COVENANT UNIVERSITY

DEPARTMENT OF MATHEMATICS

DEPARTMENTAL POSTGRADUATE HANDBOOK

2015-2019

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1. INTRODUCTION

1.1 THE NAME: COVENANT UNIVERSITY (CU)

On October 21, 2002, the African educational landscape was radically altered by the formal entry of Covenant University (CU) into the Higher Education context. Covenant University is located at Canaan land, Ota, Ogun State, Nigeria. It is a growing, dynamic vision-birthed and vision-driven University, founded on a Christian mission ethos and committed to pioneering excellence at the cutting edge of learning.

1.2 VISION

To be a leading World-Class Christian Mission University, committed to raising a new generation of leaders in all fields of human endeavour.

1.3 MISSION

To create knowledge and restore man's dignity through a Human Development concept of the Total Man, employing innovative, leading-edge, teaching and learning methods. Application of research that promotes integrated, life-transforming values through Science, Technology and Human Capacity Building.

1.4 MANDATE

The University's specific mandate can be stated as follows:

- "Raising a new generation of leaders through a qualitative and life-applicable training system that focuses on value and skill development"
- "Raising a new generation of leaders through a broad-based qualitative education built on sound biblical principles culminating in the birth of path- finders, pace-setters and trail-blazers".
- "Raising a new generation of leaders who shall redeem the battered image of the black race and restore her lost glory as this trained army of reformers begins to build the old wastes, repair the wasted cities and raise the desolation of many generations".

1.5 FOUNDING PHILOSOPHY

In response to the global demand for a departure from dogmatism to dynamism in the existing educational system, Covenant University is built on the following philosophical platform:

- a departure from form to skill
- a departure from knowledge to empowerment
- a departure from figures to future-building
- a departure from legalism to realism

- a departure from mathe-matics to life-matics.

This is reflected in our motto: “Raising a New Generation of Leaders”.

1.6 OBJECTIVES

The objectives of the University are to:

i. provide facilities for learning and give instructions and training in such areas of knowledge that will produce sound and mentally equipped graduates who will provide intellectual leadership in academic institutions, industry and the public sector through the Total Man Concept approach;
ii. develop and offer academic and professional programmes leading to the award of diplomas, first degrees and higher degrees, which emphasize planning, adaptive and technological maintenance, developmental and productive skills;
iii. promote by research and other means, the advancement of knowledge and its practical application to social, cultural, economic, scientific and technological problems;
iv. encourage and promote scholarship and conduct research in all fields of learning and human endeavour;
v. disseminate scientific and technological knowledge among scientists, researchers, industries, trade services and other bodies; and
vi. relate its activities to the technological, scientific and socio-economic needs of the people of Nigeria and to undertake other activities appropriate for a University of the highest standard.

1.7 CORE VALUES

Our Core Values as a University are the defining components of the Covenant University Vision and they reflect our beliefs in the encrypted truths that firmly define our purpose and the underlining ethos of our existence as a University.

As a University, we strongly uphold the practices embedded in our Core Values and strive to integrate these Values into all facets of our functions and operations as a University. We expect that students of Covenant University will visibly demonstrate and integrate the virtues embedded in these Core Values in their daily conduct as students who are being raised along the Vision lines of raising a New Generation of Leaders for the Continent of Africa on the Total Man Concept-driven developmental platform. All students are expected to adhere strictly to the University's Core Values in their day-to-day activities within or outside the University.

The Covenant University Core Values are: Spirituality, Possibility Mentality, Capacity Building, Integrity, Responsibility, Diligence and Sacrifice.

Spirituality

This forms the bedrock of our existence as a University and defines every aspect of our operations and context. The Christian ethos underlies our activities and conducts at all times, and every student of Covenant University is expected to exhibit the character traits and dispositions of a Jesus-centred heritage. The Jesus - factor centred approach to all issues is non-negotiable and central in the pursuit of our mandate in raising a New Generation of leaders. To this end, therefore, students are to be committed to maintaining a high level of spirituality and act in such a manner as to facilitate their spiritual growth. Attendance at Chapel Services, which every student is expected to attend with a Bible, notebook and pen, are a compulsory and essential part of students' spiritual development. Students is also expected to demonstrate a deep reverence for God at all times.

Possibility Mentality

Students of Covenant University are expected to exhibit a royal carriage, attitude, habit and character, exuding self-confidence and dignity at all levels of interaction and in general conduct. They are expected to see themselves as persons of worth and value, taking pride in their uniqueness as individuals with a positive mind-set devoid of any trace of inferiority.

Capacity Building

This is related to commitment to a lifestyle of continuous academic and personal development, striving to be continuously relevant to the overall vision requirement of the University as well as her core mission, goals and objectives. Students are encouraged to constantly seek paths for self-improvement. Openness to learning new skills and taking on board new information is a trait expected of Covenant University students in order to have robustness and depth in the quality of their output.

Integrity

Students of Covenant University are expected to demonstrate traits of honesty, uprightness and trustworthiness at all times. They must ensure that they are accountable, transparent and open in all their dealings. They shall flag truth as a virtue at all times, particularly in conduct during examinations, obeying the rules and regulations of the University, being spiritually sound, morally upright and having a good conscience.

Responsibility

We are committed to inculcating a sense of responsibility in our students. We believe in the place of discipline for effective leadership. We expect our students to respond to issues as demanded, not as convenient. Here at Covenant University, our students are not permitted to do what they like but what is right. Punctuality at lectures, as well as prompt response to assignments as demanded, is a desired trait of responsibility.

Diligence

Students of Covenant University are expected to be deeply committed to their assignments. We expect that they will extol the virtues of hard work and constantly strive towards excellent attainment in all they do.

Sacrifice

Sacrifice is the ultimate price for outstanding leadership. It is the quality of sacrifice that defines great leadership. We therefore expect students of Covenant University to go the extra-mile and pay the extra- price in the attainment of their set goals. Raising an altar of sacrifice in pursuit of their dreams is what must distinguish and define the Covenant University student.

1.8 THE TOTAL MAN CONCEPT

The Total Man Concept (TMC) is Covenant University's custom-built Programme that constitutes the core concept of her academic programmes.

This concept centres on “developing the man that will develop his world.” It is designed to make the student become intelligently conscious of his environment and thus be able to maximize his potential.

The programmes of the University are first directed at “the person” before his profession. In this way, the University will raise a generation of experts who possess the capacity to face and manage challenges.

The TMC Programme centres on three components of the human personality: the spirit, the mind, and the body.

The Spiritual Man

Spiritual development is to us a major force for the evolvement of the Total Man, as mental excellence and understanding are generated through the vital force in man, which is the Spirit of God and the Spirit of Intelligence.

As a University sponsored by a Christian Mission, character formation is considered as a spiritual issue that is instilled by self-discipline and commitment to the principles enunciated by our Lord Jesus Christ.

Covenant University provides opportunities for spiritual development through various avenues, including spiritual formation programmes and counselling, and also by creating leadership opportunities.

The Intellectual Man

Covenant University students enjoy the highest standards of excellence through the institution of academic programmes that are innovative, creative and functional.

Covenant University also encourages students to be inquisitive, bold and forthright in asking questions and facing the challenges of academic leadership.

The Total Man concept is also promoted through the introduction of a system of compulsory, theoretical and practical courses, all of which must be passed before one can be considered for a degree from the University. In addition to normal General Studies courses, we have included our own specially-designed courses in areas such as: biographical studies, entrepreneurship, family life, human development process, leadership development, mental development, success concepts, work ethics and Towards the Total Graduate (TTG) Programme.

The Physical Man

The body is a vital component of the Total Man. Covenant University is committed to providing avenues for sound physical development via recreational activities that engage the body and also enhance personality development, stimulating the cultivation of lifestyles that are conducive to healthy living. We thus encourage students to participate in sporting activities.

1.9 THE TOTAL GRADUATE

The Covenant University graduate will be mentally resourceful, intellectually reinforced, enterprisingly self-dependent, futuristically visionary and responsibility-sensitive to the changes demanded for the leadership role or dominion nature he is made for. He shall be a Total Man.

2. PRINCIPAL OFFICERS OF COVENANT UNIVERSITY

CHANCELLOR

David O. Oyedepo, Ph.D., FNAE

Vice-Chancellor

Professor Charles K. Ayo, B.Sc., M.Sc., Ph.D

Deputy Vice-Chancellor

Professor Taiwo O. Abioye, B.A., M.A., Ph.D

Registrar

Pastor Olamide Olusegun, B.A., M.A

Dean, Student Affairs

Dr. Zacchaues Omogbadegun, B.Sc., M.Sc, Ph.D

Director, Centre for Learning Resources

Dr. Christopher Nkiko, B.Sc., M.Sc., MLS., Ph.D

Director, Financial Services

Pastor Adebayo Oladehinbo, B.Sc, ACA

Director, Physical Planning & Development

Pastor Azubuike Nwoke, M. Arch

Director, Centre for Systems and Information Services

Mr. Yinka Adeboye, B.Sc., M.Sc

University Chaplain

Pastor Charles Ehekwaba

DEANS OF COLLEGES & SCHOOL OF POSTGRADUATE STUDIES

Dean, School of Postgraduate Studies

Professor Shalom Chinedu, B. Sc., M.Sc., Ph.D

Dean, College of Leadership Development Studies

Professor Charles Ogbulogo, B.A (Ed.), M.A., Ph.D

Dean, College of Science and Technology

Professor Nicholas Omoregbe, B.Sc., M.Sc., Ph.D

Dean, College of Science and Technology

Professor John Samuel Ndueso, B. Eng. M. Eng., Ph.D

3. OVERVIEW OF THE DEPARTMENT OF MATHEMATICS

The Department of Mathematics exists within the College of Science and Technology of Covenant University for the purpose of fostering advanced research in areas of mathematics having the capacity or potential for industrial applications and for the purpose of facilitating the transfer of research results and expertise between the academic and industrial sectors.

The Department of Mathematics started at the inception of the University in 2002 as a servicing unit. In 2004, it started as a full unit under the Department of Natural Sciences admitting its first set of five female students into the B.Sc. Industrial Mathematics programme. In 2006, it became an autonomous department known as Department of Mathematics. The Department is currently under the headship of Dr. E.A. Owoloko.

Vision

To be a leading Mathematics Department within the context of a leading World-Class University, committed to raising a new generation of competent, trustworthy leaders in the field of Mathematics.

Mission

To create well-balanced, high-quality and locally adaptable mathematics knowledge, employing innovative, leading-edge teaching and learning methods and research leading to the award of Master of Science and Doctor of Philosophy degrees in industrial mathematics, thereby restoring confidence and fostering a curriculum that promotes an integrated, life-applicable transforming education relevant in a globalised world. The programme is thus designed to raise a new generation of industrial mathematicians who are mentally resourceful, intellectually equipped, futuristically visionary and responsible change-agents with leadership skills to show.

Postgraduate Programmes

The Postgraduate programme in the Department started mainly for the in-house development of the members of staff of the department. This was meant to meet the dire need for high level manpower, well equipped to meet the challenges of the visions of the founding fathers of the University and the development of the nation.

The Postgraduate programme of the Department, which started in 2004 with one student, has since graduated four Ph.D students and currently has 8 Ph.D students registered in the Department.

The following options exist subject to the availability of qualified supervisors:

- Financial Mathematics
- Statistics
- Operation Research
- Optimization
- Fluid Dynamics
- Numerical Analysis

The Department of Mathematics is operated by the following committees:

i. Postgraduate Committee
ii. Curriculum Committee
iii. Research & Development Committee
iv. Academic Standards & Quality Assurance Committee
v. Disciplinary Committee
vi. Examination Timetable Committee

3.1 ORGANOGRAM OF THE DEPARTMENT

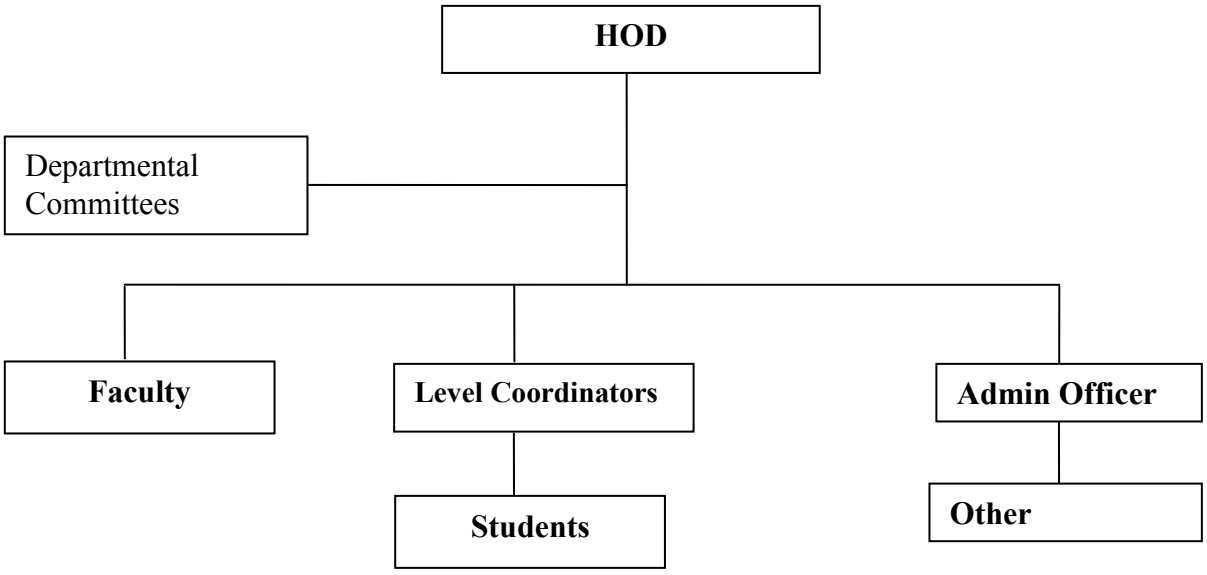

Figure 1. Administrative Structure of Department of Mathematics

3.2 PHILOSOPHY, AIMS AND OBJECTIVES OF THE PROGRAMME

Philosophy

The world of mathematics can be visualized as many concentric layers emanating outward from a "core" of pure mathematics. At this core is the investigation of significant form, nourished by its own creative energy, algebra. Venturing outward, one encounter's fields more directly concerned with physical and human problems: differential equations, numerical analysis, computational methods in optimization, financial mathematics, etc.

Mathematical modeling has been so proliferated that at the outer rim are now distinct disciplines in biomathematics and mathematical economics. The ideas, structures, and theories at the core diffuse outwards, continually providing the methods for approaching the complex problems of applied mathematics.

In return, the concerns at the outer layers infuse life into the core, with new ideas and structures. Even this concentric view by fields is too simple; for within each field of mathematics and, sometimes, within the research endeavours of a single mathematician, one can witness this dynamic dialectic between the discovery of basic form and the solution of external problem. In the Department, one senses the vitality of this interplay, with the entire spectrum of fields well represented. A prospective postgraduate student can expect a close intellectual interaction as well as opportunities for socializing with a strong and receptive college.

All postgraduate programmes of the Department are designed to provide candidates with in-depth skills that would enable them to develop a high level of mathematical competence in research and its applications to real world problems. The programmes feature rigorous apprenticeship in pure and computational mathematics and are designed to produce capable mathematicians qualified for key positions in education, government and industries. Today, not only does mathematics thrive in its traditional role of giving form, language, and often

content to natural science, but also it is increasingly taking on the role of the social discipline and even humanities. Within the last few decades, the frenetic pace of research and development in computers and high technology has led to strong new imperatives for more mathematical expertise, and the need to nurture a new generation of mathematically competent men and women has never been more crucial.

Aim

The postgraduate programmes in the Department are aimed at producing graduates with in-depth skills and mathematical competence honed by rigorous apprenticeship in pure and computational mathematics which qualifies them for key positions in research and development, education, government and industries.

Objectives

On successful completion of their studies, all the candidates should:

i. be able to apply critical and analytical reasoning in problem solving;
ii. be able to develop solving skills;
iii. have covered the core topics of Industrial Mathematics which the Department considers appropriate for the Postgraduate programme;
iv. have had the opportunity to take courses outside their main area of study; and
v. be able to carry out researches that will provide practical solutions to problems in industries, thereby bridging the gap between town and gown.

3.3. LIST OF ACADEMIC STAFF FOR POSTGRADUATE PROGRAMMES

S/N	NAME OF ACADEMIC STAFF	QUALIFICATION	RANK
1	Dr. Owoloko, E. A.	B.Sc, M. Sc, MBA, Ph.D	Senior Lecturer / HOD
2	Prof. Iyase, S.A	B.Sc, M.Sc, Ph.D	Professor
3	Dr. Adejumo, A.O.	B.Sc, M.Sc, Ph.D	Associate Professor
4	Dr (Mrs) Patience Adamu	B.Sc, M.Sc, Ph.D	Associate Professor
5	Dr. Adamu, M. O.	B.Sc, M.Sc, Ph.D	Senior Lecturer
6	Dr. Anake, T. A.	B.Sc, M.Sc, Ph.D	Senior Lecturer
7	Dr. (Mrs) Bishop, S. A.	B.Sc, M.Sc, Ph.D	Senior Lecturer
8	Dr. Agarana, M. C.	B.Sc, M.Sc, Ph.D	Lecturer I
9	Dr. (Mrs) Eke, K. S.	B.Sc, M.Sc, Ph.D	Lecturer II
10	Dr. Oghonyon, J. G.	B.Sc, M.Sc, Ph.D	Lecturer II
VISITING LECTURERS			
11	Prof. Gbadeyan, J.A.	B.Sc, M.Sc, Ph.D	Professor
12	Prof. Adewunmi, A. O.	B.Sc, M.Sc, Ph.D	Professor
13	Dr. Shittu, O. I.	B.Sc, M.Sc, Ph.D	Associate Professor
14	Dr. Idowu, A. S	B.Sc, M.Sc, Ph.D	Senior Lecturer
ADJUNCT LECTURER			
15	Professor Ogbulogo, C.	B.A, M.A, Ph.D	Professor
16	Professor Adebiyi E.	B.Sc, M.Sc, Ph.D	Professor
17	Dr. Daramola, O.	B.Sc, M.Sc, Ph.D	Associate Professor
18	Dr. Moses, C. Love	B.Sc, M.Sc, Ph.D	Associate Professor
19	Dr. Adegbuyi, O.	B.Sc, M.Sc, Ph.D	Senior Lecturer

4. STUDENT ADMISSION AND GRADUATION REQUIREMENTS

i) Master of Science (M.Sc.) Degree in Industrial Mathematics

Admission Requirements

Admission to the programme is open to holders of the degree of Bachelor of Science in Mathematics or Industrial Mathematics of Covenant University or of other universities recognized by Senate. Candidates must have a minimum of Second Class Lower Division in Mathematics or Industrial Mathematics of the Covenant University or of other universities recognized by the Senate. Graduates of Engineering, the Physical or Natural Sciences whose background are considered adequate by the Mathematics Department may also be considered.

Candidates admitted to the programme shall be required to register for a minimum of 32 course units in 2 semesters. In addition, on completion of courses, candidates shall be required to register for a project, which is also a six (6) units' course.

Requirements for the Award of M.Sc. Degree

To qualify for the award of the degree, a candidate must be credited with a minimum of 32 course units (i.e. 30 units of Industrial Mathematics courses plus Entrepreneurial Development Studies (EDS) and Total Man Concept (TMC) of 1 unit each), and satisfy the examiners in the project which carries twelve (12) units. The candidate must present at least three seminars of three (3) units each before the final project defence. The programme for the M.Sc degree in Industrial Mathematics has the duration of a minimum of eighteen months for full-time students and a minimum of twenty-four months for part-time.

Grading System: During their coursework, postgraduate students are evaluated using the 30:70 method of assessment. This implies that continuous assessment is 30% and examination is 70%. Grading is done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point Equivalents (GPE).

% Scores	**Letter Grades**	**Grade Points (GP)**
70-100	A	5
60-69	B	4
50-59	C	3
Below 50	F	0

Students' Probation, Withdrawal and Expulsion: So far, there has been no case of probation, withdrawal or expulsion from the postgraduate programme in the Department of Mathematics. Any student who fails to register for an academic session is deemed to have voluntarily withdrawn from the postgraduate programme of Covenant University. Any student with less than 3.00 CGPA shall remain in the programme for the 1st semester but shall be advised to withdraw if he/she fails to attain 3.00 CPGA at the end of the second semester. A student is expelled if found guilty of gross misconduct.

ii) Ph.D Industrial Mathematics

Admission Requirements

Admission into the Ph.D programme is open to candidates who already possess the Degree of M.Sc in Mathematics or Industrial Mathematics. The candidate must have obtained a minimum CGPA of 4.0 in the M.Sc Degree or a CGPA of 4.0 at the Master of Philosophy (M.Phil) or M.Phil/Ph.D coursework in Mathematics or Industrial Mathematics from Covenant University or any other University recognised by the Senate of Covenant University.

Candidates with a CGPA of 3.50 – 3.99 (55%) may be admitted for M.Phil/Ph.D Industrial Mathematics Programme. M.Phil/Ph.D is a conversion programme. To be eligible for conversion into the Ph.D Programme, the M.Phil candidate must have passed all the stipulated courses with a minimum CGPA of 4.0 and successfully carried out the M.Phil/Ph.D Proposal defence.

Requirements for the Award of Ph.D Degree

To satisfy the requirements for the award of the Ph.D degree in Industrial Mathematics, candidates must:

(i) take and pass at least twenty (20) credit units of coursework including other relevant requirements in Postgraduate Degree regulations. The minimum pass mark in any course and thesis shall be 50% and 60% respectively; and

(ii) prepare and submit a satisfactory supervised thesis, which must be successfully defended before a panel of Examiners.

The duration for the completion of the doctoral programme is normally a minimum period of three academic years (i.e. six semesters) of coursework and research.

Graduation Policy: To satisfy the requirement for the award of a Ph.D degree in Industrial Mathematics, candidates must take and pass a minimum of 20 credit units.

Grading System: During their coursework, postgraduate students are evaluated using the 30:70 method of assessment. This implies that continuous assessment is 30% and examination is 70%. Grading of courses is done by a combination of percentage marks and letter grades translated into a graduated system of Grade Point Equivalents (GPE).

% Scores	Letter Grades	Grade Points (GP)
70-100	A	5
60-69	B	4
50-59	C	3
Below 50	F	0

Students' Probation, Withdrawal and Expulsion: Any student who fails to register for an academic session is deemed to have voluntarily withdrawn from the postgraduate programme of Covenant University. A student whose Cumulative Grade Point is below 4.00 at the end of two consecutive semesters shall withdraw from the programme. A student who fails to sit for more than 2 courses at the end of a given semester will be deemed to have withdrawn voluntarily from the programme. A student found guilty of gross misconduct shall be expelled

5. M.Sc INDUSTRIAL MATHEMATICS COURSES

Workload by students: Per semester
Programme/Sub-Discipline/Discipline workload by students.

Grouping	Course Codes	Course Titles	Pre-Requisite	Credit Units	Contact Hours Per Week			Total Hours Per Week
					Lecture	Tutorial	Practical	
ALPHA SEMESTER								
General	EDS811	Entrepreneurial Development Studies		1	1		1	1
	TMC811	Total Man Concept		1	1			1
	MAT830	Research Methodology						
	MAT818	Functional Analysis and its Applications		3	3			3
Core/Compulsory Courses	**Industrial Mathematics**							
	MAT815	Ordinary Differential Equations 1		3	3			3
	MAT816	Theory of Financial Markets & Financial		3	3			3

		Intermediation						
	Industrial Mathematics (Statistics Option)							
	MAT851	Statistical Inference						
	MAT856	Applied Econometrics I						
	MAT814	Fourier Analysis		3	3			3
	MAT817	Computational Optimization 1		3				3
	MAT831	Numerical Linear Algebra I		3	3			3
	MAT832	Numerical Methods for Ordinary Differential Equations		3	3			3
	MAT833	Operations Research 1		3	3			3
	MAT834	Mathematical Methods in Economics		3	3			3
	MAT835	Complex Analysis		3	3			3
	MAT836	Theory of Measures		3	3			3
	MAT852	Probability Theory I		3	3			3
	MAT854	Categorical Data Analysis		3	3			3
	MAT855	Sample Survey techniques		3	3			3
	MAT857	Bayesian Inferences I		3	3			3
	MAT852	Probability Theory I		3	3			3
OMEGASEMESTER								
General		Seminar 1		3	3			3
		Seminar 2		3	3			3
		Seminar 3		3	3			3
	MAT888	Research Project		12	12			12
Core\Compulsory Courses	**Applied Mathematics Option**							
	MAT825	Ordinary Differential Equations 2		3	3			3
	MAT826	Partial Differential Equations 2		3	3			3
	MAT848	Finite Element Method		3	3			3

	MAT849	Probability Theory		3	3			3
	MAT861	Stochastic Processes		3	3			3
	Statistics Option							
	MAT849	Probability Theory		3	3			3
	MAT860	Forecasting and Time Series		3	3			3
	MAT861	Stochastic Processes		3	3			3
	MAT865	Design & Analysis of Experiments		3	3			3
	MAT868	Sample & Survey Technique		3	3			3
	MAT827	Computational Optimization II		3	3			3
	MAT828	Computational Optimization III		3	3			3
	MAT840	Mathematical Methods		3	3			3
	MAT841	Numerical methods for Partial Differential Equations		3	3			3
	MAT842	Fluid Mechanics		3	3			3
	MAT843	Mathematical Modelling		3	3			3
	MAT844	Operations Research II		3	3			3
	MAT845	Quantum Mechanics		3	3			3
	MAT862	Advanced Statistical Theory						
	MAT863	Quality Control and Practice		3	3			3
	MAT864	Applied Econometrics		3	3			3
	MAT866	Probability and Distribution Theory		3	3			3
Grand Total				66	66			66

Course Code and Description

COMPULSORY UNIVERSITY COURSES		
Alpha Semester		
Course Code	**Course Title**	**Unit**
TMC811	Total Man Concept	1
EDS811	Entrepreneurial Development Studies	1
	Sub-Total	**2**

Master of Science (M.Sc.) Programme in Industrial Mathematics

COMPULSORY DEPARTMENTAL COURSES (Statistics Option)		
Alpha Semester		
Course Code	**Course Title**	**Unit**
MAT 818	Functional Analysis and its Applications	3
MAT 830	Methods of Research in Mathematics	3
MAT 851	Statistical Inference	3
MAT 853	Mathematical/Statistical Software	0
MAT 856	Applied Econometrics I	3
MAT 885	Seminar 1	3
MAT 886	Seminar II(Proposal Defence)	3
MAT 887	Seminar III	3
MAT 888	Research Project	12
	Sub Total	**33**
COMPULSORY DEPARTMENTAL COURSES (Industrial Mathematics Option)		
Alpha Semester		
Course Code	**Course Title**	**Unit**
MAT815	Ordinary Differential Equations I	3
MAT816	Partial Differential Equations I	3
MAT818	Functional Analysis and its Applications	3
MAT830	Methods of Research in Mathematics	3
MAT853	Mathematical/Statistical Software	0
MAT885	Seminar 1	3
MAT886	Seminar II(Proposal Defence)	3
MAT887	Seminar III	3

MAT888	Research Project	12
	Sub Total	**33**

ELECTIVES

Alpha Semester		
Course Code	**Title**	**Units**
MAT 814	Fourier Analysis	3
MAT 817	Computational Optimization I	3
MAT 831	Numerical Linear Algebra I	3
MAT 832	Numerical Methods for Ordinary Differential Equations	3
MAT 833	Operations Research I	3
MAT 834	Mathematical Methods in Economics	3
MAT 835	Complex Analysis	3
MAT 836	Theory of Measures	3
MAT 852	Probability Theory I	3
MAT 854	Categorical Data Analysis	3
MAT 855	Sample Survey techniques	3
MAT 857	Bayesian Inferences I	3
	Sub-Total	**36**
Total		**69**

COMPULSORY DEPARTMENTAL COURSES (Applied Mathematics Option)		
Omega Semester		
Course Code	**Course Title**	**Unit**
MAT825	Ordinary Differential Equations II	3
MAT826	Partial Differential Equations II	3
MAT848	Finite Element Method	3
MAT849	Probability Theory	3
MAT861	Stochastic Processes	3
	Sub Total	**15**

ELECTIVES

COMPULSORY DEPARTMENTAL COURSES (Statistics Option)		
Omega Semester		
Course Code	**Course Title**	**Unit**
MAT849	Probability Theory	3
MAT860	Forecasting and Time Series	3
MAT861	Stochastic Processes	3
MAT865	Design and Analysis of Experiment	3
MAT868	Sample and Survey Techniques	3
	Sub Total	**15**

Omega Semester		
Course Code	**Title**	**Units**
MAT827	Computational Optimization II	3
MAT828	Computational Optimization III	3
MAT840	Mathematical Methods	3
MAT841	Numerical methods for Partial Differential Equations	3
MAT842	Fluid Mechanics	3
MAT843	Introductions to Mathematical Modelling	3
MAT844	Operations Research II	3
MAT845	Quantum Mechanics	3
MAT862	Advanced Statistical Theory	3
MAT863	Quality Control and Practice	3
MAT864	Applied Econometrics	3
MAT866	Probability and Distribution Theory	3
MAT867	Non-parametric and Sequential Methods	3
MAT868	Multivariate Analysis	3
MAT869	Biostatistics	3
	Sub-Total	**45**
Total		**75**

6. Ph.D INDUSTRIAL MATHEMATICS COURSES

Workload by students: Per semester

Programme/Sub-Discipline/Discipline workload by students.

Grouping	Course Codes	Course Titles	Pre-Requisite	Credit Units	Contact Hours Per Week			Total Hours Per Week
					Lecture	Tutorial	Practical	
ALPHA SEMESTER								
General	EDS911	Entrepreneurial Development Studies		1	1		1	1
	TMC911	Total Man Concept		1	1			1
	MAT930	Research Methodology						
	MAT915	Functional Analysis and its Applications		3	3			3
Core/Compulsory Courses								
	MAT985	Seminar 1		3	3			3
	MAT986	Seminar II (Proposal Defence)		3	3			3
	MAT987	Seminar III		3	3			
	MAT988	Research Project		12	12			3
Electives	MAT911	Numerical Linear Algebra II		3	3			3
	MAT912	Mathematical Methods		3	3			3
	MAT914	Finite Element Methods		3				3
	MAT916	Mathematics of Finance I		3	3			3
	MAT917	Stochastic Analysis		3	3			3
	MAT918	Advanced Analytical Dynamics		3	3			3
	MAT919	Ordinary Differential Equations		3	3			3
	MAT924	Dynamics of Distributed-Parameter System		3	3			3

	MAT931	Optimization		3	3			3
	MAT932	Theory of Measure		3	3			3
	MAT933	Mathematics of Finance II		3	3			3
	MAT934	Methods of Applied Mathematics in Dynamics		3	3			3
	MAT935	Partial Differential Equations		3	3			3
	MAT936	Numerical Analysis		3	3			3
	MAT937	Stochastic Processes		3	3			3
	MAT938	Quantum Mechanics		3	3			3
	MAT939	Mathematical Foundation on Quantum Field Theory		3	3			3
	MAT950	Statistical Inference		3	3			3
	MAT951	Categorical Data Analysis		3	3			3
	MAT952	Applied Econometrics		3	3			3
	MAT953	Advanced probability		3	3			3
	MAT954	Forecasting and Time Series Analysis		3	3			3
	MAT955	Sample Survey Method		3	3			3
	MAT 956	Theory of Multivariate Analysis		3	3			3
	MAT 957	Bioinformatics		3	3			3
	MAT 958	Financial and Economic Time Series		3	3			3
Grand Total								**92**

COMPULSORY UNIVERSITY COURSES		
Alpha Semester		
Course Code	**Course Title**	**Unit**
TMC 911	Total Man Concept	1
EDS 911	Entrepreneurial Development Studies	1
	Sub-Total	**2**

COMPULSORY DEPARTMENTAL COURSES		
Alpha Semester (Only)		
Course Code	**Course Title**	**Unit**
MAT915	Functional Analysis and Its Applications	3
MAT930	Methods of Research in Mathematics	3
MAT985	Seminar 1	3
MAT986	Seminar II(Proposal Defence)	3
MAT987	Seminar III	3
MAT988	Research Project	12
	Sub Total	**17**

ELECTIVES

MAT911	Numerical Linear Algebra II	3
MAT912	Mathematical Methods	3
MAT913	Functional Analytical Methods	3
MAT914	Finite Element Methods	3
MAT916	Mathematics of Finance I	3
MAT917	Stochastic Analysis	3
MAT918	Advanced Analytical Dynamics	3
MAT961	Dynamics of Distribution-Parameter	3
MAT962	Non-Linear and Random Analysis Dynamics	3
MAT963	Fluid Mechanics 1	3
MAT964	Fluid Mechanics II	3
MAT965	Fluid Mechanics III	3
MAT966	Fluid Mechanics IV	3
MAT919	Ordinary Differential Equations	3
MAT924	Dynamics of Distributed-Parameter System	3
MAT931	Optimization	3
MAT932	Theory of Measure	3
MAT933	Mathematics of Finance II	3
MAT934	Methods of Applied Mathematics in Dynamics	3
MAT935	Partial Differential Equations	3

MAT936	Numerical Analysis	3
MAT937	Stochastic Processes	3
MAT938	Quantum Mechanics	3
MAT939	Mathematical Foundation on Quantum Field Theory	3
MAT950	Statistical Inference	3
MAT951	Categorical Data Analysis	3
MAT952	Applied Econometrics	3
MAT953	Advanced probability	3
MAT954	Forecasting and Time Series Analysis	3
MAT955	Sample Survey Method	3
MAT956	Theory of Multivariate Analysis	3
MAT957	Bioinformatics	3
MAT 958	Financial and Economic Time Series	3
Total		**99**

7. M.Sc COURSE DESCRIPTION

Alpha Semester

MAT814: Fourier Analysis **3 units**

The Circle Group T and Fourier series on T: Convolution of functions. The Dirichlet and Fejet kernels. Cesaro summability. Fourier series in $L_2(T)$. Positive-definite functions. Introduction to the theory of Multiple Fourier transforms on $\Re$.

MAT815: Ordinary Differential Equations I **3 units**

Basic existence, uniqueness, continuation and continuous dependence results. Theory of linear equations and systems, stability theory; Poincaré-Bendixson theory; qualitative theory. Non-linear equations. Regular eigenvalue problems.

MAT816: Partial Differential Equations I **3units**

Basic examples of linear partial differential equation and their fundamental equations and solutions. Non-linear equations. Existence and regularity of solutions (local or global) of the Cauchy problem Boundary value problems and mixed boundary value problems. Propagation of singularities; hypoellipticity, local solvability-Nirenbery-Treves condition.

MAT 817: Computational Optimization I **3 units**

Optimization problems. Iterative methods of optimization. Method of least squares. Contraction mapping theorem. Newton's and Quasi-Newton's methods. Steepest-Descent methods, CGM algorithm. Function space algorithm, variable metric algorithm. Convergence analysis of these methods. Applications.

MAT818: Functional Analysis and its Application **3 units**

Normed linear spaces, Inner product spaces, Linear Operators; Banach spaces; Hilbert spaces, Symmetric, Selfadjoint, Unitary Operators on Hilbert spaces, Elements of Lebesgue Integration; Classical Banach spaces: L^P-Spaces ($1 \leq p < \infty$); L^2-Space as a Hilbert space; Green's functions; Fredholm's Alternatives; Introduction to the Theory of Distributions, Contraction Mapping Theorem. Some aspects of spectral theory of linear operators, Applications in Industry. Applications to Classical Analysis.

MAT830: Methods of Research in Mathematics 3 units

Fundamental principles of research in mathematics: Originality, creativity and independent thinking. Literature review, Identification of current issues in contemporary mathematics, Problem-solving, Analysis and synthesis, Computational techniques, Ethical issues.

MAT831: Numerical Linear Algebra I 3 units

Numerical Solution of Systems Linear Equations: Direct methods for linear equations, Gaussian Elimination method, LU Decomposition method, Cholesky method, Gram Schmidt method, Given's method, and Householder's method. Numerical Solution of Non-Linear Algebraic Equations: Iterative Methods.

MAT832: Numerical Methods for Ordinary Differential Equations Methods 3 units

Numerical solution of ordinary differential equations, initial-value and boundary value problems; higher order one-step methods: Taylor series, R-K methods, convergence and stability of these methods, multistep methods, Adams-Moulton's methods, predictor – corrector methods, stability of these methods. Shooting methods and methods for stiff equations.

MAT833: Operations Research I 3 units

Replacement Theory, Scheduling, Inventory Control, Queueing Theory, Markov Chains and Simulation, Decision Theory, Mathematical Game Theory, Gambling. Linear Programming, Networks, Allocation Methods, Integer and Mixed Programming,

MAT 834: Mathematical Methods in Economics 3 units

General equilibrium Techniques (input-Output Model, Stochastic Optimal Control etc). Convex Analysis Functions, Stabilization of Economics, Location theory. Optimal Steady-State Behaviour of an Economy with Stochastic Production and Resources. Net Present Value, Internal Rate of Return and Return on Investment, etc. Capital Market Theory. Measures of Risk and Uncertainty Applied to Investment Decision Making.

MAT835: Complex Analysis **3 units**

Periodic functions, Weierstrass functions, Elliptic curves, Modular forms, Algebraic functions, Riemann surfaces, Covering surfaces, Covering transformations, Discontinuous groups of linear transforms, automorphic forms.

MAT836: Theory of Measure **3 units**

Lebesgue measure for subsets of R^n. Lebesgue integration of real and complex-valued functions defined on R^n. General measure space (X, M, O) and Lebesgue integration with respect to O of real and complex – valued functions on X. The classical Banach spaces.

MAT851: Statistical Inference I **3 units**

Conditioning, distribution theory, approximation to distributions, modes of convergence, limit theorems, statistical models, parameter estimation, properties of estimators, confidence sets, theory of hypothesis tests, introduction to Bayesian inference and nonparametric estimation.

MAT852: Probability Theory I **3 units**

Introduction to measure theoretic probability; derivation and transformation of probability distributions; generating functions and characteristic functions; conditional expectation, sufficiency, and unbiased estimation; methods of large sample theory including laws of large numbers and central limit theorems; order statistics.

MAT853: Mathematical/Statistical Software **3 units**

Use of mathematical and statistical software, e.g. Maple, MatLab, SPSS, R, etc is used in demonstrating some examples in mathematics. Practical applications are emphasized in areas such as Optimization, Numerical Analysis, Financial methods, simulation of random processes; numerical methods of fitting linear models, multivariate analysis; methods for nonlinear modelling. Introduction of key aspects of statistical consulting and data analysis activities, report writing and presentation.

MAT854: Categorical Data Analysis **3 units**

Probability mass functions for 2x2 tables, measures of association for 2x2 tables and general CxC tables. Probability mass functions for RxC tables. Goodness of fit tests. Square tables and their applications structural models for two and higher dimensions; Log-linear models and estimate of parameters. Logistic regression and bio-assays.

MAT855: Sample Survey Techniques **3 units**

Construction and choice of strata, frames and various equal and unequal probability sampling schemes with properties. Estimation of means, proportion and their variances. Successive sampling scheme. Problems of non-sampling error and non-response: application to some selected specialized survey.

MAT856: Applied Econometrics **3 units**

OLS, Gauss-Markov Theorem. MLE. Specification and misspecification test. Predictive and non-predictive tests, Tests of hypothesis for linear model. The likelihood ratio, wald and language multiplier Tests; Multi-colinearity. Specification bias. GLS. Dummy variables and seasonal variations. Inferences based on asymptotic Distribution Theory.

MAT 857 Bayesian Inference I **3 units**

Sampling theory and its critique, subjective probability, likelihood principles, Bayes theorem, Bayesian analysis of Normal theory inference problems, the Behrens-Fisher problem, assessment of model assumptions, robustness of inference, analysis of variance, estimation of variance components, empirical Bayes, some aspects of multivariate problems, sequential nature of Bayesian inference, prior and posterior distributions of parameters in binomial, Poisson, exponential and normal populations, comparison of two normal distributions, predictive distributions, decision theory, utility, risk aversion, extensive form of analysis, two- action problems, point estimation, best population problems, economics of sampling.

Omega Semester

MAT825: Ordinary Differential Equations II **3 units**

This course will cover several topics from differential equations in abstract spaces; functional differential equations; some areas in non-linear ordinary differential equations, Topological degree and applications to ODE; Stability; Lyapunov second Method.

MAT826: Partial Differential Equations II **3 units**

Theory of Distribution; Test functions, support of distribution, operators on distributions, Tensor and convolution products Tempered distributions and Fourier transforms. Sobolev spaces; imbedding theorems, weak formulation of elliptic Boundary value problems, Lax-

Milgram theory and existence of solutions, variational formulation of elliptic problems, Ritz and Galerkin method. Applications.

MAT827: Computational Optimization II **3 units**

Equality and inequality constraints. Unconstrained minimization: Pontryain's and Hamilton's principles. Extremization of integrals. Sensitivity analysis. Penalty methods. Projection methods and applications to optimal central problems.

MAT828: Computational Optimization III **3 units**

Unconstrained continuous optimal control problems. Fletcher-Reeves algorithm, Polak-Ribierre algorithm and its application to equality constrained control problems. Unconstrained disease optimal control problems and methods of solutions. Applications.

MAT840: Mathematical Methods **3 units**

Difference, Differential, Functional and Integral Equations, Green's Functions and Conversion to Integral Equations of Partial Differential Equations, Cauchy Problems, Riemann's Method, Fundamental Solution to Laplace, Wave and Heat Equations, Transforms, Asymptotic Methods, Calculus of Variations, Non-Linear Problems.

MAT841: Numerical Methods for Partial Differential Equations **3 units**

Partial differential equation, classification, boundary value and initial value problems. Parabolic equation; Solution techniques by explicit, Fourier stability and matrix methods, stability and convergence analysis. Elliptic equations. Solution techniques by finite difference methods; iterative methods. ADI methods, Block iteration and SOR methods, convergence and stability of these methods. Hyperbolic equation: Solution techniques by method of characteristics, explicit-implicit methods, hybrid methods, Hospscotch methods, convergence and stability analysis.

MAT 842: Fluid Dynamics **3 units**

Thermodynamics Compressible flow; waves; sheeks; supersonic flow; Boundary layer theory; stability; Turbulence

MAT843 - Introduction to Mathematical Modelling 3 units

Mathematical Modelling: The art of transforming real life situations as in biology, business, deformable media, industry, and other dynamical systems into mathematical form. Case studies.

MAT844 - Operations Research II 3 units

Dynamic Programming, Inventory Problems, Graph Theory, Stock Control, Queuing Problems, Decision Theory, Non-Linear Programming, Algorithms and their Reliability, Scheduling, Simulation, Multicriterial Decision Making, Theory of Games (Linear differential), Case Studies.

MAT845 – Quantum Mechanics 3units

Background of the axiomatic approach to Nul et al. Axiomatic of continuum and Basic Concepts. Constitutive Relations. Equations of Motion and other Equations of Balance. The place of classical theories. Schrodinger equations; Stone's Theorem and its applications. Unitary transformation: Heisenberg representation; Measurement; Quantum Theories of Scattering; Angular Momentum. Motion in an external field; Bose and Fermi Statistics; Perturbation Theory.

MAT848 – Finite Elements Methods 3 units

Introduction to the Finite Element method: Formulation of the Finite Element method using the Principle of Virtual Displacement, General Isoparametric Formulation, and Variational Techniques, Generalization of the theory, Application of the Finite Element Method to the Solution of Engineering Problems e.g. in Solid Mechanics, Heat Transfer, Fluid Dynamics and Mass Transfer (and/or applications in industries). Development of appropriate Computer Programme. Case Studies.

MAT 849 – Probability Theory 3 units

Probability Spaces. Probability Distributions. Stochastic independence. Convergence. Strong Limit Theorems of independent random variables. Limit theorems for sums of independent random variables. Conditional Expectation and Martingale Theory.

MAT 860: Forecasting and Time Series **3 units**

Theory of stochastic models and their forecasting. Model building: identification, estimation. Diagnostic checking. Analysis of stationary Data Co-integration and error correction techniques.

MAT861 Stochastic Processes **3 units**

Classification of stochastic processes. Random walk models, Markov chains, inventory model, branching processes. Poisson, birth-and-death processes. Waiting time models, Estimation problems.

MAT862 Advanced Statistical Theory **3 units**

Limiting theorems. Convergence of sequence of variables and some probability functions limiting distribution. Generating functions and inversion theorems. Special parametric univariate and multivariate distributions and large sample theory. Further theory of statistical inference.

MAT863 Quality Control and Practice **3 units**

Analysis and control of variations in a production process OC of a control chart. Control charts for attributes and variables. Cumulative sum control charts. Other control charts. Methods of controlling several related characteristics; Process capability analysis. Design of control charts. Specification and Tolerance.

MAT865: Design and Analysis of Experiments **3 units**

General Linear Models; Generalized inverse of a Matrix, Factorial Experiments;·Symmetric and Asymmetric; Balanced and Partially Balanced incomplete Block Designs. Resolvable, Row-Column designs. Response Surface Methodology. Construction of Designs.

MAT866 Probability and Distribution Theory **3 units**

Sample space, algebra of sets and· events, axiomatic definition of probability and independence. Bayes theorem, random variables and their distributions. Moment, Cummulant and Probability Generating functions, Some special distributions and their properties. Multivariate continuous distribution: Marginal and Conditional Distribution. Distribution functions of random variables and some derived distributions Limiting theorems and limiting distributions. Elements of stochastic processes.

MAT867 Non-Parametric and Sequential Methods **3 units**

Distribution-free methods. Distribution of order statistics and quintiles. One and two sample tests. Confidence intervals. Transformation of statistics and their asyptotic properties. OC and ASN functions of SPRT. SPRT for composite hypotheses Elements of sequential estimation stein's two stage sampling methods for point and interval estimate.

MAT868 Multivariate Analysis **3units**

Multivariate normal distribution, estimation of mean and covariance matrix; Wishart distribution; distribution of partial and multiple correlation coefficients; Hotelling's r, Principal components.

MAT869 Biostatistics **3 units**

Advanced Regression, Bio-assays, Probit and Logit models, Growth Curves; Logistic Regression, Potency/efficacy determination. Theory of clinical trials, Ethical Issues in Medical Data Collection.

MAT885 – Seminar 1 **3 units**

A post coursework seminar on a topic approved by the Department.

MAT886 – Seminar II **3 units**

A research project proposal on a topic approved by the Department.

MAT887 – Seminar III **3 units**

A post-field seminar on a research topic approved by the Department. Practical (or industrial) application of results shall be encouraged

MAT888 – Research Project **12 units**

A research project on a topic approved by the Department. Practical (or industrial) application of results shall be encouraged

8. Ph.D COURSE DESCRIPTION

Alpha Semester

MAT911 – Numerical Solutions of Algebraic Equations 3 units

Matrix theory; Orthogonality, Norms, SVD. Matrix Factorization; LU, QR, Gram-Schimdt orthogonilization; Householder triangulation; Least squares problems. Conditioning and Stability; Conditioning and condition number; Stability. Numerical solution of Systems of Equations: GE; Pivoting; Stability of G.E; Cholesky factorization. Eigenvalue problems: Eigenvalue Algorithm, Reduction to Heisenberg or triangular forms; Shift-and-Invert and Rayleigh-Quotient-Iteration; Simple QR Algorithm with and without Shifts. Iterative Methods: Anorldi Iteration; GMRES; Lanczos Iteration; Conjugate Gradients.

MAT912 - Mathematical Methods 3 units

Fourier Integral and relation to Fourier series properties of the transform. The Hypergeometric equation: Function expressible by Hypergeometric series, Asymptotic series, Euler transforms, Legendre functions, Bessel functions, Eigenvalues and their use, Perturbation methods, Gamma function, Laplace transforms.

MAT914 – Finite Element Method 3 units

Integral Formulation and Variational methods: Weighted Integral forms, Integral Relations, Functionals, Weak Formulations of BVP.

MAT915 – Functional Analysis and its Applications 3 units

Normed linear spaces, Inner product spaces, Linear Operators; Banach spaces; Hilbert spaces, Symmetric, Selfadjoint, Unitary Operators on Hilbert spaces, Elements of Lebesgue Integration; Classical Banach spaces: L^P-Spaces ($1 \leq p < \infty$); L^2-Space as a Hilbert space; Green's functions; Fredholm's Alternatives; Introduction to the Theory of Distributions, Contraction Mapping Theorem. Some aspects of spectral theory of linear operators, Applications in Industry. Applications to Classical Analysis.

MAT916 – Mathematics of Finance I 3 units

The financial market model. European options. American options. Forwards. Futures. Pricing claims in a complete market. No-arbitrage theorem. Risk-neutral pricing. Change of numeraire. The generalized Black-Scholes model: pricing and hedging contigent claims.

Greeks. Examples of financial market models. Topics in currency exchange. Interest rate theory. Insurance. Simulations.

MAT917 – Stochastic Analysis **3 units**

Probability spaces, Random variables. Stochastic processes. Brownian motion. Martingales. Girsanov Theorem. Representation of Martingales. Stochastic integration. Ito formula. Stochastic differential equations. Existence and uniqueness of solutions. Applications.

MAT918 – Advanced Analytical Dynamics **3 units**

Principle of dynamics, strain energy, virtual work, variational principle. Lagrange's equation. Discrete systems, eigenvalues problem, natural mode of vibration. Approximate methods for finding natural modes and frequencies.

MAT919 – Ordinary Differential Equations **3 units**

Topics from, Differential Equations in abstract spaces; Functional Differential Equations. Topological degree and applications in ODE, Lyapunov second method, Stability.

MAT924 – Dynamics of Distributed-Parameter System **3 units**

Dynamics of continuous elastic systems (including strings, rods, beams, membranes and plates, formulation and solution of the boundary value problems). Rayleigh's energy methods. Rayleigh-Ritz methods, Galerkin's method.

MAT930 – Methods of Research in Mathematical Sciences **3 units**

Notion of research. Identifying research topics. Reading and understanding specialized literature. Problems-solving. Computational techniques. Analysis and synthesis. Writing scientific papers. Ethical issues. Intellectual property rights.

MAT931 – Optimization **3 units**

Programming and its applications to balance in small group behaviour, traffic flow, air pollution flow, group decision making, transportation, assignment, population dynamics, ecology, control processes, project planning and the critical path method, genetics, inventory control and queuing.

MAT932 – Theory of Measure **3 units**

Lebesgue measure for subsets of R^n. Lebesgue integration of real and complex-valued functions defined on R^n. General measure space (X, M, O) and Lebesgue integration with respect to O of real and complex – valued functions on X. The classical Banach spaces.

MAT933 – Mathematics of Finance II **3 units**

Fixed income markets, instruments, risks and the term structure of interest rates; yield curve models, calibration and fitting; pricing of interest rate derivatives using models based on short rates (Vasicek, Cox-Ingersoll-Ross), and on the static and dynamic term-structure of interest rates (Ho-Lee, Black-Derman- Toy, Hull-White and Heath-Jarrow-Morton); pricing of corporate bonds, mortgage-backed securities and insurancelinked bonds; implementation of pricing models; derivative strategies for hedging and risk management in the fixed income sector.

MAT935 – Partial Differential Equations **3 units**

Basic example of linear partial differential equations and their fundamental equations. Distribution; (Smooth, Tempered Existence and regularity of solutions (Local or Global) of the Cauchy problems; boundary value problems and mixed boundary value problems. The fundamental solutions of their partial differential equations.

MAT936 – Numerical Analysis **3 units**

Review of basic principles. Eigenvalues. Chebyschev Methods in Numerical Analysis. Numerical Solutions of Ordinary Differential Equations: Linear Multistep Methods, Runge-Kutta Methods, Hybrid methods, First Order Systems and Problems of Stiffness. Numerical Solutions of Partial Differential Equations: Elliptic, Parabolic, and Hyperbolic Systems. Quadrature Methods in Differential Equations. Applications. Special topics.

MAT937 – Stochastic Processes **3units**

Introduction of selected topics from: Gaussian processes; Markov processes; Stationery processes; Stable Law. Processes with independent-increments: Hunt processes; Diffusion processes. Applications.

MAT938 – Quantum Mechanics 3 units

Heisenberg Representation; Symmetries and Groups; Super selection Rules; Density Matrix; Propositional Calculus and Proposition system; Scattering Theory in Non-relativistic Quantum Mechanics; C*-algebraic Treatment of Quantum Mechanics.

MAT939 – Mathematical Foundation on Quantum Field Theory 3 units

Relative Quantum Mechanics; Wave Equations; Mathematics of Second Quantization; Representations of the Poincare Group. Axioms of Wightman, Segal and Hagg, Relativistic Scattering theory; Probability Theory, Euclidean Quantum Fields; P(ø) Quantum Fields. Stochastic approach may be used.

MAT950 – Statistical Inference 3 units

Concepts of convergence, asymptotic methods including the delta method, sufficiency, asymptotic efficiency, Fisher information and information bounds for estimation, maximum likelihood estimation, the EM-algorithm, Bayes estimation, decision theory, Hypothesis testing, asymptotic of the likelihood ratio test, asymptotic efficiency, statistical functional, robustness, bootstrap and jack knife, estimation with dependent data.

MAT951 – Categorical Data Analysis 3 units

Models for discrete data, distribution theory, maximum likelihood and weighted least squares estimation for categorical data, tests of fit, models selection.

MAT952 - Applied Econometrics 3 units

System estimation with instrumental variables, fixed effects and random effects estimation, M-estimation, nonlinear regression, quartile regression, maximum likelihood estimation, generalized method of moments estimation, minimum distance estimation, and binary and multinomial response models. Both theory and applications will be stressed.

MAT953 - Advanced Probability 3 units

The topics covered will change from year to year. Typical topics include the theory of large deviations, percolation theory, particle systems, and probabilistic learning theory.

MAT954 - Forecasting and Time Series Analysis 3 units

Fourier analysis of data, stationary time series, properties of autoregressive moving average models and estimation of their parameters, spectral analysis, forecasting. Discussion of applications to problems in economics, engineering, physical science, and life science.

MAT955 - Sample Survey Methods 3 units

This course will cover the design and analysis of sample surveys. Topics include simple random sampling, stratified sampling, cluster sampling, graphics, regression analysis using complex surveys and methods for handling non response bias.

MAT956 - Multivariate Analysis: Theory 3 units

Multivariate normal distribution and the Wishart distribution; estimation and hypothesis testing of mean vectors and covariance matrices; principal component analysis, canonical correlation analysis and discriminant analysis. Marcenko-Pastur law, the Tracy-Widom law, nonparametric estimation and hypothesis testing of high-dimensional covariance matrices, high-dimensional principal component analysis, etc.

MAT957 – Bioinformatics 3 units

An introduction to the use of statistical methods in the increasingly important scientific areas of genomics and bioinformatics. Topics will include- review of probability theory of one and many random variables and of events; review of statistical inference theory, classical and Bayesian; Poisson processes and Markov chain; the analysis of one and many DNA sequences, in particular shotgun sequencing, pattern analysis and motifs; substitution matrices, general random walk theory, advanced statistical inference, the theory of BLAST, hidden Markov models, microarray analysis, evolutionary models.

MAT958 - Financial and Economic Time Series 3 units

S-Plus Statistical Language, review of ARIMA models. ARCH, GARCH, threshold, switching Markov, state space, and nonlinear models.

MAT961 Dynamics of Distribution-Parameter 3 units

Dynamics of continuous elastic system (including strings, rods, beams, membranes and plates, formulation and solution of the boundary value problems). Reyleigh's energy methods, Ralyeigh – Ritz methods, Galerkin's methods

MAT962 Non-Linear and Random Analysis Dynamics 3 units

Non-linear systems: Conservative and non-conservative single-degree of freedom systems. Continuous systems (including strings, plates). Introduction to Random vibrations.

MAT963 Fluid Mechanics I 3 units

Naiver Stokes equations and exact solutions energy equation. Flow at small Reynold's number, Stokes and Oseens flows, Boundary layer theory. Appropriate methods of solution. Unsteady boundary layers, boundary layer separation and control.

MAT964 Fluid Mechanics II 3 units

Introduction to the theory of hydrodynamics stability. Thermal instability of a layer of fluid heated from below, instability due to an adverse gradient of angular motion; inviscid coquette flow, viscous coutte flow – Synge's theory, Rayleigh-Taylor instability of superposed fluids. Kelvin-Helmholtz instability. The Orr – Sommerfeld equation.

MAT965 Fluid Mechanics III 3 units

General features of oblique shocks. Centred expansion of homentropic flow. Hypersonic small disturbance theory. Hypersonic analogy and blast wave solutions. Newtonian flow. Freeman's theory of hypersonic flow part place and axis-symmetric blunt bodies. Constants/density solution. Newtonian slender body theory, optium power law body.

MAT966 Fluid Mechanics IV 3 units

Review of magnetohyrodynamics (MHD) theory. Two phase problems. Two – phase MHD problems. Radiative two-phase MHD problems. Solution of some radiative two-phase MHD problems.

MAT985 – Seminar 1 3units

A Ph.D research project proposal on a topic approved by the Department.

MAT986 – Seminar II 3units

A Ph.D research project seminar on a topic approved by the Department.

MAT987 – Seminar III 3 units

A post-field seminar on a research topic approved by the department. Practical (or industrial) application of results shall be encouraged.

MAT988 – Research Project **6 units**

A research project on a topic approved by the department. Practical (or industrial) application of results shall be encouraged