equations, Macroscopic Scale Models and Partial Differential Equations

Course Name…….. Mathematical Biology

Course Code…… Math 6721

Course Prerequisite…….. Math 5711

Credit Hours + Tutorial Hours……...3 Hrs + 2Hrs

Text Book…….. Elements of Mathematical Ecology, Mark Kot.

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Construct a model and analyze them
- Analyzed different bifurcations which can be experienced by the model

Course Description: Unstructured population models: single species models, exponential, logistic and Gomperth growth, Harvest models, bifurcations, breakpoints. Interacting populations: classical predator-prey models, to cycle or not to cycle, global bifurcations in predator-prey models, competition models, Mutualism models

Course Name…….. Mathematical Bio Economics

Course Code…… Math 6731

Course Prerequisite…….. Math 5711

Credit Hours + Tutorial Hours……...3 Hrs + 2Hrs

Text Book…….. Mathematical Bio Economics, Colin W. Clark

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Analyze different kinds of economic models
- Analyze different kinds of optimal harvest policies

Course Description: Elementary Dynamics of exploited populations: The logistic growth model, Generalized logistic models, depensation, summary and critique. Economic models of renewable recourse harvesting: The open access fishery, economic overfishing, biological overfishing optimal fishery management, the optimal harvest policy, examples based on the Schaefer model, inear variational problems, the possibility of extinction, summary and critique. Optimal control theory: One dimensional control problems, a nonlinear fishery model, economic interpretation of the maximum principle, multidimensional optimal control problems, optimal investment in renewable recourse harvesting. Dynamical systems: basic theory, dynamical systems in the plane, isoclines, nonlinear plane autonomous systems, limit cycles. Gause's model of interspecific competition.

Course Name…….. Mathematical Epidemiology

Course Code…… Math 5741

Course Prerequisite……..Math 5711

Credit Hours + Tutorial Hours……...3 Hrs + 2Hrs

Text Book…….. Alan Hastings, Population Biology: Concepts and Models, Springer, 1996

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

Course description: What is Mathematical Epidemiology? A Simple epidemiological model, Infectious Disease Modeling, The SI model, The SIS model, The SIR model, The SIRS endemic disease model, parameters from data, An Epidemiological model with explicit demography. Units and methods for the estimation of the parameters, Long term behavior of the solutions, The Reproduction number of the disease R0,

Course Name…….. Applied research methodology

Course Code…… Math 5811

Course Prerequisite…….. None

Credit Hours + Tutorial Hours……...2Hrs

Text Book…….. Applied research

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- Select theoretical and physical problems of a study
- Design methods of data collection of a study
- Prepare proposal for scientific study
- Make critical reviews of abstract theories and articles
- Relate the findings with previously done studies and generalize
- Write appropriate report of a study

Course Description

Applied Research methods: Types of research (experimental, survey, qualitative, quantitative etc), developing proposal development; literature review Stating research problem and developing hypothesis .Constructing objectives and statement of the problem, briefings of data collection, Developing methods and materials: study site and population, study design, Data collection techniques, administration and data processing sampling and sampling designs etc , writing scientific journal.

Course Name…….. Optimization and Approximation Theory

Course Code…… Math 5612
Course Prerequisite…….. None

Credit Hours + Tutorial Hours……...3Hrs + 2Hrs

Text Book…….. R. Deumlich: Optimization and Theory of Approximation, 1997

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- can identify major classes of Optimization ,various types of optimization problems and their features.
- be able to formulate a variety of practical optimization problems
- can define convex sets, convex functions, Notion of convex analysis and be able to prove optimality conditions for convex programming problems.

Course Description: Overview of major classes of Optimization; Notion of convex analysis; generalized derivatives and optimality conditions; basic solution methods; constrained problems; theory of Approximation.

Course Name…….. Optimal control
Course Code…… Math 6621
Course Prerequisite…….. Math 5612

Credit Hours + Tutorial Hours……...3Hrs + 2Hrs

Text Book…….. Brkovitz, L.D.: Optimal Control Theory, Springer-Verlag, 1974

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I		10%
	Home assignment II	10%
	Group work	10%
	Test I	10%
	Test II	10%
	Final examination	50%
	Maximum marks	100%

Course Objectives: After successful completion of the course students able to:

- know and apply the basic knowledge in variable calculus
- apply the knowledge of variable calculus
- solve Bolza and Mayer problems
- solve quadratic and lines optimal control problems

Course Description: Variational calculus, some Generalization of variational problems, Theory of Optimal Control, Bolza and Mayer Optimal control problems, Maximum principle, Quadratic Optimal control problems.

Course Name…….. Numerical Analysis

Course Code……Math 6411

Course Prerequisite…….. No

Credit Hours + Tutorial Hours……...3 Hrs + 2Hr

Text Book……..

Delivery Methods…….Active Lecture and Active learning method

Performance Evaluation……...Home assignment I 10%

Home assignment II 10%

Group work 10%

Test I 10%

Test II 10%

Final examination 50%

Maximum marks 100%

Course Objectives: After successful completion of the course students able to:

- Solve differential equations using multi step and finite element methods.
- Solve boundary value problems

Course Description

Numerical methods for differential equations: Multi-step methods; Finite difference method; Runge-Kutta-Nystorm method. Numerical methods for elliptic partial differential equations ADI methods; Neumann and mixed boundary value problems, Methods for parabolic equations; Crank-Nicholson method; Methods for hyperbolic equations, Finite element method.

Course Title: Thesis
Course Code: Math 6822
Credit Hour: 6

Learning Objectives: At the end of this course students will be able to

- Plan for scientific research work
- Solve physical and community problems through scientific study
- Produce published scientific articles that could solve societal problems
- Produce original and review articles through scientific procedures

Course Description

The following areas are assumed that post graduate students of mathematical modeling could possibly do their research projects.

- which could solve societal problems showing the application of mathematics in life sciences and Healthcare sciences
- Original work in applied mathematics to build a model and to find possible solutions.

Quality Assurance

The Department of Mathematics will monitor and maintain the quality of the program according to the quality assurance standards set by the university. To this effect, the department will:

- ensure that contents of the courses are covered.
- ensure that exams, tests, assignments and projects are properly set and conducted.
- ensure that appropriate technology is employed in the teaching-learning process.
- conduct short-term courses and seminars for staff members in order to make use of modern methodology and IT.
- make sure that tutorial classes are well-organized, relevant exercises, home works and assignments are carefully set to enhance and strengthen the students' ability to solve problems and understand the underlying theory.
- ensure that appropriate and recent text books are used for the courses. provide enough reference books for each course.
- evaluate the courses at the end of each semester based on the feed back obtained from the instructors, the tutors and the students ,so as to make the courses more relevant.
- ensure that the lectures are conducted by an appropriate instructors

CODING SYSTEM

The codes for all courses in this curriculum have a form **Math** followed by **four digits**

The first digit represents year of the batch

5 represents first year
6 represents second year

- The second digit represents Course category

  4 =Analysis

  5 = Differential

  6 = Optimization

  7 = Modeling

  8 = Research

- The third digit represents specific subject code under the second digit
- The fourth digit represents type of semester that 1 for first and 2 for second semester.

1	(1)Numerical Analysis	Math 6411
2	(1)Ordinary Differential Equations	Math 5511
3	(2)Partial Differential Equations	Math 5522
4	(1)Optimization and theory of Approximations	Math 5612
5	(2)Optimal Control	Math 6621
6	(1)Mathematical Modeling	Math 5711
7	(2)Mathematical Biology	Math 6721
8	(3)Mathematical Bio Economics	Math 6731
9	(4)Mathematical Epidemiology	Math 6741
10	(1)Applied Research Methodology	Math 5811
11	(2) Thesis	Math 6822

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6. M.A., in History Curriculum, Debre BerhanUniversity, Ethiopia