POSTGRADUATE INSTITUTE OF SCIENCE

UNIVERSITY OF PERADENIYA

Master of Industrial Mathematics Degree Programme (SLQF Level 9)

Master of Science (M.Sc.) in Industrial Mathematics Degree Programme (SLQF Level 10)

1. INTRODUCTION

Industrial Mathematics deals with developing mathematical models, finding solutions and interpreting the results of problems that come up in industry. The main objectives of this programme are to provide graduates with an adequate knowledge in Mathematics, Statistics, Operations Research and Scientific Computing, and to provide opportunities for research in applications of Mathematics to existing problems in industry. Although programmes of this nature are well-established in developed countries, it is not so in developing countries like Sri Lanka. Such programs are essential to narrow the gap that exists between scientists in industry and mathematicians.

2. PROGRAMME ELIGIBILITY

The minimum requirement for enrolment is

(a) a B.Sc. Special Degree in Mathematics or a B.Sc. Special/General degree with Mathematics as a subject or

(b) any other equivalent qualifications acceptable to the Postgraduate Institute of Science (PGIS)

Candidates should be proficient in English as English will be the medium of instruction for the programme.

3. PROGRAMME FEE

Category	Programme Fee	
	Master of Industrial Mathematics degree programme	M.Sc. in Industrial Mathematics degree programme
Local candidates	Rs. 150,000/-	Rs. 200,000/-
Foreign candidates	Rs. 300,000/-	Rs. 400,000/-

Students registered for the Master of Industrial Mathematics degree programme shall pay the Programme fee in full or in two *(1/2 at the registration and the balance at the end of the first semester)* or three *(1/3rd at the registration, another 1/3rd after 4 months from the date of*

registration and the balance after 8 months from the date of registration) installments. An additional payment of Rs. 50,000/- (or Rs. 100,000/- form foreign students) should be made at the end of the first year to continue for the M.Sc. in Industrial Mathematics degree programme. Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS. (N.B. The Programme fees given above may be revised as per recommendation of the Board of Management of the PGIS.

5. PROGRAMME STRUCTURE AND DURATION

5.1 Masters Degree by Course Work (SLQF Level 9)

The Master of Industrial Mathematics degree can be obtained by completing only the course work component.

Course work, comprising of theory courses, laboratory and/or fieldwork and an independent study, shall be conducted over a period of two semesters of 15 weeks each. The total duration of the degree, including examinations, shall be about 12 months. Satisfactory completion of a minimum of 30 credits of course work with a GPA of not less than 3.00 is required for the successful completion of the degree (Students who do not satisfy the above criteria but obtain a GPA in the range 2.75 to 2.99 for course work of 25 credits are eligible for the Postgraduate Diploma in Industrial Mathematics, and those who obtain a GPA in the range 2.75 to 2.99 for course work of 20 credits are eligible for Postgraduate Certificate).

5.2 Masters Degree (SLQF Level 10)

Completion of 30 credits of Course work as stated in 5.1 with a GPA of not less than 3.00 is a prerequisite for the Masters Degree by Course work and Research. The research project for the degree should be conducted on full-time basis, and completed during the second year. The research component is allocated 30 credits, totaling 60 credits for the entire programme. Therefore, duration of the entire programme shall be 24 months. After successful completion of the research project, the student shall be eligible for the award of the M.Sc. in Industrial Mathematics degree - SLQF Level 10 (Students who do not complete the research project within the stipulated time period shall be awarded the Master of Industrial Mathematics degree - SLQF Level 9).

5.3 Extension of the programme for M.Phil. or Ph.D.

After conducting research for a period of six months in the M.Sc. degree programme under 5.2, students who have demonstrated exceptional progress may apply for upgrading the degree status to M.Phil. The student should continue the research project and any additional research work/assignments recommended by the PGIS for a total of two years (60 credits of research) to qualify for the award of the M.Phil. degree.

During the second year of research, students who have demonstrated exceptional and continuous progress may apply for upgrading the degree status from M.Phil. to Ph.D. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (to complete 90 credits of research in total) to qualify for the award of the Ph.D. degree.

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Programme Summary

Course Code	Course	Lecture hrs.	Practical hrs	No. of Credits
Preliminary Courses *[1]				
MT 401	Preliminaries in Mathematics	30	-	-
MT 402	Statistics	30	-	-
MT 403	Computer Applications	-	30	-
Semester I				
MT 501	Differential Equations	45	-	3
MT 502	Statistical Quality Control	30	-	2
MT 503	Numerical Analysis	45	-	3
MT 504	Stochastic Process and Applications*	30	-	2
MT 505	Operations Research	45	-	3
Semester II				
MT 516	Control Theory*	45	-	3
MT 517	Topics in Computer Science	45	-	3
MT 518	Optimization Theory*	30	-	2
MT 519	Special Topics in Industrial Mathematics*	30	-	2
MT 520	Theoretical Fluid Mechanics*	45	-	3
MT 525	Financial Mathematics*	45	-	3
MT 528	Actuarial Finance*	30	-	2
MT 530	Financial Derivatives*	30	-	2
MT 599	Independent Study	500 notional hrs		5
MT 699	Research Project (one year)*[2]	3000 notional hrs		30

*[1] *Compulsory for those without sufficient background knowledge.*
* *Optional courses. Students are required to obtain 9 credits from optional courses.*
*[2] *Compulsory for M.Sc. in Industrial Mathematics* (*SLQF Level 10*).

6. PROGRAMME CONTENTS

PROGRAMME CONTENTS FOR MT 599 AND MT 699

Course code	MT 599
Course title	Independent Study
Credits	05
Compulsory/optional	Compulsory
Prerequisites	None
Time allocation	500 notional hrs
Aims	Aims: The overall aim is to familiarize the student with concepts and methods involved in scientific research **Specific aims:** 1. To explain the scientific process in the conduct of

	research. 2. To develop skills to write a review paper and a scientific research proposal. 3. To develop skills to make a presentation. 4. To master analytical skills.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Understand the scientific method. 2. Conduct an independent review of literature on a selected topic in the area of Industrial Mathematics. 3. Write a formal scientific report conforming to the guidelines provided. 4. Transfer the knowledge gained through (2) and (3) above in the form of a presentation. 5. Complete a research proposal conforming to the guidelines provided. 6. Perform a Critical analysis on the selected topic in (2) and propose solutions.
Content	*Review paper*: Review of literature; Development of the review paper in concise and professional manner and logical presentation of results that have been reported, writing the abstract, compilation of the list of references. *Proposal writing*: Interpretation and critical evaluation of results of published research; Formulation of a research problem: Concise literature review, justification, time frame, identification of resources, budgeting, etc. *Project*: Collection and statistical analysis of data on a topic associated with the review paper. *Seminar*: Presentation of literature and data collected on a given topic; Preparation of an abstract, preparation of slides.

Assessment criteria: Continuous Assessment

Component	% marks
Review paper	20
Proposal writing	10
Project	40
Seminar	30

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis

Course code	MT 699
Course title	Research Project
Credits	30
Compulsory/optional	Compulsory
Prerequisites	MT 599; GPA of 3.00 at SLQF Exit Level 9
Time allocation	One year (full-time) – 3000 notional hrs
Aims	Aims: The overall aim is to prepare the student to conduct a research independently. **Specific aims:** 1. To train students to apply scientific method in scientific research. 2. To train students to generate researchable hypotheses. 3. To train students to plan, design and conduct scientific research. 4. To gather reliable scientific data, analyse, and interpret. 5. To develop skills in scientific writing.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Apply the scientific method. 2. Design a research project. 3. Complete a research project. 4. Understand ethical issues in scientific research (There are no formal lectures related to this aspect in the Independent Study module. However, ethical issues are taught and discussed in workshops conducted by the PGIS for which participation is required). 5. Understand the patenting process in research (There are no formal lectures related to this aspect in the Independent Study module. However, patenting process is taught and discussed in workshops conducted by the PGIS for which participation is required). 6. Make presentations at national/international conferences. 7. Produce a thesis conforming to the requirements of the PGIS. 8. Write manuscripts for publication in refereed journals.
Content	The students will conduct sufficient amount of laboratory/field work on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a national/international conference, and produce a thesis.

Assessment criteria

Continuous assessment	End-semester examination
30%	Oral examination (20%) Thesis (40%)

	Conference presentation (10%)

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis

Contents of Other Courses

MT 401: Preliminaries in Mathematics
Linear Algebra: Orthogonal and orthonormal sets, orthogonal projection, Linear functionals, Adjoints, Unitary and normal operators, Hermitian forms, Spectral theorem.
Analysis: Complete metric spaces, Compactness, Fixed point theorems, Banach spaces, Hilbert spaces.

MT 402: Statistics
Variability in observations. Parameters and statistics. Measures of location and spread. Frequency distributions, Histogram, Stem and Leaf plots. Discrete data: Probability structure and cumulative distributions. Continuous data: Distribution functions, Family of Normal distributions. Simple linear regression and correlation. Probability: Properties, Conditional probability, Independence. Discrete random variables: Probability mass functions and cumulative distributions. Some common discrete distributions, Bayes' Rule. Expectations and Central Limit Theorem. Sampling from the Normal distribution. Point and interval estimation. Test of hypotheses: Simple and composite hypothesis. Tests on means and variances.

MT 403: Computer Applications
Introduction to computers, Windows and Disk operating system and commands. Microsoft applications. Computer software applications depending on the requirements of the programme.

MT 501: Differential Equations (*3 credits*)
Ordinary differential equations: Existence and Uniqueness of solutions, Continuation of solutions, Linear and Non-linear systems of differential equations, Asymptotic behaviour, Limit cycles, Perturbation theorems, Stability and Control.
Partial differential equations: Envelopes, Characteristic strips, Legendre transformation, Complete integral and Eikonal function, Hamilton Jacobi equation, Finite - Element method, Pontryagin's minimum principle, Discontinuous solutions, Weak solutions, Burger's equation, Fourier series on the Quotient-group $R / 2\pi Z$, Series expansions and Fast Fourier transforms.

MT 502: Statistical Quality Control (*2 credits*)
Control charts for attributes, Control charts for variables, Single sampling planes for attributes, Acceptance sampling by variables.

MT 503: Numerical Analysis (*3 credits*)
Solution of system of linear equations, roots of non-linear algebraic and transcendental equations, System of non-linear equations, Polynomial interpolations, Numerical Integration (Quadrature), Gaussian quadrature, Solution of ordinary differential equations, Solution of partial differential equations, Parabolic equations, Elliptic equations, Hyperbolic equations.

MT 504: Stochastic Process & Applications (*2 credits*)
Recurrent events, Random walks, Markov chains, Transition probabilities, Limiting distributions, Discrete branching process, Markov processes in continuous time, poisson processes, Birth and death processes, Queuing theory, Epidemic processes, Competition and perdition.

MT 505: Operations Research (*3 credits*)
Convex analysis, Linear programming, Graph theory and Network optimization, Queuing theory, Dynamic programming, Integer programming.

MT 516: Control Theory (*3 credits*)
Linear Feedback control systems: Input-Output approach, Block diagrams and signal flow graphs, State space approach, Digital control systems: Digital systems, Sampling of continuous-time signals, Analysis of discrete-time systems, Digital PID controllers, digital polynomial controllers and state space, Introduction to advance digital controllers.

MT 517: Topics in Computer Science (*3 credits*)
Structured programming techniques, Data base management systems, System development strategies, Information processing systems, Intelligent systems.

MT 518: Optimization Theory (*2 credits*)
Kuhn-Tucker theory and nonlinear programming, Geometric programming, Direct search and gradient method; One-dimensional search, Multi-dimensional search.

MT 519: Special Topics in Industrial Mathematics (*2 credits*)
Topics selected will be based on the availability of resource persons.

MT 520: Fluid Mechanics (*3 credits*)
Viscous Fluid: Navier-Stokes equations, High Reynolds number flow, Low Reynolds number flow, Non-viscous Flow: Free streamline theory in discontinuous motions, Jets and currents in 2-D, Stokes stream function in 3-D, Axi-symmetric flows, Compressible Flow: Vortex motion in 2-D irrotational flow.

MT525: Financial Mathematics (*3 credits*)
Time value of money, Valuation of annuities, Loan repayments, Bond valuation, Stock valuation, Rate of return of an investment fund, Term structure of interest rates, Cash flow duration and immunization, Fixed income investments, exchange rates, Investment decision criteria, Capital budgeting, Capital structure, Project analysis and evaluation, Return risk and the security market line, Introduction to Corporate Finance**.**

MT528: Actuarial Finance (2 *credits*)
Introduction to Actuarial concepts, valuation and actuarial valuation, importance of actuarial concepts and their applications in various finance fields, Introduction to insurance, Survival distribution, mortality rate, life expectancy, life table, Insurance and related models, Applications of insurance models, Life annuity and related models, Applications of life annuity models, Loss random variable and its applications in Insurance models, Premiums determination methods and related problems**.**

MT530: Financial Derivatives (2 *credits*)
Stock-Market Models, One-Step Binomial Model, Arbitrage Pricing, Expectation versus Arbitrage; Call and Put Options, Binomial Tree Models, Binomial Representation Theorem; Brownian Motion as stock models, Newtonian Differentials versus Stochastic Differentials, Ito Calculus, European options versus American options; Hedging, Speculating with derivatives, Variable Interest Rates, Stochastic Interest Rates.

7. PROGRAMME EVALUATION

Evaluation of course work is done as per guidelines stipulated in the PGIS Handbook. Scheme of evaluation of the five-credit independent study (MT 599) and the Research Project (MT 699) is given in Section 6 above.

8. TEACHING PANEL

	Name, qualifications and affiliation/address	Area of Specialization
1.	Prof. A.A.I. Perera (Ph.D. RMIT City Campus, Melbourne, Australia) Department of Mathematics, Faculty of Science, University of Peradeniya	Algebra / Graph Theory
2.	Prof. W. B. Daundasekera (Ph.D. Alabama, USA) Department of Mathematics, Faculty of Science, University of Peradeniya	Operations Research
3.	Dr. G. W. R. M. R. Palamakumbura (Ph.D. Texas Tech, USA) Department of Engineering Mathematics, Faculty of Engineering, University of Peradeniya	Applied Mathematics: Pattern formulations of PDEs
4.	Dr. R. Meegaskumbura (Ph.D. Texas Tech, USA) Department of Engineering Mathematics, Faculty of Engineering, University of Peradeniya	Numerical Analysis
5.	Dr. Z. A. M. S. Juman (Ph.D. University Brunei Darussalam, Brunei) Department of Mathematics, Faculty of Science, University of Peradeniya	Operations Research
6.	Dr. T.H.K.R. De Silva (Ph.D. University of Tennessee, USA) Department of Mathematics, Faculty of Science, University of Peradeniya	Optimal Control Theory
7.	Dr. M. I. M. Ishak (Ph.D. K-State, USA) Department of Engineering Mathematics, Faculty of Engineering, University of Peradeniya	Number Theory
8.	Dr. M. P. B. Ekanayake (Ph.D. Texas Tech, USA) Department of Electrical & Electronic Engineering, Faculty of Engineering, University of Peradeniya	Control Theory
9.	Dr. Ruwan D. Nawarathna (Ph.D. University of North Texas, USA) Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya	Machine learning Computer Vision
10.	Dr. Lakshika S. Nawarathna (Ph.D. UT Dallas, USA)) Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya	Statistics

11.	Dr. H.R.O.E. Dayarthne (Ph.D. Keio University of Japan) Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya	Computer Networking

Category II: Outside Expert

1.	Dr. U.N.B. Dissanayake (Ph.D. Alberta) Department of Mathematics, Faculty of Science, University of Peradeniya	Differential Topology

PROGRAMME COORDINATOR

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