Master of Medical Statistics (MMStats)

1. Description

This course, offered by the Faculty of Graduate Studies, provides a sound understanding of the theory and application of medical statistics relevant to professional practice. The degree will assist the acquisition of skills and experience in complex statistical analyses, identifying and implementing appropriate statistical methodology, communicating statistical results and understanding medical statistical literature. The course develops the technical skills for commencement in a professional career as a medical statistician.

2. Justification

Medical Statistics is a branch of Applied Statistics, where modern statistical methods are implemented ubiquitously. With the advancement of modern statistical techniques, medical experiments and medical data analysis has achieved an immense development. Medical Statistics contributes to improve the designs of medical experiments as well as to provide the optimum analysis of data to make effective conclusions. In order to interpret results and to make reliable conclusions, medical and healthcare professionals will need a sound understanding of statistical methods. Master of Medical Statistics will train the graduate to gain experience on application of the theory and methodologies of statistics relevant to medical practice.

Master of Medical Statistics program is designed so that a professional in medical background, will sharpen statistical analysis skills after successfully completion of the course. With the skills gain from the degree, the professionals will be able to identify the relevant statistical issues in practical problems in medical/health settings and to propose and implement appropriate statistical designs and/or analysis. Also, from the experience gain from the degree, students will be able to properly communicate statistical issues with clinical/health personnel and the presentation of statistical results in a format suitable for publication in health-related journals or professional reports. The Master of Medical Statistics degree will get the candidate ready for carrier in health sector job or progress to further postgraduate research studies.

3. Relevance

The proposed degree program is Masters of Medical Statistics, which is offered by the Faculty of Graduate Studies, is designed for professionals currently in, or seeking to be in, healthcare industry. The program is designed with the objective of developing a sound understanding of the theory and application of Medical Statistics relevant to professional practice. The degree will assist the acquisition of skills and experience in complex statistical analyses, identifying and implementing appropriate statistical methodology, communicating statistical results and understanding medical statistical literature. The course develops the technical skills for commencement in a professional career as a medical statistician.

As a lower-middle income country, Sri Lankan heath care services faces many challenges such as lack of financial resources and lack of well trained professionals. Since Sri Lankan health sector is still developing, there is a vacuum for well-trained statisticians in the health sector. Thus, to improve quality and the efficiency in health care sector, the issues should be identified and better solutions should be proposed. Thus there is a need for professionals to identify relevant statistical issues in practical problems and to implement an appropriate statistical method to find and assess the conclusions. The proposed degree program is designed to provide specialization in advanced statistical analysis. The training of this program will build capacity to design statistical experiments, identifying statistical methodologies to analyze data, and decision analysis. Successfully completion of this course, will provide experience in planning, research and analysis related to Medical Statistics.

4. Programme Outcomes

These course outcomes are aligned with the Sri Lanka Qualifications Framework level 9

On completion of this course, students will have:

- developed a sound understanding of the theory and application of the major areas of statistics relevant to medical practice
- acquired skills in complex statistical analyses using modern statistical techniques and software

- developed skills to identify the relevant statistical issues in practical problems in medical/health settings and to propose and implement an appropriate statistical design and/or analysis methodology
- developed skills and have experience in communication of statistical issues with clinical/health personnel and the presentation of statistical results in a format suitable for publication in health-related journals or professional reports
- acquired the technical skills to be able to read the medical statistical literature and implement new methodology described therein
- developed the technical skills to commence professional careers as biostatisticians and/or to progress to further postgraduate research studies.
- developed skills necessary to comprehend published health service research papers, and to integrate the implications of published research in their own studies
- ability formulate a plan for specific individual research which would further existing knowledge
- ability to communicate the results of independent research.

5. Target Group

The program is designed for those who are already employed and interested in further studies in the field of Medical Statistics/Bio-Statistics.

6. Eligibility Criteria/Entry Requirements

In order to be eligible for entry to the study programme leading to the Master of Medical Statistics, students must fulfil the following requirements:

I. A Medical degree or dental degree recognized by the Sri Lanka Medical Council.

OR

II. An Honors/Special degree in the field of Statistics, Science, Technology, Economics or any other relevant discipline.

OR

III. Any other equivalent qualification accepted by the Senate.

7. Admission Process

- Selection test/ Interview

8. Program Duration and Credits

- Duration: O**ne year**
- Number of Credits: **30 Credits**

Alternative exit

Students may exit this course early and apply to graduate with the Postgraduate Diploma in Medical Statistics after successful completion of minimum of 25 credits.

9. Medium of Instruction

- English

10. Course Structure

1st Semester

Course code	Title of the course unit	Course Status	Credit Value
MMST 51012	Basic Epidemiology	C	2
MMST 51022	Fundamentals of Medical Statistics	C	2
MMST 51032	Statistical Inferences	C	2
MMST 51041	Data Organization and Management	C	1
MMST 51051	Non Parametric Tests	C	1
MMST 51062	Linear Models	C	2
MMST 51073	Health Surveys and Health Sampling	C	3
MMST 51082	Clinical Epidemiology	C	2
Total Credits-Semester-1			**15**

2nd Semester

Course code	Title of the course unit	Course Status	Credit Value
MMST 52093	Regression Analysis	C	3

MMST 52102	Forecasting & Statistical Process Control	C	2
MMST 52112	Survival analysis	C	2
MMST 52122	Advanced Topics in Regression	C	2
MMST 52131	Bayesian Statistical Methods	O	1
MMST 52141	Applied Econometrics	O	1
MMST 52145	Independent study in Medical Statistics	C	5
Total Credits-Semester-II			**15**

C – Core; O – Optional

11. Teaching Methods and Evaluation Criteria

11.1 Teaching Methods

Lectures/ Group discussions/ Workshops/Field visits

11.2 Evaluation Criteria

- **End Semester Assessment (ESA)**

Written examination will be conducted for each course unit at the end of the semester.

- **Continuous Assessment (CA)**

The evaluation criteria of each course unit will be announced by the relevant lecturer at the commencement of each course unit.

11.3 Grading System

Table below shows the twelve tier grading system recommended by University Grant Commission in Sri Lanka. “Grade” shall be awarded for a course unit by aggregating the marks obtained for CA and the ESA. Grade Point Average (GPA) of each student is calculated based on the Grade Point Value (GPA) assigned to each grade as indicated in the table below. GPA is calculated by considering all the course units attempted by a student in order to award of the master degree.

Table 2: Twelve tier grading system

Range of marks	Grade	Grade Point Value
85-100	A+	4.00
70-84	A	4.00
65-69	A-	3.70
60-64	B	3.30
55-59	B	3.00
50-54	B-	2.70
45-49	C+	2.30
40-44	C	2.00
35--39	C-	1.70
30-34	D+	1.30
25-29	D	1.00
00-24	E	0.00

11.4 Grade Point average

Grade Point Average (GPA) is the credit –weighted arithmetic mean of the Grade point values. GPA is calculated by dividing the total credit –weighted 'Grade Point Value' by the total number of credits. GPA shall be computed to the second decimal place.

Example: A student who has completed **one course unit** two credits, **three course units** each of three credits and **two course units** each of one credit with grades A,C,B,D,C+ and A+ respectively would have the GPA of 2.48 as calculated below.

$$\textbf{GPA} = \frac{(4.0 * 2 + 2.0 * 3 + 3.0 * 3 + 1.0 * 3 + 2.3 * 1 + 4.0 * 1)}{(2 + 3 + 3 + 3 + 1 + 1)}$$

GPA = 2.4846 = 2.48

Minimum eligibility criteria for the award of M M Stats

(i) For the award of MMStats with course work

(a) Accumulate grades of B- (B minus) or better in course units aggregating at least 30 credits.

(b) Obtain a GPA of 2.70 or greater, and

(c) Complete the relevant requirements within a period of three consecutive academic years'

(ii) For the award of a MMStats with course work with Merit a student must obtain

(a) Accumulate grades of B- (B minus) or better in course units aggregating at least 30 credits

(b) a GPA of 3.70 or greater

(c) Obtain grades of A or better in course units aggregating to at least 50% of total credits for the course units considered

(d) Complete the relevant requirements within a period of one academic years

12. Course Details

<table>
<tr><td>Semester 1</td><td colspan="3"></td></tr>
<tr><td>Course Code:</td><td colspan="3">MMST 51022</td></tr>
<tr><td>Course Name:</td><td colspan="3">Fundamentals of Medical Statistics</td></tr>
<tr><td>Credit Value:</td><td colspan="3">2</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td>30</td><td>40</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Demonstrate a broad understanding of the mathematics underlying key statistical methods
➢ Demonstrate an understanding of the meaning and laws of probability.
➢ Recognize common probability distributions and their properties.
➢ Describe a given set of data in terms of the measurements of central tendency, dispersions, skewness and kurtosis,
➢ Study given real-life situations by constructing appropriate statistical models and applying concepts and procedures in statistical decision making to those models.</td></tr>
</table>

- Appreciate the role of simulation in demonstrating and explaining statistical concepts

Course Contents

- **Introduction to Statistics:** The role of Statistics in Medical Science and Health administration, Basic terminology, Sources of Information, Nature of Medical data
- **Descriptive Statistics:** Techniques of data presentation, Measures of Central Tendency, Measures of Dispersion and Shapes of distributions.
- **Probability:** Algebra of sets, Permutations and Combinations, Random or non-deterministic experiment, Sample space, Events and event space, Classical, frequency and axiomatic definitions of probability, Conditional probability, Partition of a sample space, Total probability and Bayes' Theorem.
- **Probability Models:** Bernoulli, Binomial, Poisson and Normal models.
- Sampling and sampling distributions: Random sampling, Stratified sampling, Sampling error, Sampling distributions.
- **Decisions about relationships:** Introduction to Correlation, Relationship between interval/ratio variables, Geometric appearance of relationship, Product-Moment Correlation.
- Linear Regression: Prediction of one variable from another, linear regression.
- Case studies.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details:	Theory (%)	Practical (%)	Other (%)
Quizzes- 20, mid-term Examination-20	60	N/A	N/A

References/Reading Materials:

- Heiman, Gary W. Basic Statistics for the Behavioral Sciences. 4th ed. Boston, MA: Houghton Mifflin Company, July 2002. ISBN: 0618220178
- Robert W. Broyles. Fundamentals of Statistics in Health Administration Jones & Bartlett Learning, 2006 - Business & Economics - 374 pages
- Bernard Rosner, Fundamentals of Biostatistics, Cengage Learning, ISBN-13: 978-0538733496

Semester 1			
Course Code:	**MMST 51032**		
Course Name:	**Statistical Inferences**		
Credit Value:	**2**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	15	55

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Have a deeper understanding of fundamental concepts in statistical inference and their practical interpretation.
- Understand the theoretical basis for frequentists and Bayesian approaches to statistical inference.
- Be able to develop and apply parametric methods of inference, with particular reference to problems of relevance in medical statistical contexts.
- Choose from the list of basic statistical techniques covered, the appropriate descriptive or inferential statistical technique based on the researcher's hypothesis, the level of measurement of the variables and the testing of the appropriate assumptions.
- Have the theoretical basis to understand the justification for more complex statistical procedures introduced in subsequent units.

- Have an understanding of basic alternatives to standard likelihood-based methods, and be able to identify situations in which these methods are useful.
- Write interpretive summary reports for both descriptive and inferential statistical analysis

Course Contents

Classical estimation theory, bias and efficiency. Likelihood function, likelihood based methodology, maximum likelihood estimation and inference based on likelihood ration, Wald and score test procedures. Bayesian approach to statistical inference vs classical frequentist approach.

Confidence intervals, Interpretation of these concepts in medical contexts, including an emphasis on the difference between statistical and practical significance.

Introduction to hypothesis testing: Relate the concepts of effect size, sample size, one or two tailed tests, level of significance and power of a statistical test, type I and II errors and p-values.

One sample inference for the mean parameters and variance parameters and binomial proportion, power of test and sample size determination. Relationship between confidence intervals and hypothesis testing

Two sample inference: comparing two groups/methods using confidence intervals and hypothesis tests (p - values); assessing the association between an outcome and an exposure using the chi-squared test;

- Analysis of Variance: one way ANOVA, two-way/ two-factor/ANOVA

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details:	Theory (%)	Practical (%)	Other (%)
Quizzes- 20, mid-term -20	60	N/A	N/A

References/Reading Materials:

- Alexander M.. Mood, Franklin A..Graybill , Pittenger Duane C. Boes, 3rd Edition, Reprinted (2005), 'Introduction to the Theory of Statistics', McGraw-Hill.
- D.R. Cox: Principles of Statistical Inference. Cambridge University Press, 2006.
- P.H. Garthwaite, I.T. Jolliffe & B. Jones: Statistical Inference (2nd edition). Oxford University Press, 2002.
- P.M. Lee: Bayesian Statistics: An Introduction (2nd edition). Arnold, 1997.
- J.A. Rice: Mathematical Statistics and Data Analysis (3rd edition). Duxbury, 2006.
- G.A. Young and R.L. Smith: Essentials of Statistical Inference. Cambridge University Press, 2005.
- Hill, A.B., Hill, I.D. (1991.) Bradford Hill's Principles of Medical Statistics (12thed.). London, Edward Arnold.
- Basic Statistical Analysis. Rischard C. Sprinthall
- Medical Statistics. Betty R Kirkwood and Jonathan A. C. Sterne
- Douglas G. Altman. Practical Statistics for Medical Research. ISBN 9780412276309 - CAT# C7630
- Martin Bland. An Introduction to Medical Statistics. Fourth Edition. ISBN: 9780199589920

<table>
<tr><td>Semester 1</td><td colspan="3"></td></tr>
<tr><td>Course Code:</td><td colspan="3">MMST 51041</td></tr>
<tr><td>Course Name:</td><td colspan="3">Data Organization and Management</td></tr>
<tr><td>Credit Value:</td><td colspan="3">1</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td></td><td>45</td><td>55</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Explore a dataset in a number of ways
➢ Identify the data type for each variable in a dataset and create new variables with a specific data type
➢ Apply variable and value labels, check for implausible data values and duplicate observations, ascertain missing data
➢ Reshape data between long and wide forms and merge relational datasets
➢ Sort observations and analyze data by different sub groups
➢ Use do files to keep track of the commands rerun analyses when required
➢ Use automated commands and create macros
➢ Use loops, nested loops and conditional execution within commands when required</td></tr>
<tr><td colspan="4">Course Contents
➢ Data types, Storing and Importing Data, Convert between types and set the display formats for different variables, Changing the layout of a dataset and related functions, Reshape data between long and wide forms, Merging, Appending and Collapsing datasets, Stratification and perform operations separately for subgroups, Creating do files and inserting commands, Advanced Automation, Loops and conditional execution.</td></tr>
</table>

<table>
<tr><td colspan="4">Teaching /Learning Methods:
Lectures, interactive contacts, Practical classes and discussions</td></tr>
<tr><td colspan="4">Assessment Strategy:
CA (Case studies, assignments, reports, presentations, tests) and ESA.</td></tr>
<tr><td>Continuous Assessment
40%</td><td colspan="3">Final Assessment
60%</td></tr>
<tr><td>Details:
Quizzes- 20, mid-term -20</td><td>Theory (%)
N/A</td><td>Practical (%)
60</td><td>Other (%)
N/A</td></tr>
<tr><td colspan="4">References/Reading Materials:
➢ Armitage P, Berry G, Matthews JNS. Statistical Methods in Medical Research (4thedition). 2008; Wiley-Blackwell, London.</td></tr>
</table>

<table>
<tr><td>Semester 1</td><td colspan="3"></td></tr>
<tr><td>Course Code:</td><td colspan="3">MMST 51051</td></tr>
<tr><td>Course Name:</td><td colspan="3">Non parametric Tests</td></tr>
<tr><td>Credit Value:</td><td colspan="3">1</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>15</td><td></td><td>35</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Identify appropriate non-parametric test for given real life problem, apply nonparametric tests, and interpret conclusions.
➢ Be able to develop and apply non-parametric methods of inference, with particular reference to problems of relevance in medical statistical contexts
➢ Be able to apply Bootstrap samples</td></tr>
</table>

- Be able to create empirical CDF and understand how to estimate the density.

Course Contents

Introduction to non-parametric methods. Differences between parametric & non parametric tests, Calculation & Interpretation of one sample tests: Sign test, Wilcoxon signed rank test, Calculation & Interpretation of two sample tests: Mann-Whitney U test, paired Wilcoxon signed –rank test,

- Analysis of Variance: Kruskal-Wallis H test, Friedman ANOVA, Spearman's rank correlation, Robust Estimation, Jackknives and Bootstrap methods, Density Estimation

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details:	Theory (%)	Practical (%)	Other (%)
Quizzes- 20, mid-term -20	60	N/A	N/A

References/Reading Materials:

- Peter Sprent, Nigel C. Smeeton Applied Nonparametric Statistical Methods, Fourth Edition CRC Press
- Wayne W. Daniel , Applied Nonparametric Statistics 2nd Edition

<table>
<tr><td>Semester 1</td><td colspan="3"></td></tr>
<tr><td>Course Code:</td><td colspan="3">MMST 51062</td></tr>
<tr><td>Course Name:</td><td colspan="3">Linear Models</td></tr>
<tr><td>Credit Value:</td><td colspan="3">2</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td>30</td><td>40</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Understand the major theoretical aspects of generalised linear models.
➢ Appreciate regression modelling strategies for generalised linear models.
➢ Including estimation issues, choice of models, prediction and goodness of fit of a selected model.
➢ Be proficient in the analysis of binary outcome data, either form a standard study design or from a matched study design.
➢ Be capable of analysing ordered and unordered categorical outcomes using simple measures of association and complex regression models.
➢ Be capable of analysing count data whether it satisfies standard distributional assumptions or whether it is over dispersed.
➢ Be capable to compare different groups of data and find similarities based on Analysis of Variance</td></tr>
<tr><td colspan="4">Course Contents
Linear Models: Applications of generalized linear models with an emphasis on underlying theoretical issues, and practical interpretation of the results of fitting these models.
➢ Analysis of Variance: One-way ANOVA, Factorial ANOVA, Main effects & interaction, Interpretation of two way ANOVA table, Completely randomized design,</td></tr>
</table>

<table>
<tr><td colspan="4">Randomized block design, Balance incomplete block design, Latin square design, Repeated measure ANOVA, MANOVA, ANCOVA</td></tr>
<tr><td colspan="4">Teaching /Learning Methods:
Lectures, interactive contacts, Practical classes and discussions</td></tr>
<tr><td colspan="4">Assessment Strategy:
CA (Case studies, assignments (written and practical), reports, presentations, tests) and ESA.</td></tr>
<tr><td>Continuous Assessment
40%</td><td colspan="3">Final Assessment
60%</td></tr>
<tr><td>Details:
Quizzes- 20, mid-term -20</td><td>Theory (%)
60</td><td>Practical (%)
N/A</td><td>Other (%)
N/A</td></tr>
<tr><td colspan="4">References/Reading Materials:
Michael Kutner , Christopher Nachtsheim , John Neter, William Li., 5th Edition, “ Applied Linear Statistical Models”
Montgomery, D.C., 5th Edition, (2001), ‘Design and Analysis of Experiments’, John Wiley & Sons.
Hicks, C.R., 4th Edition, (1993), ‘Fundamental Concepts in Design of Experiments’, Oxford University Press.
S. E. Fienberg, 2nd Edition,(1980), ‘The analysis of cross- classified categorical data’, New York Springer
Aqresti, 2nd Edition, (2002), ‘Categorical data analysis’, John Wiley& sons.
D. Collet, 2nd Edition, (2003) ‘Modelling Binary data’, Chapman & Hall</td></tr>
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Semester 1	
Course Code:	**MMST 51073**
Course Name:	**Health Surveys and Health Sampling**

<table>
<tr><td>Credit Value:</td><td colspan="3">3</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>45</td><td>30</td><td>75</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Derive and compare population measures of mortality, illness, fertility and survival, using basic demographic tools such as life tables and age standardization.
➢ Access the main sources of routinely collected health data and choose the appropriate one, taking into account their advantages and disadvantages.
➢ Design a valid and reliable health survey to collect primary data, design an efficient sampling strategy to obtain random sample of the target population, and choose the most appropriate mode of delivery.
➢ Analyze, interpret and present the results of survey data, taking the sampling strategy into account.
➢ Comprehensive understanding of the main principles and methods of sampling required to collect and analyze social survey data
➢ Understanding of the issues of associated with measurements in the health and social science</td></tr>
<tr><td colspan="4">Course Contents
➢ Introduction to a variety of health-related data collection sources, calculation of population fertility, mortality & morbidity rates, health service utilization measures, disease registration & reporting. Population censuses, Sample surveys, Vital statistics and other sources, Demographic data and their quality. Cohort and period life tables, Construction of life tables. Use of direct & indirect age standardization, life expectancy calculations. Development, design & delivery of health questionnaires.
➢ Use of focus groups, standard instruments for health surveys, coding, validity, reliability of measures & models of data collection. Efficient sampling strategies, data interpretation & analysis including stratification, clustering & weighting.
➢ key concepts in sampling such as a sampling frame, non-response, variance, survey</td></tr>
</table>

weights and design effects, and how to select samples using the main probability sampling methods (simple random sampling, systematic sampling, stratified sampling and cluster sampling). Multistage, Probability proportional to size, Estimation techniques for the various sampling methods, calculate sample sizes for descriptive, case-control. Cohort studies and different types of interventional studies.

- Issues associated with measurement in the health and social sciences. Types of reliability:
- Inter & Intra Rater, Test-Retest, Parallel Forms, Internal Consistency. Types of Validity: Face, Content, Consensual, Criterion & Construct: Convergent & Discriminant. Statistical Tests For Reliability/validity, Cronbach's Alpha, Kappa, Intra-Class Correlation, Limits Of Agreement. Exploratory factor analysis: Assumptions, factor loading, Eigen values, Communalities, Factor extraction, Interpretation of factor analysis output. Confirmatory factor analysis: Assumptions and interpretation.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A

References/Reading Materials:

- Steven G. Heeringa, Brady T. West, Patricia A. Berglund (2010) "Applied Survey Data Analysis" (Chapman & Hall/CRC Statistics in the Social and Behavioral Sciences) 1st Edition
- R. L. Chambers (2003), C. J. Skinner (Editor) "Analysis of Survey Data", Wiley
- William G. Cochran, "Sampling Techniques", 3rd Edition, Wiley

Semester 1	

<table>
<tr><td>Course Code:</td><td colspan="3">MMST 51012</td></tr>
<tr><td>Course Name:</td><td colspan="3">Basic Epidemiology</td></tr>
<tr><td>Credit Value:</td><td colspan="3">2</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td></td><td>70</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ explain and contextualize the purposes of descriptive and analytical epidemiology
➢ analyses the strengths and weaknesses of different epidemiological study designs
➢ interpret and communicate the results of epidemiological studies
➢ solve complex problems relating to the use of epidemiological concepts and study designs
➢ discuss probable sources of error and methods of minimizing errors in such data
➢ describe and calculate measures of risk of exposure
➢ critically analyses epidemiological papers from the medical research
➢ Argue for and against the different methods of data collection in survey research, i.e. apply stratified analysis for controlling confounding factors & describing effect modifiers
➢ Contrast the processes commonly used to collect data
➢ Independently plan, design a small scale research project and prepare a detailed proposal</td></tr>
<tr><td colspan="4">Course Contents
➢ Rates, Prevalence, Cumulative incidence, Incidence density, Proportionate Mortality & Proportionate Mortality Ratio, Survival rates: five-year survival. Descriptive & analytical epidemiology, epidemiological study designs. Sample size calculations, Questionnaire design, sample and data collection methods, Odds Ratio, Relative Risk (RR), Attributable Risk (AR), Attributable Risk Percent, Random error, Systematic errors – Bias: Selection, Information & Confounding: Measures to overcome confounding, Matching, restriction & randomization, Stratified and multivariate analysis.</td></tr>
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<table>
<tr><td colspan="4">➢ Statistical Techniques that will be introducing using statistical software: OR, RR, AR, IRR and Calculation of 95% Confidence Intervals, Stratified Analysis, Calculation of Pooled Odds Ratio, RR, IRR & 95% CI, Mantel- Haenszel Method, Test-based Method, Interpretation, Test for Homogeneity, Confounding & Effect Modification.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods:
Lectures, interactive contacts, Practical classes and discussions</td></tr>
<tr><td colspan="4">Assessment Strategy:
CA (Case studies, assignments, reports, presentations, tests) and ESA.</td></tr>
<tr><td>Continuous Assessment
40%</td><td colspan="3">Final Assessment
60%</td></tr>
<tr><td>Details:
Quizzes- 20, mid-term -20</td><td>Theory (%)
60</td><td>Practical (%)
N/A</td><td>Other (%)
N/A</td></tr>
<tr><td colspan="4">References/Reading Materials:
➢ Hennekens, C.H., Buring, J.E. (2006). Epidemiology In Medicine, Brown and Company, Boston.
➢ Rothman, K.J. Epidemiology-An introduction. Oxford University Press.
➢ Basic epidemiology, R Bonita, R Beagkehole, T Kjellstrom 2nd edition, 2006. World Health Organization</td></tr>
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Semester 1	

<table>
<tr><td>Course Code:</td><td colspan="3">MMST 51082</td></tr>
<tr><td>Course Name:</td><td colspan="3">Clinical Epidemiology</td></tr>
<tr><td>Credit Value:</td><td colspan="3">2</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td></td><td>40</td></tr>
<tr><td colspan="4">Course Aim/Intended Learning Outcomes:
On successful completion of this module, students will be able to:
➢ Identify the benefits and ethical issues involved in randomization as a mechanism for reduction and balancing bias, and implement a variety of randomization schemes.
➢ Describe the principles behind the common experimental designs and be able to implement, analyze and interpret data from a variety of randomized designs.
➢ Describe the advantages and disadvantages of the use of surrogate endpoints.
➢ Describe the principles underlying Phase I, II and III and IV studies as well as of the scientific basis underlying issues in clinical studies including intention-to-treat, blinding, interim analyses, missing data subgroup analyses and the reporting thereof.
➢ State the reasons for the importance of sample size in clinical studies, and perform sample size calculations for a variety of trial designs with different outcomes.
➢ Explain the role of statistical methods in evidence-based health care.
➢ Determine appropriate statistical methods of particular relevance to evidence-based health care in particular clinical applications.
➢ Correctly employ these statistical methods and have the skills to effectively communicate with clinicians on the application of these methods and interpretation of results.</td></tr>
<tr><td colspan="4">Course Contents
➢ This unit will introduce randomized comparisons as a major tool used in medical research and the basis of providing evidence for improving clinical practice. By developing problems based on clinical questions, the need and value of different experimental designs will be introduced and expanded. Within this context, issues with regards to randomization, ethical issues, clinical study design and analysis interpretation will be developed, as will</td></tr>
</table>

selection of outcome variables, surrogate endpoints and dealing with missing data. Efficiency issues such as sample size and power will be introduced at appropriate points in the unit. Assessment of the application, analysis and utility of crossover and equivalence trials. Cluster randomized trials, complex interventions, Stepped-wedge design

- Methods for assessment of clinical agreement, statistical properties of diagnostic tests and their interpretation, Pre-test probability, Post-test probability, Sensitivity, Specificity, Positive & Negative Predictive Values (PV), Diagnostic test accuracy, Likelihood Ratios (LR), 95% CI, Diagnostic OR, Application & interpretation, Multilevel LRs, ROC curves, Sample size calculations. Fundamentals of modelling for clinical prediction. Systematic reviews and meta-analysis methods in the context of randomized trials, diagnostic tests and observational studies, assessing heterogeneity, Random effects model/Fixed effects model, and publication bias, Funnel Plots. Prognosic factor research & models development and Validation.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment	Final Assessment		
40%	60%		
Details:	Theory (%)	Practical (%)	Other (%)
Quizzes- 20, mid-term -20	60	N/A	N/A

References/Reading Materials:

- Robert H. Fletcher , Suzanne W. Fletcher , Grant S. Fletcher. (2014). “Clinical Epidemiology: The Essentials . " "Wolters Kluver/ Lippincott Williams & Wilkins.

Semester 2	

Course Code:	**MMST 52093**		
Course Name:	**Regression Analysis**		
Credit Value:	**3**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	30	75

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Understand the major theoretical and computational issues underlying analyses based on linear models.
- Develop appropriate regression modelling strategies based on unit matter considerations, including choice of models, control for confounding and appropriate parameterization.
- Be proficient at using a statistical software package to perform multiple regression and analysis of variance.
- Understand the construction, use and interpretation of regression modelling diagnostics.
- Express the results of statistical analyses of linear models in language suitable for communication to medical investigators or publication in biomedical or epidemiological journal articles.
- Appreciate the role of modern techniques including non-parametric smoothing and variance components models.

Course Contents

Pearson correlation & partial correlation. Bivariate and tri-variate regression. Assumptions of linear regression and properties of least squares estimation. Evaluation of regression models. Standardized coefficients. Nonlinearity and interaction. Dummy (indicator) variables. Multicollinearity. Model building strategies. Heteroscedastity. Effect modification /interaction, together with the development of associated inference procedures. Multiple regression strategies and model selection issues will be presented together with model checking and diagnostics.

<table>
<tr><td colspan="4">Conditional /Unconditional logistic regression for a binary outcome as a special case of generalized linear modelling. Statistical Tests (Wald test, Likelihood ratio test, Model building strategies, Goodness of fit tests). Ordinal LR, Multinomial LR, Dummy (indicator) variables. Multicollinearity. Model building strategies.
➢ Nonparametric regression techniques, and random effects and variance components models will also be outlined.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods:
Lectures, interactive contacts, Practical classes and discussions</td></tr>
<tr><td colspan="4">Assessment Strategy:
CA (Case studies, assignments, reports, presentations, tests) and ESA.</td></tr>
<tr><td>Continuous Assessment
40%</td><td colspan="3">Final Assessment
60%</td></tr>
<tr><td>Details:
Quizzes- 20, mid-term -20</td><td>Theory (%)
60</td><td>Practical (%)
N/A</td><td>Other (%)
N/A</td></tr>
<tr><td colspan="4">References/Reading Materials:
➢ Draper, N.R and smith, 3rd Edition, (1998), ‘Applied Regression Analysis’, John Wiley & Sons.
➢ Michael Kutner , Christopher Nachtsheim , John Neter, William Li. Applied Linear Regression Models 5th Edition
➢ Sanford Weisberg. Applied Linear Regression, 4th Edition. ISBN: 978-1-118-59479-7, John Wiley & Sons.
➢ Hosmer D W, Lemeshow S, Rodney X. Sturdivant. Applied logistic regression 3rd Edition. John Wiley & sons New York 2013 ISBN: 978-0-470-58247-3</td></tr>
</table>

Semester 2			
Course Code:	**MMST 52112**		
Course Name:	**Survival analysis**		
Credit Value:	**2**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	40

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Understand the major theoretical and computational issues underlying survival analysis.
- Develop appropriate survival analysis strategies based on unit matter considerations, including choice of models, control for confounding and appropriate parameterization.
- Be proficient at using at least two different statistical software packages (e.g. Stata, SPSS) to perform survival analysis.
- Understand the construction, use and interpretation of appropriate graphs for showing results and checking statistical assumptions.
- Express the results of statistical analyses of censored data in language suitable for
- communication to medical investigators
- publication in biomedical or epidemiological journals
- Formulate and report on appropriate Survival Analysis models using Cox Regression and Time Dependent Covariates.
- Ability to analyze hierarchical and repeated measures data for both continuous and binary outcomes

Course Contents

- Fundamentals of Survival Analysis, Problems with conventional methods, Types of censoring, Kaplan-Meier curve definition and its extension, survival prospects using logrank test, Proportional hazards models, Partial likelihood estimation, Interpretation of

parameters, graphical displays and assessing underlying assumptions, Competing risks, Time dependent covariates, Discrete time analysis, Sensitivity analysis for censoring, Choice of time axis, Testing the proportional hazards assumption, Stratification, Heterogeneity and time dependence, Repeated events, Left censoring, left truncation. Various extensions of this model, including time-dependent covariates, multiple outcomes and censored linear regression model.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments, reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A

References/Reading Materials:

- David G. Kleinbaum, Michtel Klein (2012). "Survival Analysis (Statistics for Biology and Health) " Spriger.
- David W. Hosmer, Jr., Stanley Lemeshow. Susanne May, (2008) "Applied Survival Analysis" , 2nd Edition, ISBN: 978-0-471-75499-2
- Klugman, Stuart A.; Panjer, Harry H.; Willmot, Gordon E. Loss Models: from Data to Decisions (4th edition). 2012.

Semester 2			
Course Code:	**MMST 52122**		
Course Name:	**Advanced Topics in Regression**		
Credit Value:	**2**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	30	30	40

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Appraise how the type of data and the nature of the research questions affects the appropriate analysis methodology
- Contrast a range of advanced regression techniques, testing assumptions appropriately
- Contrast Multi-level Modelling analyses for nested and repeated measures data for nominal and metric response variables.
- A nuanced understanding of the conceptual foundations and basic mathematical formulation of the multilevel model.
- The ability to understand, interpret and explain the output from multilevel modeling software
- An appreciation of the advantages and disadvantages of multilevel modeling as compared with other approaches to nested data.
- Identify the most appropriate method of regression analysis in any particular research context.
- The ability to extend the multilevel model to dichotomous outcomes.

Course Contents

- Multilevel Modelling: Introduction to multilevel (hierarchical) data structures, Summary methods, Introduction to multilevel modelling and MLwiN, Multilevel models for longitudinal/repeated measures data, Multilevel models using Stata, Repeated binary data analysis using MLwiN, Alternative analysis: Generalized Estimating Equations (GEEs)

➢ Missing Data - Methods Case available analysis, Simple imputation analysis, Multiple imputation analysis.			
Teaching /Learning Methods: **Lectures, interactive contacts, Practical classes and discussions**			
Assessment Strategy: CA (Case studies, assignments (written and practical), reports, presentations, tests) and ESA.			
Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A
References/Reading Materials: ➢ Goldstein H, 2003, Multilevel statistical models, London, Arnold Publishers ➢ Snijders T, Bosker R, 1999 Multilevel analysis: an introduction to basic and advanced multilevel modeling, London, Sage ➢ Hox J, 2002, Multilevel analysis: techniques and applications, Mahwah, NJ, Lawrence Erlbaum.			

Semester 2			
Course Code:	**MMST 52131**		
Course Name:	**Bayesian Statistical Methods**		
Credit Value:	**1**		
Core/Optional	**Optional**		
Hourly Breakdown	Theory	Practical	Independent Learning
	15	15	20

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Understand Bayes' rule, prior distributions and their applications to medical statistics;
- Be able to apply Bayesian methods to medical data using SAS and WINBUGS software;
- Interpret credible intervals and probabilities from a Bayesian standpoint
- Impute data using MCMC Bayesian methodology

Course Contents

- The principles of prior and posterior distributions, Bayes' rule for statistical inference, conjugate and non-conjugate priors, the Gibbs sampler, Wishart and inverse Wishart distributions, the Metropolis and Metropolis-Hastings algorithms, Jeffries invariant prior, hierarchical linear models from a Bayesian perspective, the concept of credible intervals, exchangeable prior models for robust inference, Bayesian mixture models and Markov Chain Monte Carlo (MCMC) models.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments (written and practical), reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A

References/Reading Materials:

- Peter Congdon, "Bayesian Statistical Modelling " Springer.
- Gianluca Baio, "Bayesian Method in Health Economics" Chapman & Hall
- Peter Hoff, "A first course in Bayesian Statistical Methods" Springer, 2009
- Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari and Donald B. Rubin, "Bayesian Data Analysis" Chapman & Hall/CRC Text in Statistical Science, 3rd ed.

Semester 2			
Course Code:	**MMST 52141**		
Course Name:	**Applied Econometrics**		
Credit Value:	**1**		
Core/Optional	**Optional**		
Hourly Breakdown	Theory	Practical	Independent Learning
	15		35

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- understand the principles of estimation and hypothesis testing in a multivariate setting
- know the properties of different estimators and tests
- be able to apply econometric techniques to actual data using computer packages

- be critically aware of the assumptions made in building econometric models
- write up the results of a study of an economic problem that includes econometric analysis
- proficiently use the time series testing and estimation capabilities of a range of packages
- explain the concepts used for the qualitative and limited dependent variables methods and to apply them to simple situations.
- explain the concepts used for survival analysis and panel data models and to apply them to simple situations.
- use Stata to develop further your understanding of the syllabus material (T,P)

Course Contents

- Specification and Data Issues; Functional form misspecification, Proxy variables, Measurement errors, Instrumental variables estimation, Econometric models with time series. Maximum Likelihood Principle, LP and Logit, Probit Models, Truncated and Censored Regression Models, Duration Models, Panel Data Models; Fixed effects estimation, Random effects estimation, Poisson regression model

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments (written and practical), reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A

References/Reading Materials:

- Wooldridge J.M. (2016) Introductory Econometrics, 6th Edition. Cengage Learning.
- Angrist J.D. and Pischke J.S. (2008) Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press.
- Principles of Econometrics, 4th Edition, Wiley by R. Carter Hill, William E. Griffits and Guay C. Lim.

- Maddala. G.S., 3rd Edition, (2001), 'Introduction to Econometrics', Wiley
- Jones, A., Applied Econometrics for Health Economists, Radcliffe Publishing, 2007

Semester 2			
Course Code:	**MMST 52102**		
Course Name:	**Forecasting & Statistical Process Control**		
Credit Value:	**2**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	30		70

Course Aim/Intended Learning Outcomes:

On successful completion of this module, students will be able to:

- Plot time series and describe their characteristics.
- Identify fundamental concepts in time series modelling, such as time series decomposition and stationarity.
- Compute indices based on time series data.

- Appraise the limitations of regression as a forecasting tool.
- Interpret forecast results for a general non-statistical audience.
- Choose an appropriate type of control chart with appropriate control limits and interpret obtained results.
- Design a sampling plan and apply for health data.

Course Contents

Range of forecasting methods and their application to planning and decision-making. Common tools and packages used in forecasting, the use of historical data to identify appropriate forecasting model, use the final model to forecast future values. The univariate analysis of time series (ARMA/ARIMA models). Multivariate time series analysis (VAR models).

- Quality characteristics, Process control inspections, Cumulative Sum (CUSUM) charts, Plotting X-bar and R Charts, Plotting X-bar and s Charts, plotting p Charts, plotting np Charts, plotting u Charts, Plotting c Charts, Acceptance inspection schemes for attributes and variables. Indifference quality level; AQL methods, LTPD designs. Sampling at process control and acceptance sampling, Description of Lot Quality Assurance Sampling: ROC curves, Producers' risk, Consumers' risk.

Teaching /Learning Methods:

Lectures, interactive contacts, Practical classes and discussions

Assessment Strategy:

CA (Case studies, assignments (written and practical), reports, presentations, tests) and ESA.

Continuous Assessment 40%	Final Assessment 60%		
Details: Quizzes- 20, mid-term -20	Theory (%) 60	Practical (%) N/A	Other (%) N/A

References/Reading Materials:

- Introduction to Statistical Quality Control, 7th Edition by Douglas C. Montgomery,
- 2013, John Wiley & Sons, Inc., New York.
- Quality Management in Health Care: Principles and Methods, By Donald Lighter, Douglas C. Fair

- Brockwell and Davis, 2nd Edition, (1991), 'Time Series- Method and Forecasting', Springer.
- Box and Jenkins, (1976), 'Time Series Analysis', John Willy.
- DeLurgio, S.A., (1998), 'Forecasting Principles and Applications', McGraw Hill.
- Chatfield, C., 2nd Edition, (1980), 'Analysis of Time Series', Chapman-Hall

Semester 2			
Course Code:	**MMST 52145**		
Course Name:	**Independent Study in Medical Statistics**		
Credit Value:	**5**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
		150	350

Course Aim/Intended Learning Outcomes:

At the end of this course students should be able to conduct an independent study in an area in Medical Statistics.

Course Contents

- A statistical analysis related to major sub disciplines in Medical Statistics curriculum under an assigned supervisor or self-study on an advanced topic in Medical Statistics.

<table>
<tr><td colspan="4">Teaching /Learning Methods:
Interactive contacts, Practical classes and discussions</td></tr>
<tr><td colspan="4">Assessment Strategy:</td></tr>
<tr><td>Continuous Assessment

……30%……..%</td><td colspan="3">Final Assessment

……70%…….%</td></tr>
<tr><td>Details: Two progress review presentation %,

15, each</td><td>Theory (%)

……..</td><td>Practical (%)

……..</td><td>Other (%)(specify)
Viva-voce examination %,
Project Report %
……</td></tr>
<tr><td colspan="4">References/Reading Materials:
➢ JH Abramson, ZH Abramson, 1999. Survey methods in Community Medicine.
➢ Designing clinical research: an epidemiological approach, SB Hulley, SR Cummings. 1988.</td></tr>
</table>

Contributors to the development of the curriculum

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MBBS (Kelaniya), M.Sc (Colombo), MD (Colombo), Graduate Certificate in Economics (Adelaide), MSc (Health Economics and Policy)

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5). Prof. M.M Gunathilake

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6). Dr. (Mrs) A. P. Hewaarachchi

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7). Dr. (Mrs.) D. D. M. Jayasundara

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8). Dr. W.V.A.D Karunarathne

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9). Dr. U. P. Liyanage

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Department of Statistics & Computer Science, University of Kelaniya

10). Senior Professor R.P Chitra Ranjani

PhD (Finance) – University Business School, P.U., India, M. Com – P.U, India,

B. Com – University of Kelaniya

11). Dr. Sudath Samaraweera

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Director, Cancer Control Prgramme, Ministry of Health,

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12). Dr. S.D. Viswakula

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Department of Statistics, University of Colombo

Date : …….. …….

Chair of the BoS

Date : ……. ……..…….……

Dean of the Faculty of Graduate Studies

Recommendation of IQAU Director of the University

Date : ……..…… …….

Director- IQAU, University of Kelaniya

Approval of the Vice-Chancellor

Date : ……..…… …….

Vice-Chancellor -University of Kelaniya