Course Content – Department of Statistics

ST 1006	Introduction to Probability and Statistics	ST 3051	Statistical Inference I
ST 1008	Probability and Distributions	ST 3070	Special Topics
ST 1009	Exploratory Data Analysis	ST 3072	Applied Regression Analysis
ST 1010	Statistical Theory	ST 3073	Surveys and Sampling
ST 1011	Introduction to Surveys	ST 3074	Time Series Analysis
ST 1012	Basic Statistical Computing	ST 3075	Design of Experiments
IS 1006	Fundamentals of Statistics	ST 3082	Statistical Learning, I
IS 1007	Introduction to Statistical computing	ST 3083	Multivariate Data Analysis
IS 1008	Introduction to Probability and Distributions	ST 3084	Statistical Inference II
IS 1009	Introduction to Survey Design	ST 3085	Computational Statistics
MS1001	Principles of Management	DS 3001	Data Visualization Techniques
MS1003	Operational Research I	DS 3002	Data Ethics and Data Security
ST 2004	Analysis of Variance and Design of Experiments	DS 3003	Machine Learning I
ST 2006	Basic Statistical Inference	DS 3004	Essential Calculus and Linear Algebra for Data Science
ST 2006	Basic Statistical Inference	IS 3001	Sampling Techniques
ST 2007	Applications in Statistical Inference	IS 3003	Special Topics I
ST 2008	Statistical Methods in Quality Control	IS 3050	Statistical Inference
ST 2009	Applied Non Parametric Methods	IS 3051	Advanced Statistical Process Control
ST 2009	Applied Non-Parametric Methods	IS 3052	Advanced Topics in Experimental Design
ST 2010	Introduction to Statistical Modeling	IS 3053	Data Mining Techniques
ST 2010	Introduction to Statistical Modeling	MS 3002	Advanced Marketing Research
IS 2003	Design and Analysis of Industrial Experiments	ST 4011	Econometrics
IS 2005	Statistical Packages	ST 4012	Special Topics for ST
MS2001	Statistical Quality Control	*ST 4013	Special Topics for ST + CS
MS2004	Introduction to Marketing Research	ST 4031	Stochastic Processes and Applications
ST 3003	Marketing Research	ST 4035	Data Science
ST 3006	Regression Analysis	ST 4036	Time to Event Analysis
ST 3007	Operational Research	ST 4037	Epidemiology
ST 3009	Applied Time Series	*ST 4040	Individual Project ST+CS
ST 3012	Statistical Process Control	ST 4050	Individual Project ST
IS 3001	Sampling Techniques	ST 4051	Scientific Writing
IS 3004	Applied Multivariate Methods	ST 4052	Statistical Learning II
IS 3005	Statistics in Practice I	ST 4054	Linear Models
MS 3004	Quality Management/Project Management	ST 4055	Generalized Linear Models
MS 3009	Operational Research II	ST 4056	Medical Statistics
ST 3008	Applied statistical models	DS 4001	Image Analysis
ST 3010	Introduction to Health Statistics	DS 4002	Machine Learning II
ST 3011	Statistical Programming	DS 4003	Special Topics for Data Science
ST 3013	Essential Mathematics for Statistics	DS 4004	Big Data analytics

DS 4006	Professional Practice
DS 4005	Causal Inference
DS 4007	Research Project in DS
IS 4002	Advanced Statistical Modeling
IS 4003	Special Topics II
IS 4006	Individual Project
IS 4007	Statistics in Practice II
IS 4009	Industrial Training
IS 4010	Industry Research Project
IS 4011	Professional Practice
MS 4007	Risk Management
MS 4008	Industrial Psychology
EC 4004	Industrial Training

* Courses offered for Honours intake 2022 only.

Courses offered by the Department of Statistics

for Level I and II

Physical Science

Level One

	Pre Req	Course Unit	Title	Credit	Hours	P1	P2	P3	P4	P5	P6
SI		ST 1006	Introduction to Probability and Statistics	2	30L	o		o		o	
SI		ST 1008	Probability and Distributions	2	30L		x		x		x
SI		ST 1009	Exploratory Data Analysis	2	15L30P		x		x		x
SII		ST 1010	Statistical Theory	2	30L		x		x		x
SII		ST 1011	Introduction to Surveys	2	15L30P	o	o	o	o	o	o
SII		ST 1012	Basic Statistical Computing	2	15L30P	o	o	o	o	o	o

Level Two

	Pre Req	Course Unit	Title	Credit	Hours	P1	P2	P3	P4	P5	P6
SI		ST 2006	Basic Statistical Inference	3	45L	o	x	o	x	o	x
SI		ST 2007	Applications in Statistical Inference	1	30P		x		x		x
SI		ST 2008	Statistical Methods in Quality Control	2	30L	o	o	o	o	o	o
SII	ST2006	ST 2004	Analysis of Variance and Design of Experiments	2	30L	o	x	o	x	o	x
SII	ST 2006	ST 2009	Applied Non Parametric Methods	2	30L	o	o	o	o	o	o
SII		ST 2010	Introduction to Statistical Modeling	1	15L		o		o		o

Course Content - Level I

<table>
<tr><td colspan="5">Level I - Semester 1</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 1006</td></tr>
<tr><td>Course Name</td><td colspan="4">Introduction to Probability and Statistics</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C (30L)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional (P1, P3, P5)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

The theory and methods of probability and statistics play an important role in our lives. They enable important understanding to be gained and informed decisions to be made about a population by examining only a small random sample from that population. The course is designed to develop students' understanding and knowledge of descriptive and inferential statistics, and to strengthen students' skills in data analysis and interpretations.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course the student will be able to,

● describe data graphically and compute summary measures
● compute probabilities by modeling sample spaces and apply rules of probability
● construct the probability distribution of a random variable, expectation and variance
● identify and compute probabilities based on practical situations using commonly used distributions.</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Descriptive Statistics: Types of data (qualitative, quantitative, continuous, discrete, etc.); scales of measurement (nominal, ordinal, interval, ratio); data summarization: frequency table, cum. frequency table, histogram, bar chart, pie chart, percentiles, quartiles, 5–number summary, Box plot, outliers; Measures of location: mean, trimmed mean, median, mode; Measures of dispersion: range, inter quartile range, variance, standard deviation, coefficient of variation; skewness, kurtosis; Counting techniques: counting rules, permutations and combinations; Elementary probability: probability definitions, finite sample space, events, probability rules and associated theorems, conditional probability, independence, multiplication rule, Bayes' theorem; One dimensional random variables: probability density function and probability (mass) function, cum. distribution function, expected value and variance of functions of random variables, moment generating function; Probability distributions: discrete distributions (Uniform, Bernoulli, Binomial, Poisson) and applications; continuous distributions (Uniform, Exponential, Normal) and applications; central limit theorem with applications.</td></tr>
</table>

Teaching /Learning Methods: Interactive lectures, Recorded videos, Tutorial sessions, Practice exercises, Assignments, Quizzes			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (specify) ……30……. % ……..% ……..	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: • Mann, P. S. (2010). Introductory Statistics (7th ed). John Wiley & Sons. • Crawshaw, J., & Chambers, J. (1984). A Concise Course in A-Level Statistics (4th ed). Nelson Thornes Limited. • Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). Mathematical Statistics with Applications (7th ed). Cengage Learning • Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2011). Statistics for Business and Economics (11th ed.). South-Western College • Spiegel, M. R., Schiller, J.J, & Srinivasan, R.A. (2012). Schaum's Outline of Probability and Statistics (4th ed). McGraw-Hill Education			

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Level I - Semester 1				
Course Code	ST 1008			
Course Name	Probability and Distributions			
Credit Value	2C (30L)			
Core/Optional	Core (P2,P4,P6)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				

The measure of how likely an event is to happen is termed as probability. A mathematical function that provides the probability of occurrence of various possible outcomes of an experiment is termed as probability distribution. The subject is basically concerned with the concepts of probability and probability distributions based on different types of random variables.

Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

- compute probabilities by modeling sample spaces and apply rules of probability
- construct the probability distribution of a random variable, expectation and variance
- identify and compute probabilities based on practical situations using commonly used distributions, and the central limit theorem.

Course Content: (Main topics, Sub topics)

Introduction to probability; Counting techniques: counting rules, permutations and combinations; Elementary probability: probability definitions, finite sample space, events, probability rules and associated theorems, conditional probability, independence, multiplication rule, Bayes' theorem; One dimensional random variables: probability density function and probability (mass) function, cum. distribution function, expected value and variance of functions of random variables, moment generating function; Probability distributions: discrete distributions (Uniform, Bernoulli, Binomial, Negative Binomial, Hypergeometric, Poisson, and Geometric) and applications; continuous distributions (Uniform, Exponential, Gamma, Chi-squared, Beta, Normal, t and F) and applications; central limit theorem with applications.

Teaching /Learning Methods: Interactive lectures, Recorded videos, Tutorial sessions, Practice exercises, Assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70…….%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
……30……. % ……..% ……..%	…70…..	……..	……

Recommended Reading:

- Mann, P. S. (2010). Introductory Statistics (7th ed). John Wiley & Sons.

- Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). Mathematical Statistics with Applications (7th ed). Cengage Learning
- Spiegel, M. R., Schiller, J.J, & Srinivasan, R.A. (2012). Schaum's Outline of Probability and Statistics (4th ed). McGraw-Hill Education

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Level I - Semester 1				
Course Code	ST 1009			
Course Name	Exploratory Data Analysis			
Credit Value	2C (15L 30P)			
Core/Optional	Core (P2,P4,P6)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100

Course Aim:

Exploring Data is essential to understand the structure and pattern of the data. This course trains the students to explore data sets of various types and teaches suitable methods to organize and present data to extract stories from them.

Intended Learning Outcomes:

Upon successful completion of the course the student will be able to,

- explore and interpret data and draw meaningful conclusions using descriptive methods using one or more statistical software packages
- present statistical information clearly, in both written and oral form.

Course Content: (Main topics, Sub topics)

Picturing distributions with graphs: Individuals and variables, Categorical variables (pie charts, bar graphs), Quantitative variables (histograms, stem plots, time plots), picturing distributions with graphs using statistical software; Describing distributions with numbers: measuring center (mean, median, comparing the mean and the median), measuring spread (quartiles, five-number summary, boxplots, spotting suspected outliers, standard deviation), choosing measures of center and spread, describing distributions with numbers using statistical software; organizing a statistical problem; The Normal distributions: density curve, the 68–95–99.7 rule, the standard Normal distribution, finding Normal proportions; Relationships between two quantitative variables: explanatory and response variables, scatterplots, adding categorical variables to scatterplots, measuring linear association-correlation, facts about correlation, the best fitted line using least-squares, misuses of correlation and least square relationships; Relationship between two categorical variables: marginal distributions, conditional distributions, Simpson’s paradox; General Misuses of Statistics

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, group work, presentation, quizzes, tutorial classes, assignments			
Assessment Strategy: At least 3 in class assignments + 1 group project+ Final Exam			
Continuous Assessment ……50……..%	Final Assessment ……50……%		
Details: quizzes, mid-term, other (group project) ...30..... % .....% .....20.....%	Theory (%) …50…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: • Moore, D. S., Notz, W. I., & Fligner M. A. (2011). *The Basic Practice of Statistics (6th ed).* W. H. Freeman			

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Level I - Semester 2				
Course Code	ST 1010			
Course Name	Statistical Theory			
Credit Value	2C (30L)			
Core/Optional	Core (P2,P4,P6)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: This course explains how to use statistical theories in problems in the real world. Random variables, many statistical distributions and their properties will be discussed. Multidimensional random variables and transformation techniques are also being discussed. Apart from that, theories of order statistics will be discussed.				
Intended Learning Outcomes:				

After the successful completion of the course, students will be able to

- integrate advanced concepts in probability
- apply probability concepts efficiently for problem solving

Course Content: (Main topics, Sub topics)

Two–dimensional random variables: joint distribution (discrete, continuous), marginal and conditional distributions, independence, bivariate normal distribution, covariance, correlation, conditional expectation, expectation of functions of random variables; Bivariate transformations (discrete and continuous); Order statistics; Asymptotic theory.

Teaching /Learning Methods: Interactive lectures, Recorded videos, Tutorial sessions, Practice exercises, Assignments, Quizzes

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
……30……. % ……..% ……..%	…70……	……..	……

Recommended Reading:

- Gupta, S. C., & Kapoor, V. K. (2000). Fundamentals of Mathematical Statistics (10th ed). Sultan Chand & Sons
- Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). Mathematical Statistics with Applications (7th ed). Cengage Learning
- David, H. A., & Nagaraja, H. N. (2003). Order Statistics (3rd ed). John Wiley and Sons.
- Serfling, R. J. (1980) Approximation Theorems of Mathematical Statistics (1st ed). Wiley Interscience

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Level I - Semester 2	
Course Code	ST 1011
Course Name	Introduction to Surveys
Credit Value	2C (15L 30P)
Core/Optional	Optional (P1,P2,P3,P4,P5,P6)

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td>30</td><td>55</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

It is often required to conduct surveys to obtain information about individuals. A survey should be carefully planned and conducted to obtain the right information. Slight mistake may lead to obtaining completely wrong information. [ST1011 provides the foundation knowledge to conduct a survey with practical experience]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

● solve a real life problem by properly planning and designing a survey focusing on selecting a sample scientifically</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Producing data via surveys: Random & nonrandom sampling methods, cautions about sample surveys, planning and designing surveys, designing a questionnaire, pretesting, margin of error; Producing data via experiments: Randomized experimental methods, cautions about experiments; Solving a real world problem through a sample survey: Formulate a suitable research question, develop an appropriate sampling scheme, develop questionnaire, develop implementation plan, data collection, and analysis.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, zoom sessions, group activities, group projects, quizzes, tutorial classes, assignments, presentations</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 2 in class assignments + 1 group project + Final exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……40……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (group project)

..... % .....% .....%</td><td>Theory (%)

…40…..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Scheuren, F. (2004) What is a Survey? (2nd ed). American Statistical Association
● Yates, F. (1960) Sampling Methods for Census & Surveys (3rd ed). Charles Griffin and Company Limited</td></tr>
</table>

- Groves, R. M., Fowler, F. J., Couper, M. P., Lepkowski, J. M., Singer, E., & Tourangeau, R. (2009). Survey Methodology (2nd ed). John Wiley and Sons.

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<table>
<tr><td colspan="5">Level I - Semester 2</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 1012</td></tr>
<tr><td>Course Name</td><td colspan="4">Basic Statistical Computing</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C (15L 30P)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional (P1,P2,P3,P4,P5,P6)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td>30</td><td>55</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Since computational data analysis is an essential part of handling data analysis, competent statisticians must be able to use commonly available spreadsheet packages to solve data analysis problems. ST 1012 provides a good foundation to computational data analysis, using spreadsheet package Microsoft Excel.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● perform data management using Excel
● employ Excel functions
● generate Recording and VBA Macros
● analyze data at exploratory level</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to Excel, Manipulate worksheets, Import/Export files, Templates, Advanced formatting techniques, Excel functions, Database features, Pivot tables, Record Macros, Sub procedures in VB, VBA Macros, Data analysis tool-pack.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, videos, practice exercises , assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 5 lab assignments</td></tr>
<tr><td colspan="2">Continuous Assessment</td><td colspan="3">Final Assessment</td></tr>
</table>

……100……..%	……..%		
Details: quizzes, mid-term, other (lab assignments) ..... % .....% ...100.....%	Theory (%) ……	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Bloch, S. C. (2003) Excel for Engineers and Scientists (2nd ed). Wiley ● Walkenbach, J. (2013) Microsoft Excel 2013 Bible. Wiley ● Muir, N. C. (2007) Teach Yourself VISUALLY Excel 2007. Wiley ● Moore, M. (2014) Mastering excel macros: Introduction. Kindle			

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Course Content - Level II

Level II - Semester 1				
Course Code	ST 2006			
Course Name	Basic Statistical Inference			
Credit Value	3C (45L)			
Core/Optional	Core (P2,P4,P6) | Optional(P1,P3,P5)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim: Inferential statistics use a random sample of data taken from a population to describe and make inferences about the population. Inferential statistics are valuable when examination of each member of an entire population is not convenient or possible. ST 2006 introduces the basic theory and application of Inferential Statistics.				
Intended Learning Outcomes: After the successful completion of the course, students will be able to, ● identify and compute probabilities based on sampling distributions and the central limit theorem				

- understand the theories of statistical inferences
- apply the appropriate models in different settings to solve real-life problems
- perform statistical inferences involving the mean, variance and proportion and goodness of fit tests

Course Content: (Main topics, Sub topics)

Sampling distributions, applications of central limit theorem; point estimation, bias and mean square error; interval estimation, margin of error, determination of sample size; types of errors associated with hypothesis testing, power of the test, power curves; sampling from normal distributions, inferences about the mean and variance; large sample inference, inference for proportions; chi-square goodness-of-fit tests, chi-square tests for association.

Teaching /Learning Methods: Interactive lectures, videos, quizzes, tutorial classes, assignments

Assessment Strategy: 2 inclass assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
.....20..... % .....% .....%	…80…..	……..	……

Recommended Reading:

- Moore, D. S., Notz, W. I., & Fligner M. A. (2011). *The Basic Practice of Statistics* (6th ed). W. H. Freeman
- Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). *Mathematical Statistics with Applications* (7th ed). Cengage Learning

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Level II - Semester 1	
Course Code	ST 2007
Course Name	Applications in Statistical Inference
Credit Value	1C (30P)
Core/Optional	Core (P2,P4,P6)

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>30</td><td>20</td><td>50</td></tr>
<tr><td colspan="5">Course Aim:

Discovering more about data with powerful statistical analysis and data visualization is very important to a statistician. ST 2007 teaches how SPSS can be used to analyze and visualize a set of data and to interpret and make conclusions based on the results.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● apply appropriate hypothesis tests and create interval estimations to solve real world problems using SPSS.
● manage data within the SPSS platform</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to SPSS, Data management, Application of central limit theorem, Inference about the mean/variance of a Normal population, Inference about means/variances of Normal populations - two sample problems, Inferences about the proportions, Chi-Square test for the goodness of fit /independence</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lab sessions, Assignments, Videos, Practice exercises</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 3 lab assignments + 1 group project</td></tr>
<tr><td>Continuous Assessment

……100……..%</td><td colspan="4">Final Assessment

…….%</td></tr>
<tr><td>Details: quizzes, mid-term, other (group project)

.....50..... % .....% ...50.....%</td><td>Theory (%)

…….</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Meyers, L. S., Gamst, G. C., & A. J. Guarino, A. J. (2013) Performing Data Analysis Using IBM SPSS (1st ed). John Wiley & Sons
● Field, A. (2013) Discovering Statistics Using IBM SPSS Statistics (4th ed). SAGE Publications Ltd</td></tr>
</table>

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<table>
<tr><td colspan="5">Level II - Semester 1</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 2008</td></tr>
<tr><td>Course Name</td><td colspan="4">Statistical Methods in Quality Control</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C (30L)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional (P1,P2,P3,P4,P5,P6)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Statistical Process Control (SPC) is a set of techniques that provides a clearer understanding of the evolution and behavior of a process or system. Quality verification of a design characteristic of a manufactured product is typically achieved through inspection or sampling. This course is focused on the basic statistical methods used in quality control from the theoretical basis, classical and conventional methods to the practical aspects of statistical process control.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● analyze data using tools of Statistical Process Control (SPC),
● design and interpret variable and attribute type control charts by applying the basics of control chart designs and sensitizing tools.</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Methods and philosophy of statistical quality control; Tools to enhance the quality of the process; Variable type control charts: charts, R charts, S charts; Attribute type control charts: P charts, C charts, U charts; Control charts for short productions; Economic designs of control charts; Lot by lot acceptance sampling for attributes.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, quizzes, tutorial classes, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment</td><td colspan="3">Final Assessment</td></tr>
</table>

……20……..%	……80……..%		
Details: quizzes, mid-term, other (specify) .....20..... % .....% .....%	Theory (%) …80….	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Montgomery, D. C. (2009) *Introduction to Statistical Quality Control* (6th ed). John Wiley & Sons			

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Level II - Semester 2				
Course Code	ST 2004			
Course Name	Analysis of Variance and Design of Experiments			
Credit Value	2C (30L)			
Core/Optional	Core (P2,P4,P6) | Optional(P1,P3,P5)			
Prerequisites	ST 2006			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Analysis of variance (ANOVA) and design of experiments are both topics that are usually covered in separate lectures. Basic methods of experimental design in the sense that how the observations or measurements should be obtained to answer a query in a valid, efficient and economical way will be discussed. The basic ANOVA to compare the averages of two or more populations are different on some dependent variable. That question is answered by appropriate calculations using sample data. This course is intended to help to understand the calculations for the simple versions of ANOVA.				
Intended Learning Outcomes: After the successful completion of the course, students will be able to, ● identify the appropriate experimental design to suit the situation where a cause and effect relationship has to be established. ● apply the proper design technique for available data				
Course Content: (Main topics, Sub topics)				

Principles of design, Replication and randomization, Model for a completely randomized design, Analysis of variance for one–way classification, Standard errors for specific comparisons.			
Teaching /Learning Methods: Interactive lectures, quizzes, tutorial classes, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes, mid-term, other (specify) .....20..... % .....% .....%	Theory (%) …80…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Kuehl, R. O. (1999). Design of Experiments: Statistical Principles of Research Design and Analysis 2nd ed.). Duxbury Press ● Montgomery, D. C. (2001). Design and Analysis of Experiments (5th ed.). John Wiley & sons			

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Level II - Semester 2				
Course Code	ST 2009			
Course Name	Applied Non Parametric Methods			
Credit Value	2C (30L)			
Core/Optional	Optional (P1,P2,P3,P4,P5,P6)			
Prerequisites	ST 2006			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Most of the commonly used statistical methods (parametric methods) provide valid information about the data only if the underlying population meets certain assumptions. However, when the population data has an				

unknown distribution, or when the sample size is small, the parametric tests cannot be used. Non-parametric methods will be used in such situations. [ST2009 provides the basic knowledge about distribution-free methods]

Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

- identify situations where non-parametric methods are applicable
- apply the appropriate non-parametric statistical method for a particular problem
- apply the methods and find the solution for the research question

Course Content: (Main topics, Sub topics)

Introduction, One sample location tests, Tests involving two samples, Two independent sample tests for differences in location, Two independent sample tests for differences in spread, Two related samples, Tests involving more than two samples, Miscellaneous tests, Test of randomness, Tests using frequency data.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
.....20..... % .....% .....%	…80…..	……..	……

Recommended Reading:

- Conover, W. J. (1999). *Practical Non-Parametric Statistics* (3rd ed.). Wiley & Sons
- Daniel, W. W. (2000). *Applied Non-parametric Statistics* (2nd ed.). Cengage Learning
- Lehmann, E. L., & D'Abrera, H. J. M. (2006). *Nonparametrics: statistical methods based on ranks* (1st ed.). Springer

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<table>
<tr><td colspan="5">Level II - Semester 2</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 2010</td></tr>
<tr><td>Course Name</td><td colspan="4">Introduction to Statistical Modeling</td></tr>
<tr><td>Credit Value</td><td colspan="4">1C (15L)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional (P2,P4,P6)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td></td><td>35</td><td>50</td></tr>
<tr><td colspan="5">Course Aim:

The concept of Statistical modelling is introduced through this model. Various types of statistical models are discussed and taught when to use what, depending on the interest and the research question concerned. How the model changes when the main variable of interest changes is emphasized through this course.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to

● recognize and use different forms of statistical models in the given context</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to the concept of Statistical Modeling, Building relationships between variables, Understanding the systematic and error components in modeling, Exploration of commonly used statistical models.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td>Continuous Assessment

……20……..%</td><td colspan="4">Final Assessment

……80……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

.....20..... % .....% .....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

……..</td><td colspan="2">Other (%)
(specify)

……</td></tr>
</table>

Recommended Reading:

- Mead, R., Curnow, R. N., & Hasted, A. M. (2002). *Statistical Methods in Agriculture and Experimental Biology* (3rd ed.). CRC Press

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Industrial Statistics

Level One

	Pre Req	Course Unit	Title	Credit	Hours	IS
SI		IS 1006	Fundamentals of Statistics	3	30L30P	x
SI		IS 1007	Introduction to Statistical computing	1	30P	o
SI		MS1001	Principles of Management	1	15L	x
SII		IS 1008	Introduction to Probability and Distributions	3	45L	x
SII		IS 1009	Introduction to Survey Design	2	15L30P	o
SII		MS1003	Operational Research I	2	30L	x

Level Two

	Pre Req	Course Unit	Title	Credit	Hours	IS
SI		IS 2005	Statistical Packages	1	30P	x
SI		ST 2006	Basic Statistical Inference	3	45L	x
SI		MS2001	Statistical Quality Control	2	30L	x
SII		IS 2003	Design and Analysis of Industrial Experiments	2	30L	x
SII	ST 2006	ST 2009	Applied Non-Parametric Methods	2	30L	o
SII		ST 2010	Introduction to Statistical Modeling	1	15L	o
SII	IS 1009	MS2004	Introduction to Marketing Research	1	15L	x

Course Content - Level I

<table>
<tr><td colspan="5">Level I - Semester 1</td></tr>
<tr><td>Course Code</td><td colspan="4">IS 1006</td></tr>
<tr><td>Course Name</td><td colspan="4">Fundamentals of Statistics</td></tr>
<tr><td>Credit Value</td><td colspan="4">3C (30L 30P)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td>30</td><td>90</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Statistics is very useful in many fields of study and in everyday life. One needs to have a working knowledge of the ideas and basic tools of practical statistics. [IS 1006: provides both the mechanics and the concepts needed for practical statistical work, at a level appropriate for beginners].</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

explore and interpret data and draw meaningful conclusions with descriptive methods using statistical software packages

● apply the basic concept of statistical inference through sample information and sampling distribution
● formulate the inferential methods appropriately as confirmatory analysis for the descriptive methods
● present statistical information clearly, in both written and oral form</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Picturing distributions with graphs: individuals and variables, categorical variables (pie charts, bar graphs), quantitative variables (histograms, stemplots, time plots), picturing distributions with graphs using statistical software; Describing distributions with numbers: measuring center (mean, median, comparing the mean and the median), measuring spread (quartiles, five-number summary, boxplots, spotting suspected outliers, standard deviation), choosing measures of center and spread, describing distributions with numbers using statistical software; organizing a statistical problem; The Normal distributions: density curve, the 68–95–99.7 rule, the standard Normal distribution, finding Normal proportions; Relationships between two quantitative variables: explanatory and response variables, scatterplots, adding categorical variables to scatterplots, measuring linear association-correlation, facts about correlation, the best fitted line using least-squares, misuses of correlation and least square relationships; Relationship between two categorical variables: marginal distributions, conditional distributions, Simpson’s paradox; Introduction to statistical inference: population versus sample, random sampling designs,</td></tr>
</table>

observation versus experiment; Sampling distributions: parameters and statistics, statistical estimation and the law of large numbers, sampling distribution of $\underline{x}$, central limit theorem; Inference in Practice - the basics: the reasoning of statistical estimation, confidence Intervals, tests of significance			
Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions			
Assessment Strategy: At least 3 in-class assignments + 1 group project + Final exam			
Continuous Assessment ……50……..%	Final Assessment ……50……..%		
Details: quizzes, mid-term, other (group project) ..... % .....% .....%	Theory (%) …50….	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Moore, D. S., Notz, W. I., & Fligner M. A. (2011). *The Basic Practice of Statistics (6th ed).* W. H. Freeman ● Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2011). *Statistics for Business and Economics* (11th ed.). South-Western College			

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Level I - Semester 1				
Course Code	IS 1007			
Course Name	Introduction to Statistical Computing			
Credit Value	1C (30P)			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		30	20	50
Course Aim: Computational data analysis is an essential part of modern statistics. Competent statisticians must be able to use commonly available spreadsheet packages to do data analysis and solve data analysis problems. IS 1007 is an				

<table>
<tr><td colspan="4">introduction to spreadsheet package Microsoft Excel, which will give them the basic skills to grasp spreadsheet software works to suit their needs.</td></tr>
<tr><td colspan="4">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● perform data management using Excel
● handle Excel functions and Recording Macros</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Introduction to Excel, Manipulate worksheets, Import/Export files, Templates, Excel functions, Pivot tables, Link and embed worksheets and workbooks, Record Macros, Data analysis tool-pack.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive lectures, videos, practice exercises , assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: At least 4 lab assignments</td></tr>
<tr><td colspan="2">Continuous Assessment

……100……..%</td><td colspan="2">Final Assessment

…….%</td></tr>
<tr><td>Details: quizzes, mid-term, other (lab assignments)

..... % .....% .....100.....%</td><td>Theory (%)

…….
.</td><td>Practical (%)

……..</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

● Bloch, S. C. (2003) Excel for Engineers and Scientists (2nd ed). Wiley
● Walkenbach, J. (2013) Microsoft Excel 2013 Bible. Wiley
● Muir, N. C. (2007) Teach Yourself VISUALLY Excel 2007. Wiley</td></tr>
</table>

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Level I - Semester 1	
Course Code	MS 1001
Course Name	Principles of Management
Credit Value	1C (15L)
Core/Optional	Core
Prerequisites	

<table>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td></td><td>35</td><td>50</td></tr>
<tr><td colspan="5">Course Aim:

A sound knowledge of management concepts are essential to succeed in the corporate world. MS 1001 provides a theoretical as well as a practical framework to understand how the managerial process is executed and to it can be used to solve managerial issues.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● recognize the basic concepts of management practices
● apply the concepts in a business environment</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Concept of management and evolution of management: Scientific management and other schools of thought; Socio-Industrial imperatives for evolution of thoughts; Functional areas of Management: Planning, Organizing, Staffing, Monitoring, Evaluation; Modern management practices.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 3 business cases + Presentations + Final exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……60……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

...40..... % .....% .....%</td><td>Theory (%)

…60…..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Robbins, S. P., De Cenzo, D. A., & Coulter, M. (2012) Fundamentals of Management: Essential Concepts and Applications (8th ed.). Pearson</td></tr>
</table>

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Level I - Semester 2				
Course Code	IS 1008			
Course Name	Introduction to Probability & Distributions			
Credit Value	3C (45L)			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

The measure of how likely an event is to occur is termed as probability. A mathematical function that provides the probability of occurrence of various possible outcomes in an experiment is termed as probability distribution. This subject provides a broad introduction of concepts of probability based on one-dimensional and two-dimensional random variables. Further, this subject focuses on the knowledge of the probability distributions based on different types of one-dimensional random variables.

Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

- compute probabilities by applying basic rules of probability
- construct the probability distribution of a random variable, expectation and variance
- identify and compute probabilities based on practical situations using commonly used univariate distributions and order statistics
- apply the concept of two-dimensional random variables
- compute probabilities under joint distributions, marginal and conditional distributions and compute such probabilities.

Course Content: (Main topics, Sub topics)

Basic concepts of probability: probability definitions, counting rules, probability rules, conditional probability, independence, Bayes theorem, probability theorems; One dimensional random variables: discrete and continuous distributions, expected value, expectation of functions of random variables, variance, associated theorems, moment Generating Functions, distributions of functions of random variables; Some discrete probability distributions: Bernoulli, Binomial, Poisson, Geometric, Negative Binomial; Some continuous probability distributions: Uniform, Exponential, Gamma, Normal; Relationships between distributions; Two –dimensional random variables (discrete): joint distribution, marginal and conditional distributions, independence, conditional expectation; Order Statistics: distribution of minimum, distribution of maximum.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (specify) .....30... % .....% .....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Bain, L. J., & Engelhardt, M. (1992). *Introduction to Probability and Mathematical Statistics* (2nd ed.). Brooks/Cole ● Dekking, F. M., Kraaikamp, C., Lopuhaä, H. P., & Meester, L. E. (2005) *A Modern Introduction to Probability and Statistics: Understanding Why and How.* Springer			

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Level I - Semester 2				
Course Code	IS 1009			
Course Name	Introduction to Survey Design			
Credit Value	2C (15L 30P)			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: The data required for certain studies are gathered via a survey conducted over a sample of individuals selected from the respective population. A properly planned survey is mandatory to collect quality data. This course introduces the important aspects in conducting surveys. [IS 1009 provides foundation knowledge to conduct a survey with practical experience]				
Intended Learning Outcomes: Upon successful completion of the course the students will be able to,				

- formulate a real-life problem emerging from a large complex population by conducting focus group meetings with industry personnel

Course Content: (Main topics, Sub topics)

Producing data via surveys: Random & nonrandom sampling methods, cautions about sample surveys, planning and designing surveys, designing a questionnaire, pretesting, margin of error; Producing data via experiments: Randomized experimental methods, cautions about experiments; Planning and designing a complex industry oriented survey: formulate a problem with the collaboration of industry via focus group meetings, develop an appropriate sampling scheme, develop questionnaire, develop implementation plan.

Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions

Assessment Strategy: At least 2 in class assignments + 1 group project + Final exam

Continuous Assessment	Final Assessment
……60……..%	……40……..%

Details: quizzes, mid-term, other (group project)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....%	…40….	…….	……

Recommended Reading:

- Scheuren, F. (2004) *What is a Survey?* (2nd ed). American Statistical Association
- Yates, F. (1960) *Sampling Methods for Census & Surveys* (3rd ed). Charles Griffin and Company Limited
- Groves, R. M., Fowler, F. J., Couper, M. P., Lepkowski, J. M., Singer, E., & Tourangeau, R. (2009). *Survey Methodology* (2nd ed). John Wiley and Sons.

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Level I - Semester 2	
Course Code	MS 1003
Course Name	Operational Research I
Credit Value	2C (30L)
Core/Optional	Core
Prerequisites	

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Mangers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision making activities in an optimum way.[MS1003 provides a good theoretical as well as practical foundation for basic operational research techniques]

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- identify decision variables and formulate a suitable Linear Programming model for a real situation
- obtain a solution for the formulated model using an appropriate technique
- use suitable software to solve the proposed models

Course Content: (Main topics, Sub topics)

Introduction to Operational Research, Overview of Linear Programming, Integer Programming and Solution Techniques, Zero-One Programming and Solution Techniques, Transportation Models and Solution Techniques, Assignment Models and Solution Techniques.

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
.....20... % .....% .....%	…80…..	……..	……

Recommended Reading:

- Taha, H. A. (2016). *Operational Research: An Introduction* (10th ed.). Pearson
- Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall
- Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill

Course Content - Level II

<table>
<tr><td colspan="5">Level II - Semester 1</td></tr>
<tr><td>Course Code</td><td colspan="4">IS 2005</td></tr>
<tr><td>Course Name</td><td colspan="4">Statistical Packages</td></tr>
<tr><td>Credit Value</td><td colspan="4">1C (30P)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>30</td><td>20</td><td>50</td></tr>
<tr><td colspan="5">Course Aim:

Statistical software has become an essential component of applied statistics. It is important to be familiar with a range of statistical packages. IS 2005 introduces SPSS for data analysis using basic statistical techniques and simple modeling techniques.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● perform data management using SPSS, basic data analysis using SPSS
● calculate interval estimations, and perform hypothesis tests</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to SPSS, Data Management, Numerical/ graphical summaries, Applications in hypothesis testing and confidence intervals.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lab sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 4 assignments</td></tr>
<tr><td>Continuous Assessment

……100……..%</td><td colspan="4">Final Assessment

……%</td></tr>
<tr><td>Details: quizzes, mid-term, other (lab assignments)</td><td>Theory (%)</td><td colspan="2">Practical (%)</td><td>Other (%) (specify)</td></tr>
</table>

..... % .....% ...100.....%	…….	……..	……

Recommended Reading:

- Moore, D. S., Notz, W. I., & Fligner M. A. (2011). *The Basic Practice of Statistics* (6th ed). W. H. Freeman
- Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). *Mathematical Statistics with Applications* (7th ed). Cengage Learning

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Level II - Semester 1				
Course Code	ST 2006			
Course Name	Basic Statistical Inference			
Credit Value	3C (45L)			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Inferential statistics use a random sample of data taken from a population to describe and make inferences about the population. Inferential statistics are valuable when examination of each member of an entire population is not convenient or possible. ST 2006 introduces the basic theory and application of Inferential Statistics.

Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

- identify and compute probabilities based on sampling distributions and the central limit theorem
- understand the theories of statistical inferences
- apply the appropriate models in different settings to solve real-life problems
- perform statistical inferences involving the mean, variance and proportion and goodness of fit tests

Course Content: (Main topics, Sub topics)

Sampling distributions, applications of central limit theorem; point estimation, bias and mean square error; interval estimation, margin of error, determination of sample size; types of errors associated with hypothesis testing, power of the test, power curves; sampling from normal distributions, inferences about the mean and variance; large sample inference, inference for proportions; chi-square goodness-of-fit tests, chi-square tests for association.

Teaching /Learning Methods: Interactive lectures, videos, quizzes, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes, mid-term, other (specify) ...20... % .....% .....%	Theory (%) …80…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Moore, D. S., Notz, W. I., & Fligner M. A. (2011). *The Basic Practice of Statistics* (6th ed). W. H. Freeman ● Wackerly, D. D., Mendenhall, W., & Scheaffer, R. L. (2008). *Mathematical Statistics with Applications* (7th ed). Cengage Learning			

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Level II - Semester 1				
Course Code	MS 2001			
Course Name	Statistical Quality Control			
Credit Value	2C (30L)			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Statistical quality control is one of the techniques used in a broader framework of quality management in various industries. Statistical techniques for monitoring and controlling the quality of manufacturing products in various aspects will be discussed. Statistical process control and acceptance sampling methods for the efficient administration of statistical quality control will be discussed. The use and application of various quality tools for generating quality improvements will also be addressed.				
Intended Learning Outcomes:				

<table>
<tr><td colspan="4">After the successful completion of the course, students will be able to,

● identify the statistical methods for quality control and fundamentals essential for industrial process control

● apply various quality tools for generating quality improvements</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Introduction to Quality Control; Sampling Inspection: examples and definitions, usage of sampling Inspection, classification of inspection plan; Acceptance Sampling: single, OC curve, average run length, method of choosing sampling plans, inspection schemes; Control charts: control charts for variables (X-bar chart, S chart, R chart), control charts for attributes (P chart, C chart, U chart), lot by lot acceptance sampling for attributes.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="4">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

……20……..%</td><td colspan="2">Final Assessment

……80……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

.....20... % .....% .....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

……..</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

● Montgomery, D. C. (2009) Introduction to Statistical Quality Control (6th ed). John Wiley & Sons
● Mitra, A. (2008). Fundamentals of Quality Control and Improvement (3rd ed.). Wiley</td></tr>
</table>

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Level II - Semester 2	
Course Code	IS 2003
Course Name	Design and Analysis of Industrial Experiments
Credit Value	2C (30L)
Core/Optional	Core
Prerequisites	

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

In order to establish cause and effect relationship between factors affecting a process and its output, systematic planning and analysis of experiments are needed. IS2003 provides basic theory and application of statistical design and analysis of experiments.

Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

- identify the appropriate experimental design
- apply it in situations especially on industrial applications where a cause and effect relationship has to be established

Course Content: (Main topics, Sub topics)

Basic elements of experimental design: experimental unit, treatments, replication, randomization; Homogeneous experimental units: completely randomized design with one-way and factorial treatment structures; Blocking for increased precision: randomized complete block, Latin square and in-complete block, designs; Factorial treatment designs.

Teaching /Learning Methods: Interactive lectures, quizzes, tutes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
.....30... % .....% .....%	…70…..	……..	……

Recommended Reading:

- Kuehl, R. O. (1999). *Design of Experiments: Statistical Principles of Research Design and Analysis* 2nd ed.). Duxbury Press
- Montgomery, D. C. (2001). *Design and Analysis of Experiments* (5th ed.). John Wiley & sons

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<table>
<tr><td colspan="5">Level II - Semester 2</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 2009</td></tr>
<tr><td>Course Name</td><td colspan="4">Applied Nonparametric Methods</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C (30L)</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4">ST 2006</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Most of the commonly used statistical methods (parametric methods) provide valid information about the data only if the underlying population meets certain assumptions. However, when the population data has an unknown distribution, or when the sample size is small, the parametric tests cannot be used. Non-parametric methods will be used in such situations. [ST2009 provides the basic knowledge about distribution-free methods]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

● identify situations where non-parametric methods are applicable
● apply the appropriate nonparametric statistical method for a particular problem
● apply the method and find the solution for a research question</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction, One Sample Location Tests, Tests Involving Two Samples, Two Independent Sample Tests for Differences in Location, Two Independent Sample Tests for Differences in Spread, Two Related Samples, Tests Involving more than Two Samples, Miscellaneous Tests, Test of Randomness, Tests using Frequency Data.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
</table>

.....20..... % .....% .....%	…80….	……..	……

Recommended Reading:

- Conover, W. J. (1999). *Practical Non-Parametric Statistics* (3rd ed.). Wiley & Sons
- Daniel, W. W. (2000). *Applied Non-parametric Statistics* (2nd ed.). Cengage Learning
- Lehmann, E. L., & D'Abrera, H. J. M. (2006). *Nonparametrics: statistical methods based on ranks* (1st ed.). Springer

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Level II - Semester 2				
Course Code	ST 2010			
Course Name	Introduction to Statistical Modeling			
Credit Value	1C (15L)			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15		35	50

Course Aim:

The concept of Statistical modelling is introduced through this model. Various types of statistical models are discussed and taught when to use what, depending on the interest and the research question concerned. How the model changes when the main variable of interest changes is emphasized through this course.

Intended Learning Outcomes:

After the successful completion of the course, students will be able to,

- recognize and use different forms of statistical models in the given context

Course Content: (Main topics, Sub topics)

Introduction to the concept of Statistical Modeling, Building relationships between variables, understanding the systematic and error components in modeling, Exploration of commonly used statistical models.

Teaching /Learning Methods: Interactive lectures, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes, mid-term, other (specify) .....20... % .....% .....%	Theory (%) …80…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Mead, R., Curnow, R. N., & Hasted, A. M. (2002). *Statistical Methods in Agriculture and Experimental Biology* (3rd ed.). CRC Press			

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Level II - Semester 2				
Course Code	MS 2004			
Course Name	Introduction to Marketing Research			
Credit Value	1C (15L)			
Core/Optional	Core			
Prerequisites	IS 1009			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15		35	50
Course Aim: Marketing research is a widely used approach to gain insights about issues faced by companies. MS 2004 provides the knowledge on fundamentals in marketing research with Suggested Readings to real life case studies.				
Intended Learning Outcomes: After the successful completion of the course, students will be able to, ● apply basic statistical methods in a marketing research context ● establish the fundamentals to obtain a comprehensive understanding of advanced concepts of marketing research ● familiarize with the marketing research industry				
Course Content: (Main topics, Sub topics)				

<table>
<tr><td colspan="4">Introduction, Marketing research process, Qualitative and quantitative methods used in marketing research, Defining a marketing research problem, methods of data collection in marketing research, Sampling design in marketing.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="4">Assessment Strategy: At least 1 case studies + At least 1 presentation + Final exam</td></tr>
<tr><td colspan="2">Continuous Assessment

……30……..%</td><td colspan="2">Final Assessment

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

……..</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:
● Parasuraman, A., Grewal, D., & Krishnan, R. (2006). Marketing Research (2nd ed.). South-Western College</td></tr>
</table>

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Physical Science- BSc Degree

Level Three

	Pre Req	Course Unit	Title	Credit	Hours	P1	P2	P3	P4	P5	P6
SI	ST 2006	ST 3006	Regression Analysis	2	30L	o	x	o	x	o	x
SI		ST 3007	Operational Research	3	45L	o	x	o	x	o	x
SI	ST 2006	ST 3009	Applied Time Series	2	30L	o	x	o	x	o	x
SI	ST 1011, ST 2006	IS 3001	Sampling Techniques	2	30L	o	o	o	o	o	o
SII	ST 2008	ST 3012	Statistical Process Control	2	30L	o	o	o	o	o	o

Industrial Statistics- BSc Degree

Level Three

	Pre Req	Course Unit	Title	Credit	Hours	IS
SI		ST 3006	Regression Analysis	2	30L	x
SI		ST 3009	Applied Time Series	2	30L	o
SI	IS 1009	IS 3001	Sampling Techniques	2	30L	x
SI		MS 3009	Operational Research II	3	30L 30P	x
SII		IS 3004	Applied Multivariate Methods	2	30L	x
SII		IS 3005	Statistics in Practice I	3	90P	o
SII		MS 3004	Quality Management/Project Management	2	30L	o

Course Content - Level III (Physical Science- BSc Degree, Industrial Statistics- BSc Degree)

<table>
<tr><td colspan="5">Level III - Semester 1</td></tr>
<tr><td>Course Code</td><td colspan="4">ST 3006</td></tr>
<tr><td>Course Name</td><td colspan="4">Regression Analysis</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core(P2,P4,P6,IS) | Optional(P1,P3,P5)</td></tr>
<tr><td>Prerequisites</td><td colspan="4">ST 2006</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Regression Analysis is essential when relationships between and among variables are to be studied. Here we focus on developing linear models (both simple and multiple) relating a response variable and one or more other variables. Both quantitative and qualitative variables are considered as explanatory variables. Methods for fitting models, model estimation, interpretation, and model diagnostics are also practiced.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After the successful completion of the course, the students will be able to,

● analyze relationships among variables for a given situation, using equations or regression models
● carryout appropriate diagnostic tests to validate the model
● interpret and analyze the models that fit the data well</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to regression, Correlation, Uses of regression, Simple linear regression model, Parameter estimation, inferences about the model and prediction, Goodness of fit testing, Residual analysis, Multiple regression.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory …70….%.	Practical ……..	Other (specify) ……

Recommended Reading:

- Atkinson, A. C. (1985). *Plots, Transformations, and Regression*. Oxford
- Cook, R.D. & Weisberg, S. (1982) *Residuals and Influence in Regression*, Chapman & Hall.
- Draper, N. R. and Smith, H. (1981) *Applied Regression Analysis*. (2nd ed.). New York: Wiley & Sons.
- Draper, N.R. and Smith, H. (1998). *Applied Regression Analysis*, (3rd ed.). New York: John Wiley & Sons.
- Mead, R. and Curnow, R.N. (1993). *Statistical methods in agriculture and experimental biology*. Chapman & Hall

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Level III - Semester 1				
Course Code	ST 3007			
Course Name	Operational Research			
Credit Value	3C			
Core/Optional	Core (P2,P4,P6) | Optional (P1,P3,P5)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Managers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision-making activities in an optimum way. [ST3007 provides a good foundation about some of the widely used operational research techniques]

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- describe the fundamental concepts of real world applications in operational research
- model decision making problems
- solve the formulated model/s using appropriate techniques and software packages

Course Content: (Main topics, Sub topics)

Integer Programming models and solution techniques (Cutting Plane algorithm, Branch-and-Bound algorithm), Zero-one Programming models (mind expanding problems),Transportation models and solution techniques (North-West Corner method, Least Cost method, Vogel's Approximation method, U-V Method), Assignment models and solution techniques(Hungarian method), Inventory Models (Deterministic inventory models with shortages and without shortages),Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models),Solution techniques using suitable OR packages.			
Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory …..70……%	Practical …….	Other (specify) ……
Recommended Reading: ● Taha, H. A. (2016). *Operational Research: An Introduction* (10th ed.). Pearson ● Verma, A. P. (2009). *Operations Research* (3rd ed). S. K. Kataria & Sons ● Panneerselvam, R. (2006) *Operations Research* (2nd ed.). PHI Learning Pvt. Ltd. ● Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall ● Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill			

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Level III - Semester 1	
Course Code	ST 3009
Course Name	Applied Time Series
Credit Value	2C
Core/Optional	Core(P2,P4,P6) | Optional (P1,P3,P5,IS)
Prerequisites	ST 2006

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Most of the real-life processes are time related. This course is designed to provide students univariate time series techniques and models in an applied setting.

Intended Learning Outcomes:

After successful completion of the course the students will be able to,

- Fit the appropriate univariate time series models
- Forecast using the fitted models

Course Content: (Main topics, Sub topics)

Introduction: Areas of application, Objectives of time series analysis, Components of time series, Descriptive analysis. Distributional properties: Independence, Autocorrelation, Stationary. Probability models to time series: Random walk, Autoregressive model. Moving Average model, mixed models, parameter estimation, Diagnostics. Forecasting: Optimal forecasts, Forecasts for ARMA models, Exponential Smoothing forecasting method.

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, quizzes, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory	Practical	Other (specify)
..... % .....% .....20.....%	…80…..	……..	……

Recommended Reading:

- Makridakis, S. G., Hyndman, R. J., & Wheelwright, S. C. (1998). *Forecasting: Methods and Applications* (3rd ed.). Wiley
- Chatfield, C. (2016). *The Analysis of Time Series: An Introduction* (6th ed.). CRC Press

- Box, G. E. P., Jenkins, G. M., Reinsell, G. C., & Ljung, G. M. (2015). *Time Series Analysis: Forecasting and Control* (5th ed.). Wiley

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Level III - Semester 1				
Course Code	IS 3001			
Course Name	Sampling Techniques			
Credit Value	2C			
Core/Optional	Core (IS) | Optional (PS)			
Prerequisites	ST 1011 and ST 2006 or IS 1009			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

This course concentrates on the statistical aspects of taking and analyzing a sample. It gives guidance on how to design and analyze many different forms of sample surveys. [IS 3001 provides a good theoretical as well as practical foundation for sampling techniques used in practice]

Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

- identify and effectively apply the theory behind sampling techniques that are commonly used in statistics

Course Content: (Main topics, Sub topics)

Simple Random Sampling (SRS), Sample size determination, Ratio and Regression estimators under SRS, Stratified, Systematic, and Quota sampling. Separate and combined estimators for stratified sampling. Cluster sampling, Multi-stage sampling, Complex sample designs and related issues.

Teaching /Learning Methods: Interactive lectures, practical sessions, group work/projects, quizzes, tutorial classes, assignments

Assessment Strategy: At least 1 in-class assignment + At least 1 Group project + Final exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (group project)	Theory	Practical	Other (specify)
...10..... % .....% .....20.....%	…70…..%	……..	……

Recommended Reading:

- Thompson, S. K. (2002). *Sampling* (2nd ed.). John Wiley & Sons
- Som, R. K. (1995). *Practical sampling Techniques* (2nd ed.). CRC Press
- Rao, P. S. R. S., & Myron J. Katzoff, M. J. (2010). *Hand book of Sampling Techniques and Analysis* (1st ed.). CRC Press

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Level III - Semester 2				
Course Code	ST 3012			
Course Name	Statistical Process Control			
Credit Value	2C			
Core/Optional	Optional (PS only)			
Prerequisites	ST 2008			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Cumulative sum (CUSUM) and exponentially weighted moving average (EWMA) Control Charts are capable of detecting small shifts in process parameters, leading to more effective process monitoring, as opposed to traditional Shewhart's control charts which misjudge the occurrence of small process shifts. When there is more than one process parameter, to detect shifts in these, Multivariate Control Charts are used. In addition to these Control Charts capability analysis, acceptance sampling schemes and process optimization techniques will also be discussed.

Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

- investigate and analyze process capability, advanced charts and control charts for correlated data
- recognize the statistical quality control methods using acceptance sampling, response surface approach for optimizing the process

Course Content: (Main topics, Sub topics)

Capability analysis; Cumulative Sum (CUSUM) control charts; Exponentially Weighted Moving Average (EWMA) Charts; Acceptance sampling: double, sequential, multiple; Decision theory approach; Multivariate control charts; Process optimization with design experiment.				
Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes				
Assessment Strategy: 2 in-class assignments + Final Exam				
Continuous Assessment ……20……..%	Final Assessment ……80……..%			
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....20.....%	Theory …80…..%	Practical ……..		Other (specify) ……
Recommended Reading: ● Montgomery, D. C. (2008). *Introduction to Statistical Quality Control* (6th ed). Wiley ● Duncan, A. J. (1986). *Quality Control and Industrial Statistics* (5th ed.). Irwin				

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Level III - Semester 1				
Course Code	MS 3009			
Course Name	Operational Research II			
Credit Value	3C			
Core/Optional	Core (IS only)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150
Course Aim: Mangers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision making activities in an optimum way.				

[MS3009 is a continuation of MS1003 that extends the theoretical and practical knowledge on operational research techniques]

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- describe the fundamental concepts of real world applications in operational research and model decision making problems
- solve the formulated model/s using appropriate techniques and software packages

Course Content: (Main topics, Sub topics)

Network Models (Minimal Spanning Tree algorithm, algorithms for Shortest-Route problem, Maximal Flow model), Project Planning (Critical Path Method, Programming Evaluation and Review Technique), Inventory Models (Deterministic inventory models with shortages and without shortages, Probabilistic Inventory models), Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models), Solution techniques using suitable OR packages.

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, group work, presentation, tutorial classes, assignments

Assessment Strategy: At least 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory	Practical	Other (specify)
..... % .....% .....30.....%	…70…..%	……..	……

Recommended Reading:

- Taha, H. A. (2016). *Operational Research: An Introduction* (10th ed.). Pearson
- Verma, A. P. (2009). *Operations Research* (3rd ed). S. K. Kataria & Sons
- Panneerselvam, R. (2006) *Operations Research* (2nd ed.). PHI Learning Pvt. Ltd.
- Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall
- Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill

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<table>
<tr><td colspan="5">Level III - Semester 2</td></tr>
<tr><td>Course Code</td><td colspan="4">IS 3004</td></tr>
<tr><td>Course Name</td><td colspan="4">Applied Multivariate Methods</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core (IS only)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. This course provides some theoretical background as well as a good practical foundation for commonly used multivariate techniques.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

● apply the related multivariate techniques to data with multiple measurements satisfying the underlying theories and assumptions
● demonstrate basic computer skills in analyzing such data with the help of appropriate statistical packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Overview, examples and introduction. multivariate normal distribution ; mean vector and variance covariance matrix, correlation matrix; bivariate normal distribution and density, missing values and outliers, summary statistics, standardized data; sample correlations; multivariate data plots, checking for multivariate normality; eigen-values and eigenvectors; geometric descriptions; principal components analysis, factor analysis, discriminant analysis, cluster analysis; multivariate inference; inference for one and two independent samples, profile analysis, repeated measurements, MANOVA, canonical variates analysis, canonical correlations.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, discussion of examples within lectures, exercises, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory …70…..%	Practical ……..	Other (specify) ……
Recommended Reading: ● Johnson, D. E. (1998). *Applied Multivariate Methods for Data Analysts* (1st ed.). Duxbury Press ● Johnson, R. A., & Wichern, D. W. (2013*). Applied Multivariate Statistical Analysis* (3rd ed.). Pearson Education Limited ● Afifi, A., May, S., & Clark, V. A. (2003). *Computer Aided Multivariate Analysis* (4th ed.). CRC Press			

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Level III - Semester 2				
Course Code	IS 3005			
Course Name	Statistics in Practice I			
Credit Value	3C			
Core/Optional	Optional(IS only)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		90	60	150
Course Aim: To be employed as a Statistician, a Data Analyst or a Data Scientist, apart from the technical and theoretical knowledge, one should possess and acquire skills to solve real world problems and communicate findings effectively. Through this module, such exposure is provided in a classroom environment.				
Intended Learning Outcomes: After the successful completion of this course, students will be able to, ● employ the complex process of problem-solving a massing various areas in the field of statistics ● formulate the problems, improve on report-writing and research skills, their communication, personnel and business skills				
Course Content: (Main topics, Sub topics) This course deals with general principles involved with statistical methods covered in levels I, II in solving real-life statistical problems.				

Teaching /Learning Methods: Practical sessions, interactive lectures, group work/projects, presentations, assignments			
Assessment Strategy: Presentations on topics + 2 in-class assignments + 2 Case studies + Writing Newspaper article + Interim workshop participation + Industry Group project + Attendance			
Continuous Assessment ……95……..%	Final Assessment ……5……..%		
Details: quizzes(test on Data Analysis, test on statistical modelling), Presentations on topics, Case studies(two with 10% & 5%), Writing Newspaper article, Interim workshop participation, Industry Group project ..30... % ..10...% ..15...% ..5...% ..5...% ..30...%	Theory …….	Practical ……	Other (Attendance) ……5……%
Recommended Reading: ● Chatfield, C. (1995). *Problem Solving: A Statistician's Guide* (2nd ed.). CRC Press			

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Level III - Semester 2				
Course Code	MS 3004			
Course Name	Quality Management/Project Management			
Credit Value	2C			
Core/Optional	Optional(IS only)			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				

To be employed as a statistician or data scientist, the students should possess managerial skills also such as organizational environment, feasibility analysis, risk management, human resource management etc.. MS 3004 provides those tools with some theoretical knowledge and practical examples.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- apply key theoretical concepts on quality control and project management practiced by the corporate world

Course Content: (Main topics, Sub topics)

Quality Management: Macro and Micro organizational Environment (PESTEL, Resource Based View)Market Analysis(Porter's Five Forces Analysis, SWOT Analysis) Project Feasibility Analysis (Johnson & Schole's SFA Framework) Stakeholder Analysis, Organizational Change Management; Project Management: Project Selection, Approach Selection, The Work Breakdown Structure, The Network Diagram, Cost Effort Estimation, Optimizing the Network, Gantt Chart, Risk Management, Cost Estimation, Contract Management, Productivity Improvement, Project Management Steps, Making the Budget, Project Monitoring and Control, Human Resource Management, Project Termination.

Teaching /Learning Methods: Interactive lectures, group presentation, quizzes and assignments

Assessment Strategy: At least 1 case study + presentation + Final exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (case study and presentation)	Theory	Practical	Other (specify)
..... % .....% ...30.....%	…70…..%	……..	……

Recommended Reading:

- Heagney, J. (2016). *Fundamentals of Project Management*. AMACOM

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Statistics Research Honours Degree

Level	Pre-requisite	Course Unit	Title	Credit	Type	ST
III		ST 3003	Marketing Research	2	30 L	O
		ST 3007	Operational Research	3	45 L	O
		ST 3051	Statistical Inference I	3	45 L	X
		ST 3072	Applied Regression Analysis	3	45 L	X
		ST 3074	Time Series Analysis	2	30 L	X
		ST 3075	Design of Experiments	2	30 L	X
S1		ST 3085	Computational Statistics	2	15 L 30 P	X
		CS 3008	Introduction to Data Structures and Algorithms	3	30 L 30 P	O
		PM 3033	Real Analysis 1	3	45 L	O
		ST 3012	Statistical Process Control	2	30 L	O
		ST 3013	Essential Mathematics for Statistics	3	45 L	X
		ST 3070	Special Topics	2	15 L 30 P	O
		ST 3073	Surveys and Sampling	3	45 L	X
S2		ST 3082	Statistical Learning, I	2	60 P	X
		ST 3083	Multivariate Data Analysis	3	45 L	X
		ST 3084	Statistical Inference II	2	30 L	X
		IT 3002	Database Systems	3	30 L 30 P	O
		PM 3034	Real Analysis II	3	45 L	O
IV		ST 4011	Econometrics	2	30 L	O
		ST 4031	Stochastic Processes and Applications	3	45 L	X

S1		ST 4051	Scientific writing	1	30 P	O
		ST 4052	Statistical Learning II	2	60 P	X
		ST 4054	Linear Models	3	45 L	X
		ST 4056	Medical Statistics	3	45 L	O
		CS 4104	Data Analytics	3	30 L 30 P	O
		CS 4127	Advanced Concepts in Software Design & Development	3	30 L 30 P	O
S2		ST 4012	Special Topics for ST	2	30 L	O
		ST 4050	Individual Project ST	8	240 P	X
		ST 4055	Generalized Linear Models	3	30 L 30 P	X
		CS 4125	Logic Programming	3	30 L 30 P	O
		EC 4004	Industrial Training	3	90 P	O

Data Science Honours Degree (for Honours intake 2023 an onwards)

Level III

Level	Semester	Pre-requisite	Course Unit	Title	Credit Value	Type	DS
III	S1	ST 2010	ST 3008	Applied statistical models	3	30L, 30P	X
			ST 3051	Statistical Inference I	3	45L	X
			ST 3074	Time Series Analysis	2	30L	O
			ST 3085	Computational Statistics	2	15L 30P	O
			DS 3001	Data Visualization Techniques	1	30P	X
			DS 3002	Data Ethics and Data Security	2	30L	X
			CS 3008	Introduction to Data Structures and Algorithm	3	30L 30P	X

	SII		ST 3011	Statistical Programming	2	60P	X
			DS 3003	Machine Learning I	2	60P	X
			ST 3083	Multivariate Data analysis	3	45L	X
		ST 3051	ST 3084	Statistical Inference II	2	30L	X
			DS 3004	Essential Calculus and Linear Algebra for Data Science	3	45 L	X
			IT 3002	Database System	3	30L, 30P	X

Level IV

Level	Semester	Pre-requisite	Course Unit	Title	Credit Value	Type	DS
IV	S1		ST 4051	Scientific Writing	1	30P	X
			DS 4001	Image Analysis	2	15L, 30P	O
			DS 4002	Machine Learning II	2	60 P	X
			DS 4003	Special Topics for Data Science	2	15L 30P	O
			DS 4004	Big Data analytics	3	30L 30P	X
			DS 4005	Causal Inference	1	30P	X
			CS 4127	Advanced Concepts in Software Design & Development	3	30L, 30P	X
		IT 3002	CS 4128	Advanced Database Management	3	30L 30P	X
	SII		DS 4007	Research Project in DS	8	240P	X
			DS 4006	Professional Practice	4	120P	X
			CS 4111	Intelligent System	3	30L, 30P	O
			CS 4113	Natural Language Processing	3	30L 30P	X
			CS 4117	Embedded Systems	3	30L 30P	O

Statistics with Computer Science Research Honours Degree (for Honours intake 2022)

Level Three

	Pre Req	Course	Title	Credit	Hours	ST+CS
SI		ST3003	Marketing Research	2	30L	o
SI		ST 3007	Operational Research	3	45L	o
SI		ST 3051	Statistical Inference I	3	45L	x
SI	ST 1004, ST 2004	ST 3072	Applied Regression Analysis	3	45L	x
SI		ST 3085	Computational Statistics	2	15L 30P	o
SI		ST 3074	Time Series Analysis	2	30L	o
SI		CS 3001	Visual Programming Technologies	3	30L 30P	x
SI		CS 3105	Computer Graphics I	3	30L 30P	o
SI		CS 3120	Machine Learning and Neural Computing	3	30L 30P	x
SI		CS 3112	Advanced Web Development	3	30L 30P	o
SI		CS 3008	Introduction to Data Structures and Algorithm	3	30L 30P	x
SI		PM 3056	Real Analysis 1	2	30L	o
SII		ST 3083	Multivariate Data analysis	3	45L	x
SII	ST 3051	ST 3084	Statistical Inference II	2	30L	x
SII		ST 3082	Statistical Learning I	2	60P	x
SII		ST 3013	Essential Mathematics for Statistics	3	45L	x
SII		IT 3001	Management Information System	3	30L, 30P	o
SII		IT 3002	Database System	3	30L, 30P	o

Level Four

	Pre Req	Course	Title	Credit	Hours	ST+CS
SI		ST 4051	Scientific Writing	1	30P	o
SI		ST 4054	Linear Models	3	45L	o
SI		ST 4031	Stochastic Processes and Application	3	45L	o
SI		ST 4052	Statistical Learning II	2	60P	x
SI		CS 4104	Data Analytics	3	30L, 30P	x

SI		CS 4106	Computer Graphics II	3	30L, 30P	o
SI		CS 4127	Advanced Concepts in Software Design & Development	3	30L, 30P	x
SI		CS 4128	Advanced Database Management	3	30L 30P	x
SI		CS 4113	Natural Language Processing	3	30L 30P	o
SII		*ST 4013	Special Topics for ST+CS	2	30L	o
SII		ST 4055	Generalized Linear Models	3	30L 30P	x
SII		*ST 4040	Individual Project ST+CS	8	240P	x
SII		CS 4111	Intelligent System	3	30L, 30P	o
SII		C S4117	Embedded Systems	3	30L 30P	o
SII		CS 4125	Logic Programming	3	30L 30P	o
SII		EC 4004	Industrial Training	0	90P	o

* Courses offered for Honours intake 2022 only.

Industrial Statistics Research Honours Degree

Level	Pre-requisite	Course Unit	Title	Credit Value	Type	IS
III	IS 1009	IS 3001	Sampling Techniques	2	30 L	X
		IS 3050	Statistical Inference	3	45 L	X
		IS 3051	Advanced Statistical Process Control	2	30 L	X
S1		ST 3006	Regression Analysis	2	30 L	X
		ST 3074	Time Series Analysis	2	30 L	O
		ST 3085	Computational Statistics	2	15L 30P	X
		FM 3012	Economics I for Finance and Insurance	3	45 L	O
		MS 3002	Advanced Marketing Research	1	15 L	X
		MS 3009	Operational Research II	3	30 L 30 P	O
		MS 3018	Accounting for Finance	3	45 L	O
		CS 3112	Advanced Web Development	3	30 L 30 P	O

		IS 3003	Special Topics I	2	15 L 30 P	O
		IS 3052	Advanced Topics in Experimental Design	2	30 L	X
		IS 3053	Data Mining Techniques	2	15 L 30 P	X
S2		ST 3082	Statistical Learning, I	2	60 P	X
		ST 3083	Multivariate Data Analysis	3	45 L	O
		MS 3004	Quality Management/Project Management	2	30 L	X
		IT 3002	Database Systems	3	30 L 30 P	O
IV		IS 4002	Advanced Statistical Modeling	3	45 L	X
		IS 4003	Special Topics II	2	30 L	O
		ST 4011	Econometrics	2	30 L	O
		ST 4031	Stochastic Processes and Applications	3	45 L	X
S1		ST 4035	Data Science	3	30 L 30 P	O
		ST 4036	Time to Event Analysis	2	30 L	O
		ST 4051	Scientific Writing	1	30 P	O
		ST 4052	Statistical Learning II	2	60 P	X
		MS 4007	Risk Management	2	30 L	O
		MS 4008	Industrial Psychology	2	30 L	O
		FM 4007	Economics II for Finance and Insurance	3	45 L	O
		CS 4113	Natural Language Processing	3	30 L 30 P	O
		IS 4011	Professional Practice	4	120 P	X
S2		IS 4006	Individual Project	8	240 P	X

Course Content - Level III (ST)

Level III - Semester 1	
Course Code	ST 3003
Course Name	Marketing Research
Credit Value	2C

<table>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Marketing research is a widely used approach to gain insights about issues faced by companies. ST 3003 provides an introduction to the methodologies adopted in marketing research with references to real life case studies.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● understand and identify key aspects of the marketing research process
● appraise basic methodological frameworks in marketing research in different scenarios
● design and formulate a marketing research along theoretical concepts</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction, The Marketing Research Process, Defining the problem with exploratory research, Survey research: Methods of communication with respondents, Test marketing, Measurements and Attitude scaling, Questionnaire design, Sampling procedures, Data analysis, report writing and presentation: Stochastic models of brand choice, Applications of General Linear Models in marketing, Conjoint analysis, Correspondence analysis, Advertising media models, Marketing response models.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....20.....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Lehmann, D.R., Gupta, S. & Steckel, J.H. (1998). Marketing Research. Addison-Wesley
● Crask, M., Fox, R. J, & Stout, R. G. (1995). Marketing research: principles and applications. Prentice Hall, Englewood Cliffs, N.J</td></tr>
</table>

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<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 3007</td></tr>
<tr><td>Course Name</td><td colspan="4">Operational Research</td></tr>
<tr><td>Credit Value</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Managers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision-making activities in an optimum way. [ST3007 provides a good foundation about some of the widely used operational research techniques]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● describe the fundamental concepts of real world applications in operational research
● model decision making problems, obtain solution/s for the formulated model/s using appropriate techniques and software packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Integer Programming models and solution techniques (Cutting Plane algorithm, Branch-and-Bound algorithm), Zero-one Programming models (mind expanding problems),Transportation models and solution techniques (North-West Corner method, Least Cost method, Vogel’s Approximation method, U-V Method), Assignment models and solution techniques(Hungarian method), Inventory Models (Deterministic inventory models with shortages and without shortages),Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models),Solution techniques using suitable OR packages.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% ...30.....%	…70…..	…….	……

Recommended Reading:

- Taha, H. A. (1997). *Operations research: an introduction* (6th ed). Prentice Hall, Upper Saddle River, N.J Verma, A. P. (2009). *Operational Research* (3rd ed). S. K. Kataria & Sons.
- Panneerselvam, R. (2006). *Operational Research* (2nd ed). PHI Learning Pvt. Ltd.
- Wagner,H. M. (1975). *Principles of operations research: with applications to managerial decisions* (2nd ed). University of Michigan
- Hillier, F. S., & Liebermann, G.D. (1980). *Operations research* (3rd ed). Holden-Day

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Level III - Semester 1				
Course Code	ST 3051			
Course Name	Statistical Inference I			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3051 carries a theoretical foundation for one part of this tool, namely, estimation].

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the underlying theory behind statistical estimation
- apply the necessary techniques to find estimates of population parameters
- appraise the properties of estimators

Course Content: (Main topics, Sub topics)

Generating moments using characteristic function; Sampling from Normal population: sampling distributions of sample mean and sample variance (s^2), independence of sample mean and s^2; Properties of estimators: Mean-squared error, Unbiasedness, Consistency, Sufficiency, Completeness, Efficiency; Factorization criterion; Variance Reduction: Cramer-Rao Lower Bound,

Rao-Blackwell Theorem, Lehmann-Scheffe' Theorem; Methods of Estimation: Method of moments, Maximum Likelihood and Its Properties, Least Squares; Interval Estimation: Pivotal Method, General Method.			
Teaching /Learning Methods: Interactive lectures, recorded videos, practice exercises, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed). Pearson ● Lindgren, B. (2017). *Statistical Theory* (4th ed). CRC Press ● Mood, A. M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill			

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Level III - Semester 1				
Course Code	ST 3072			
Course Name	Applied Regression Analysis			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim:				

Regression analysis is a popular statistical tool used to explore and establish linear relationship between a specific response variable and several other variables. ST3072 provides with theory and application of linear regression models.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- formulate a suitable regression model to describe a relationship between a response variable and one or more explanatory variables
- apply appropriate diagnostics to evaluate the model and interpret the model to describe the problem

Course Content: (Main topics, Sub topics)

Simple Linear Regression: introduction, correlation, uses of Regression, simple linear Regression model, parameter estimation, inferences about the model, prediction, coefficient of determination; Model Adequacy: residuals, outliers, lack of fit, transformations; Multiple Linear Regression: Multiple Linear Regression model, parameter estimation, inferences about the model, prediction, model adequacy, variable selection methods, use of categorical variables as predictors, analysis of co-linearity; Transformation of Variables; Polynomial regression; weighted least square.

Teaching /Learning Methods: Interactive lectures, videos, quizzes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment		
……30……..%	……70……..%		
Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	……..	……

Recommended Reading:

- Draper, N.R., & Smith, H. (1998). *Applied Regression Analysis* (3rd ed). Wiley
- Kleinbaum, D. G., Kupper, L. L., Muller, K. E., & Nizam, A. (1997). *Applied Regression Analysis and Other Multivariable Methods* (3rd ed). Duxbury Press
- Chatterjee, S., & Hadi, A. L. (2012). *Regression Analysis by Example* (5th ed). Wiley
- Montgomery, D. C., Peck E. A., & Vining, G. (2007). *Introduction to Linear Regression Analysis* (4th ed). Wiley

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<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 3074</td></tr>
<tr><td>Course Name</td><td colspan="4">Time Series Analysis</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Time series analysis usually studies patterns in data evolving over time (time series data) and use these patterns to forecast the future behavior. For e.g., next month sales of a company can be forecasted by studying patterns in past sales data of that company. ST 3074 provides necessary tools and theories to study and forecast time series data.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to,

● fit suitable models for univariate time series data
● forecast univariate time series</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction: definition, types of time series, components of time series, time plot, time series decomposition, transformation, differencing, autocorrelation; Stationarity: stationary & non-stationary time series, tests for stationarity; Modelling time series: time series models, model identification, parameter estimation, diagnostic checks, forecasting.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practical sessions, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td rowspan="2">Details: quizzes, mid-term, other (in-classes)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
<tr><td>…80…..</td><td>……</td><td colspan="2">……</td></tr>
<tr><td colspan="5">..... % .....% .....20.....%</td></tr>
</table>

Recommended Reading:

- Makridakis, S. G., Weelwright, S. C., & Hyndman, R. J. (1997). *Forecasting Methods and Applications* (3rd ed). Wiley
- Chatfield, C (2003). *The analysis of Time Series: An Introduction* (6th ed). Chapman and Hall/CRC
- Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Forecasting and Control* (3rd ed). Prentice Hall

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Level III - Semester 1				
Course Code	ST 3075			
Course Name	Design of Experiments			
Credit Value	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

If one wants to establish cause and effect relationship in experimentation, one needs to have an experiment statistically designed. [ST 3075 provides a good foundation for this aspect with details of several commonly used statistical designs].

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- employ basic planning and designing skills to propose suitable experimental designs
- analyze data and interpret results to answer specific questions in comparative experiments

Course Content: (Main topics, Sub topics)

Principles of planning and designing comparative experiments; Review of ANOVA and related topics; Basic designs: completely randomized design (CRD), randomized complete block design (RCBD), Latin squares/multiple Latin squares, treatment contrasts and mean comparisons; Factorial experiments (2k and others); confounding and partial confounding in 2k experiments; split-plot designs; analysis of covariance.

Teaching /Learning Methods: Interactive lectures, videos, quizzes, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment

……30……..%	……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Montgomery, D. C. (2017). Design and analysis of experiments (9th ed). Wiley ● Kuehl, R.O. (1999). *Design of Experiments: Statistical principles of research design and analysis* (2nd ed). Duxbury Press ● Box, G. E. P., Hunter, W. G., & Hunter, J. S. (1978). *Statistics for experiments: An introduction to design, data analysis and model building*. John Wiley & Sons			

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Level III - Semester 1				
Course Code	ST 3085			
Course Name	Computational Statistics			
Credit Value	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: Computational statistics refer to the computational methods that enable statistical methods. This course provides students some widely used such methods and techniques using the free and open source statistical software, R.				
Intended Learning Outcomes: After a successful completion of the course, the students will be able to, ● generate random numbers using different distributions ● simulate data from different distributions ● apply bootstrap methods to analyze data				
Course Content: (Main topics, Sub topics)				

Introduction to Random numbers: pseudo random numbers, properties of random numbers, testing for basic properties, software for random number generation; Introduction to Simulation: simulation of random variables, Monte Carlo simulation methods, simulation of inventory models, simulation of queuing models; Data Re-sampling: Introduction to Bootstrap, Bootstrap estimation of Variance, Bootstrap Confidence Intervals, Introduction to EM algorithm.			
Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Givens, G. H., & Hoeting, J. A. (2012). *Computational Statistics* (2nd ed). Wiley ● Gentle, J. E (2005). *Elements of Computational Statistics*. Springer ● Efron, B., & Tibshirani, R. J. (1993). *An introduction to the bootstrap* (1st ed). Chapman and Hall/CRC			

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Level III - Semester 2				
Course Code	ST 3012			
Course Name	Statistical Process Control			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Cumulative sum (CUSUM) and exponentially weighted moving average (EWMA) Control Charts are capable of detecting small shifts in process parameters, leading to more effective process monitoring, as opposed to				

traditional Shewhart's control charts which misjudge the occurrence of small process shifts. When there is more than one process parameter, to detect shifts in these, Multivariate Control Charts are used. In addition to these Control Charts capability analysis, acceptance sampling schemes and process optimization techniques will also be discussed.

Intended Learning Outcomes:

Upon successful completion of the course, the student will be able to,

- investigate and analyze process capability, advanced charts and control charts for correlated data
- recognize the statistical quality control methods using acceptance sampling, response surface approach for optimizing the process

Course Content: (Main topics, Sub topics)

Capability analysis; Cumulative Sum (CUSUM) control charts; Exponentially Weighted Moving Average (EWMA) Charts; Acceptance sampling: double, sequential, multiple; Decision theory approach; Multivariate control charts; Process optimization with design experiment.

Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	…….	……

Recommended Reading:

- Montgomery, D. C. (2008). *Introduction to Statistical Quality Control* (6th ed). Wiley
- Duncan, A. J. (1974). *Quality Control and Industrial Statistics* (4th ed). R. D. Irwin

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Level III - Semester 2	
Course Code	ST 3013
Course Name	Essential Mathematics for Statistics
Credit Value	3C

Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Mathematical theories such as linear algebra, matrices, calculus etc. are required for proofs of most of the higher level statistical theories. ST 3013 provides those tools for students with the required amount of theoretical knowledge.

Intended Learning Outcomes:

After a successful completion, students will be able to,

- apply basic mathematical tools in solving theoretical and practical problems in Statistics

Course Content: (Main topics, Sub topics)

Linear algebra: Linear dependence, rank and the solution of homogeneous equations, characteristic polynomials, eigenvalues , eigenvectors, spectral theorem for symmetric matrices, idempotent matrices and properties, orthogonal projections, trace of a matrix and properties, positive definite/semi definite matrices, quadratic forms, differential calculus in matrix notation, direct product (kronecker)of any two matrices, generalized inverse /conditional inverse ; Calculus: Concepts of functions, limits and continuity, L'Hopital's rule, the fundamental theorem of calculus, approximation of definite integrals, Improper integrals; Series and Sequences: sequences and their convergence, series and convergence of series, power series and their convergence of radius, Taylor series and their application; Several variable calculus: functions of several variables, continuity, differentiability, derivatives, multiple integrals, change of variables

Teaching /Learning Methods: Interactive lectures, quizzes, assignments, discussion sessions based on the given problem set at the end of a topic.

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Graybill, F. A. (2001). *Matrices with applications in Statistics* (2nd ed). Brooks/Cole
- Bonar, D. D., & Khoury, M.J. (2006). *Real Infinite Series* (1st ed). American Mathematical Society
- Courant, R., & John, F. (1965). *Introduction to Calculus and Analysis, Volume 1.* Springer-Verlag
- Lang, S. (1987). *Calculus of several variables* (3rd ed). Springer

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Level III - Semester 2				
Course Code	ST 3070			
Course Name	Special Topics			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim:				
Intended Learning Outcomes:				
Course Content: (Main topics, Sub topics) Selected topics depending on the availability of teaching staff.				
Teaching /Learning Methods: Interactive lectures, practical sessions, group projects, presentations, assignments				
Assessment Strategy: 2 in-class assignments + Final Exam				
Continuous Assessment ……30……..%	Final Assessment ……70……..%			
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……	Other (%) (specify) ……	

Recommended Reading:

- Depends on the topic

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Level III - Semester 2				
Course Code	ST 3073			
Course Name	Survey and Sampling			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Sampling is the process of selecting a representative group from a population. While many surveys and samples give valuable information; some, unfortunately don't. This course concentrates on the statistical aspects of taking and analyzing a sample. It gives guidance on how to tell when a sample is valid or not, and how to design and analyze many different forms of sample surveys. [ST 3073 provides a good theoretical as well as practical foundation for sampling techniques used in practice]

Intended Learning Outcomes:

After the completion of the course, the students will be able to,

- recognize the building blocks and the theory of random sampling design a survey
- estimate parameters based on the design of the study

Course Content: (Main topics, Sub topics)

Fundamentals of probability sampling and estimation; Simple Random Sampling: theory involved in estimation procedures, sampling weights, estimating population mean, variance, total & proportion, estimating a ratio & its variance, estimation using Ratio and Regression methods and their properties, Sample size determination; Stratified Random Sampling: proportional and optimal cost allocation to strata, estimating population mean, variance, total & proportion, overview of advanced topics in stratified random sampling, Estimating a ratio & its variance, regression estimators, sample size determination, post-stratification, quota sampling; Cluster Sampling: overview of cluster sampling, clustering with equal and unequal probabilities, sample size determination, design effect and intra-cluster correlation; Multi-stage sampling: Complex surveys and related problems, sources of errors in surveys.

Teaching /Learning Methods: Interactive classroom sessions

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Lohr, S. L. (2009). *Sampling: Design and Analysis* (2nd ed). Cengage Learning ● Cochran, W. G. (2007). *Sampling Techniques* (3rd ed). Wiley India Pvt. Limited ● Barnet, V. (1974). *Elementary Sampling Theory.* Routledge ● Kish, L. (1995). *Survey Sampling.* Wiley			

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Level III - Semester 2				
Course Code	ST 3082			
Course Name	Statistical Learning I			
Credit Value	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	100
Course Aim: Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields such as biology, finance, marketing etc. ST presents some important modeling techniques and prediction techniques such as ridge regression, LASSO, elastic net, principle component regressions etc., along with relevant applications.				
Intended Learning Outcomes: Upon successful completion of the course, students will be able to, ● explore complex data sets, select appropriate statistical techniques to solve problems involved and justify their choice ● implement these techniques using an appropriate programming language ● evaluate the results and explain the results to non-statisticians using non statistical terms				

Course Content: (Main topics, Sub topics) Introduction to statistical learning; Advanced regression model: understanding models, variable selection, validation and cross validation, Shrinkage method and ridge regression, Lasso, principal component regression and partial least squares; Resembling method: cross validation, bootstrap; Classification: understanding classification problems using logistic regression, multivariate logistic regression, and discriminant analysis.
Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations
Assessment Strategy: 4 group projects and presentations + Attendance

Continuous Assessment	Final Assessment
……85……..%	……15……%

Details: quizzes, mid-term, other (group projects and presentations)	Theory (%)	Practical (%)	Other (%) (attendance)
..... % .....% .....85.....%	……..	……..	……15……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning: with Applications in R* (2013). Springer Science & Business Media

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Level III - Semester 2				
Course Code	ST 3083			
Course Name	Multivariate Data Analysis			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim:				

In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. For eg., a heart attack may be the result of a combination of factors like excess weight, high blood pressure, high cholesterol, genetic effects, etc. etc. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. [ST 3083 provides a good theoretical as well as practical foundation for commonly used multivariate techniques].

Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to,

- analyze multivariate data and make decisions based on multivariate hypothesis tests
- apply dimension reduction methods; clustering data and discriminate new observations to pre-defined clusters

Course Content: (Main topics, Sub topics)

Review of matrix algebra; Mean and variance-covariance of a random vector; correlation matrix; Properties of multivariate normal distribution and applications; Checking for multivariate normality; Hypothesis testing using multivariate tests; MANOVA ; Principal component analysis; Factor analysis; Discriminant analysis; Cluster analysis.

Teaching /Learning Methods: Interactive lectures, practical sessions, tutorials, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	……..	……

Recommended Reading:

- Johnson, R. A., & Wichern, D. W. (2012). *Applied multivariate statistical analysis* (6th ed). Phi Learning Private Limited
- Morrison, D. F. (2004). *Multivariate statistical methods* (4th ed). Duxbury Press
- Johnson, D. E. (1998). *Applied multivariate methods for data analysts* (1st ed). Duxbury Press

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<table>
<tr><th colspan="5">Level III - Semester 2</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 3084</td></tr>
<tr><td>Course Name</td><td colspan="4">Statistical Inference II</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3084 carries a theoretical foundation for one part of this tool, namely, testing statistical hypotheses].</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

● recognize the underlying general theory behind testing statistical hypotheses
● apply the necessary techniques to real life situations</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Parametric Inference: Introduction to Hypothesis Testing, Errors, Power, Neymann-Pearson Lemma, Most Powerful Tests, Uniformly Most Powerful Tests, Likelihood Ratio Tests, Sequential Tests, Sequential Probability Ratio Test (SPRT), Wald's Identity, Average Sample Number (ASN); Distribution-free Inference: Tests of Randomness, Run Tests, One sample Location Tests for Median, Sign Test; Asymptotic Relative Efficiency (ARE); Two sample Location problem.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practice exercises, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td>Continuous Assessment

……30……..%</td><td colspan="4">Final Assessment

……70……%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

……</td></tr>
</table>

Recommended Reading:

- Mood, A.M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill
- Lindgren, B. W. (1976). *Statistical Theory* (3rd ed). Macmillan
- Hogg, R. V., & Craig, A. T. (1970). *Introduction to Mathematical Statistics* (3rd ed). Macmillan

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Course Content - Level IV (ST)

Level IV - Semester 1				
Course Code	ST 4011			
Course Name	Econometrics			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Analysis of economic and financial data requires the formulation of a unique methodological framework. ST 4011 provides the theoretical as well as a practical foundation for the students to analyze and make accurate projections of economic and financial data.

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- apply statistical methods in the context of economics
- carry out a successful econometric analysis

Course Content: (Main topics, Sub topics)

Linear regression model and properties of least squares estimates; Autocorrelation; Heteroscedasticity; Multicollinearity; Model specification; Simultaneous equations; Unit roots, Non- stationary and Cointegration.

Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....20.....%	Theory (%) …80…..	Practical (%) ……..	Other (%) (specify) ……

Recommended Reading:

- Pindyck, R. S., & Rubinfeld, D. L. (1998). *Econometric Model and Economic Forecasts* (4th ed). Irwin/McGraw-Hill
- Wooldridge, J. M. (2015). *Introductory Econometrics: A Modern Approach* (6th ed). Cengage Learning
- Greene, W.H. (2012). *Econometric Analysis* (7th ed). Pearson Education
- Johnston, J., & DiNardo, J. (1996). *Econometric Methods* (4th ed). McGraw-Hill/Irwin

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Level IV - Semester 1				
Course Code	ST 4031			
Course Name	Stochastic Processes and Application			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Stochastic processes underlie many ideas in statistics such as time series, Markov chains, Markov processes, Poisson Processes etc. Thus, Stochastic Process helps to understand the applications of Statistics in a simpler way and in a more commanding fashion. In addition, it enables to develop models for situations of interest. ST4031 provides a sound theoretical and practical foundation for stochastic processes.

Intended Learning Outcomes:

Upon successful completion of this course, students will be able to,

- recognize the properties of basic stochastic processes

<table>
<tr><td colspan="4">

- apply the knowledge of probability theory and stochastic processes to analyze problems in practice

</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Generating function; Basics of Brownian motion; Poisson process; Random walks; Discrete parameter Markov Chains; Continuous parameter Markov Chains; Branching process; Birth and Death processes; Queuing processes.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive lectures, videos, tutorials, in-class assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

……30……..%</td><td colspan="2">Final Assessment

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

- Bailey, N. T. J. (1970). *The Elements of Stochastic Processes*. John Wiley
- Feller, W. (2008). *An Introduction to Probability Theory and Applications* (2nd ed). Wiley India Pvt. Limited
- Cox, D. R., & Miller, H. D. (1977). *The Theory of Stochastic Processes.* Chapman and Hall/CRC
- Trivedi, K. S. (2016). *Probability and Statistics with Reliability Queues and Computer Science Applications* (2nd ed). Wiley

</td></tr>
</table>

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Level IV - Semester 1				
Course Code	ST 4051			
Course Name	Scientific Writing			
Credit Value	1C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional

		30	20	50

Course Aim:

Scientific writing is essential for communication of scientific knowledge in the form of reports, dissertations, journal papers and thesis. It is necessary that students become more effective writers by communicating the results or findings, academically and professionally. Summarizing, literature review, writing articles, referencing and citing are the main aspects focused in this course.

Intended Learning Outcomes:

After a successful completion, students will be able to,

- search, identify, read, and analyze research articles which are relevant to their research activities
- write a quality scientific literature review for a selected research problem

Course Content: (Main topics, Sub topics)

Read and discuss text/papers for a general sense of what research is/are about, how one thinks when doing research, and what the major research activities are; Identify research articles from different areas of statistics/computer science, involving different methodologies of research, and abstract them; Select an area related to statistics, which is of particular interest to students, write a professional quality literature review for a problem of your choice.

Teaching /Learning Methods: Interactive lectures, forums, videos, quizzes, assignments

Assessment Strategy: at least 2 assignments

Continuous Assessment	Final Assessment
……100……..%	……0……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....100.....%	……..	……..	……

Recommended Reading:

- Peer reviewed journal papers

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<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 4052</td></tr>
<tr><td>Course Name</td><td colspan="4">Statistical Learning II</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>60</td><td>40</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields biology, finance, marketing etc. ST4052 presents some important classification and clustering techniques such as discriminant analysis, bagging, random forest, boosting, k-means clustering etc., along with relevant applications.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

● explore complex data sets, select the relevant statistical techniques discussed to solve problems involved and justify their choice
● implement these techniques using an appropriate programming language
● evaluate the results and explain the results to non-statisticians using non statistical terms</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Moving beyond linearity: polynomial regression, regression splines, smoothing splines; Tree-based methods: the basics of decision tree, bagging, random forest, boosting; Support Vector machines; Unsupervised learning: dimension reduction techniques, clustering</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations</td></tr>
<tr><td colspan="5">Assessment Strategy: 4 group projects and presentations + Attendance</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……15……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other(group projects and presentations)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (attendance)</td></tr>
</table>

..... % .....% .....85.....%	……	…….	……15……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning* (1st ed.). Springer-Verlag New York

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Level IV - Semester 1				
Course Code	ST 4054			
Course Name	Linear Models			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Linear models describe a continuous response variable as a function (linear in parameters) of one or more predictor variables. For example, we may explain credit card balance as a function (linear in parameters) of average monthly income, gender, student status etc. Linear models can be utilized to describe and predict the behavior of complex systems. ST 4052 provides a thorough theoretical foundation for regression and design models with aid of linear algebra.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the fundamentals of the general linear model
- distinguish between different linear models found in real life situations
- appraise the optimal estimation and inference related to different linear models

Course Content: (Main topics, Sub topics)

Elementary linear and matrix algebra: idempotent matrices, trace of matrices, generalized and conditional inverses; Solutions of linear equations; Derivatives of quadratic forms; Expectation of random matrices; Multivariate normal distribution and its properties; Distribution of quadratic forms; General linear model: optimal estimation and hypothesis testing, applications to regression model, continued application of optimal inference, design models, estimability, solving normal equations, components of variance models and mixed models

Teaching /Learning Methods: Interactive lectures, tutorials, in-class assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) ……
Recommended Reading: ● Graybill, F. A. (2000). *Theory and applications of the linear model.* Duxbury ● Graybill, F. A. (2001). *Matrices with Applications in Statistics* (2nd ed.). Brooks/Cole ● Christensen, R. (2013). *Plane answers to complex questions* (2nd ed.). Springer Science & Business Media			

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Level IV - Semester 1				
Course Code	ST 4056			
Course Name	Medical Statistics			
Credit Value	3C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim: Medical statistics constitutes statistical methods for analyzing data on medicine and health sciences which include epidemiology, public health, forensic medicine and clinical research. [ST 3077 provides both theory and applications on statistical methods for analyzing medical data]				
Intended Learning Outcomes: After a successful completion of the course, the students will be able to,				

<table>
<tr><td colspan="4">

- define, compute and interpret statistics
- identify and apply statistical models in epidemiology, clinical trials, and survival studies in order to analyze data from medical studies

</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Introduction; Epidemiology: basic designs for epidemiological studies, relative risk and odds ratio, confounding and interaction; Analysis of data from cohort and case control studies; Matched case control studies; Logistic regression; Clinical trials: introduction, protocols for clinical trials, cross-over designs, allocation to treatment, sample size determination, Phase I and Phase II studies; Survival Analysis: analysis of survival data, the survival and hazard functions; Non-parametric procedures: Kaplan-Meier estimate of survivor functions, log-rank test for comparing two survival times; Parametric modeling: proportional hazards model, Cox's proportional hazards model.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="4">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

……20……..%</td><td colspan="2">Final Assessment

……80……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....20.....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

……..</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

- Armitage, P. (2017). *Statistical methods in medical research* (4th ed). Wiley India
- Case-control studies

</td></tr>
</table>

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Level IV - Semester 1	
Course Code	ST 4012
Course Name	Special Topics for ST
Credit Value	2C
Core/Optional	Optional
Prerequisites	

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:
Intended Learning Outcomes:
Course Content: (Main topics, Sub topics) Selected topics depending on the availability of teaching staff.
Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments
Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	……..	……

Recommended Reading:
● Depends on the topic

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Level IV - Semester 2				
Course Code	ST 4055			
Course Name	Generalized Linear Models			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional

	30	30	90	150

Course Aim:

Generalized Linear models describe a response variable from an exponential family as a linear function of one or more predictor variables. For example, we may have binomial, Poisson, gamma etc distribution for response variables. ST 4055 provides a thorough theoretical and practical foundation in fitting, estimating, interpreting and testing in generalized linear models.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- identify and apply a suitable generalized linear model for a given dataset
- apply appropriate diagnostics to evaluate the model

Course Content: (Main topics, Sub topics)

Introduction to Statistical modeling; Exponential family and GLMs: estimation, inference; Logistic regression: binary logistic model, link function, over dispersion and bio-assay, multinomial logistic model, ordinal logistic model; Log-linear models: contingency tables, link function; comparison of logistic and log-linear models; Gamma models; Model Adequacy: residuals, outliers, lack of fit.

Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions

Assessment Strategy: At least 2 assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	……	……

Recommended Reading:

- Agresti, A. (2012). *Categorical Data Analysis* (3rd ed). Wiley
- Collett, D. (1991). *Modelling Binary Data* (2nd ed). Taylor & Francis
- McCullah, P., & Nelder, J. A. (1989). *Generalized Linear Models* (2nd ed). Chapman and Hall/CRC
- Aitkin, M., Anderson, D., Francis, B., & Hinde, J. (1989). *Statistical Modelling in GLIM.* Oxford University Press

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<table>
<tr><th colspan="5">Level IV - Semester 2</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 4050</td></tr>
<tr><td>Course Name</td><td colspan="4">Individual Project</td></tr>
<tr><td>Credit Value</td><td colspan="4">8C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>240</td><td>560</td><td>800</td></tr>
<tr><td colspan="5">Course Aim:

Working on a research project gives the opportunity to work closely with a faculty member who is an experienced researcher. The research project represents the concentration of interests and studies, and possibly, a real contribution to knowledge. It provides an opportunity to learn something new, to improve problem-solving skills and to challenge oneself in new ways.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the project, the students will be able to,

● solve real world problems using appropriate theories and techniques learnt throughout the degree program
● extend and develop existing theories to solve complex statistical problems</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)</td></tr>
<tr><td colspan="5">Teaching /Learning Methods:</td></tr>
<tr><td colspan="5">Assessment Strategy: Thesis + Viva</td></tr>
<tr><td>Continuous Assessment

……..%</td><td colspan="4">Final Assessment

……100……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

..... % .....% .....%</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (thesis and viva)</td></tr>
</table>

	……..	……	……100……

Recommended Reading:

- Depends on the project title

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Level IV - Semester 2				
Course Code	EC 4004			
Course Name	Industrial Training			
Credit Value	3EC			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		90	210	300

Course Aim:

Industrial training provides first hand experience for the undergraduates to work fulltime in an organization outside the university. The main intention of the programme is to enhance their communication and teamwork skills. They will also be conducting real-time applications using the knowledge they gained at the university while improving their ability to explore new techniques.

Intended Learning Outcomes:

Upon successful completion of Industrial Training, the students will be able to,

- integrate classroom theory with workplace practice
- develop greater clarity about academic and career goals
- recognize administrative functions and company culture
- appreciate the ethical basis of professional practice in relevant industry
- display a capacity for critical reasoning and independent learning
- explore options in career plans and goals

Course Content: (Main topics, Sub topics)

Industrial training provides students to understand and appreciate real-life working experiences. Students may realize their ambition and ascertain their career path from the experience gained during industrial training. The training provides students the opportunity to meet and network with people in the industry, and for the industry the opportunity to identify talents and potential skilled employees.

Teaching /Learning Methods: 8 weeks training in an industrial placement			
Assessment Strategy: Student Progress & Progress Reports +External supervisor/s+ Final Report			
Continuous Assessment ……50……..%	Final Assessment ……50……..%		
Details: Student Progress & Progress Reports (25%) External supervisor/s (25%)	Theory (%) ……..	Practical (%) ……	Other (%) Final Report (50 %)
Recommended Reading: ● None			

Course Content - Level III (DS) (for Honours intake 2023 an onwards)

Level III - Semester 1				
Course Code:	ST 3008			
Course Name:	Applied Statistical Models			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites	ST 2010			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150
Course Aim: Statistical models describe a response variable as a function of one or more predictor variables. The response variable can have any type of distribution for example, normal, binomial, Poisson etc. The predictors can be either categorical or continuous, also random effects or fixed effects. ST 3008 provides some theoretical foundation and thorough practical knowledge on regression, GLMs, nonlinear models and mixed effects models.				

Intended Learning Outcomes:

After successful completion of the course, the students will be able to,

- analyze and interpret categorical and continuous data using appropriate linear and non-linear models using SAS/R
- validate the fitted models using appropriate model diagnostic tools

Course Content: (Main topics, Sub topics)

Introduction to modeling. Continuous models with fixed effects: Simple Linear Regression, Multiple Linear Regression, Non Linear Regression. Data categorization. Contingency table analysis. Categorical models with fixed effects: log linear models, logistic models, Polytomous regression, Ordinal response models, Nominal response models, Analysis of categorical data using a SAS/R, Interpreting parameter estimates, Goodness of fit test. Introduction to random effects and mixed models.

Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions

Assessment Strategy: 2 in-class assignments + 1 Case studies/ Group project + Final exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes % , In-classes % (Case studies/ Group project)	Theory (%)	Practical (%)	Other (%) (specify)
…… % …….20……..% ……10……. %	…70…..	…….	……

Recommended Reading:

- Chatterjee, S., & Hadi, *A*. S. (2006). *Regression Analysis by Example* (4th ed.). John Wiley & Sons
- Agresti, A. (2003). *Categorical Data Analysis* (2nd ed.). John Wiley & Sons
- Dobson, A.J., & Barnett, A. (2008). *An introduction to Generalized Linear Models* (3rd ed.). Taylor & Francis
- Brown, H., & Prescott, R. (2015). *Applied Mixed Models in Medicine* (3rd ed.). John Wiley & Sons
- Collet, D. (2002). *Modeling Binary Data* (2nd ed.). CRC Press

<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">ST 3051</td></tr>
<tr><td>Course Name:</td><td colspan="4">Statistical Inference I</td></tr>
<tr><td>Credit Value:</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3051 carries a theoretical foundation for one part of this tool, namely, estimation].</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

● recognize the underlying theory behind statistical estimation
● apply the necessary techniques to find estimates of population parameters
● appraise the properties of estimators</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Generating moments using characteristic function; Sampling from Normal population: sampling distributions of sample mean and sample variance (s^2), independence of sample mean and s^2; Properties of estimators: Mean-squared error, Unbiasedness, Consistency, Sufficiency, Completeness, Efficiency; Factorization criterion; Variance Reduction: Cramer-Rao Lower Bound, Rao-Blackwell Theorem, Lehmann-Scheffe' Theorem; Methods of Estimation: Method of moments, Maximum Likelihood and Its Properties, Least Squares; Interval Estimation: Pivotal Method, General Method.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes %, mid-term %, other % (In-classes)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
</table>

…… % ……..% ……30……..%	…70…..	…….	……

Recommended Reading:

- Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed). Pearson
- Lindgren, B. (2017). *Statistical Theory* (4th ed). CRC Press
- Mood, A. M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill

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Level III - Semester 1				
Course Code:	ST 3074			
Course Name:	Time Series Analysis			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Time series analysis usually studies patterns in data evolving over time (time series data) and use these patterns to forecast the future behavior. For e.g., next month sales of a company can be forecasted by studying patterns in past sales data of that company. ST 3074 provides necessary tools and theories to study and forecast time series data.

Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to;

- fit suitable models for univariate time series data
- forecast univariate time series

Course Content: (Main topics, Sub topics)

Introduction: definition, types of time series, components of time series, time plot, time series decomposition, transformation, differencing, autocorrelation; Stationarity: stationary & non-stationary time series, tests for stationarity; Modelling time series: time series models, model identification, parameter estimation, diagnostic checks, forecasting.

Teaching /Learning Methods: Interactive classroom sessions

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes %, mid-term %, other % (In-classes) …… % ……..% …….20……..%	Theory (%) …80…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Makridakis, S. G., Weelwright, S. C., & Hyndman, R. J. (1997). *Forecasting Methods and Applications* (3rd ed). Wiley ● Chatfield, C (2003). *The analysis of Time Series: An Introduction* (6th ed). Chapman and Hall/CRC ● Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Forecasting and Control* (3rd ed). Prentice Hall			

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Level III - Semester 1				
Course Code:	ST 3085			
Course Name:	Computational Statistics			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: Computational statistics refer to the computational methods that enable statistical methods. This course provides students some widely used such methods and techniques using the free and open source statistical software, R.				
Intended Learning Outcomes: After a successful completion of the course, the students will be able to, ● generate random numbers using different distributions ● simulate data from different distributions ● apply bootstrap methods to analyze data				

Course Content: (Main topics, Sub topics)			
Introduction to Random numbers: pseudo random numbers, properties of random numbers, testing for basic properties, software for random number generation; Introduction to Simulation: simulation of random variables, Monte Carlo simulation methods, simulation of inventory models, simulation of queuing models; Data Re-sampling: Introduction to Bootstrap, Bootstrap estimation of Variance, Bootstrap Confidence Intervals, Introduction to EM algorithm.			
Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes %, mid-term %, other % (In-classes) …… % ……..% …….30……..%	Theory (%) …70…..	Practical (%) ……	Other (%) (specify) ……
Recommended Reading: ● Givens, G. H., & Hoeting, J. A. (2012). *Computational Statistics* (2nd ed). Wiley ● Gentle, J. E (2005). *Elements of Computational Statistics*. Springer ● Efron, B., & Tibshirani, R. J. (1993). *An introduction to the bootstrap* (1st ed). Chapman and Hall/CRC			

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Level III - Semester 1				
Course Code:	DS 3001			
Course Name:	Data Visualization Techniques			
Credit Value:	1C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		30	20	50

Course Aim:

Visualize data using various exploratory techniques and tools to retrieve information and to present the findings to statistical and non-statistical audiences.

Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

- Identify the essentials of data visualization tools and techniques.
- Apply proper data visualization techniques to acquire important information from raw data.
- Evaluate and communicate analytical results

Course Content: (Main topics, Sub topics)

Elements of Visualization: visualizing process, explanatory vs. exploratory, Do's and Don'ts of visualizations, Color theory; Types of graphs: visualizing relationships, distribution and composition; Data visualization using software tools (R and Tableau/ Power BI / plotly); Interactive data visualization: Dashboards.

Teaching /Learning Methods: Interactive lab sessions

Assessment Strategy: Continuous assessments (100%) [group projects + At least 2 In-class assignments]

Continuous Assessment	Final Assessment		
……100……..%	……..%		
Details: quizzes %, In-classes %, other % (Group project) …… % ……50……% …….50……..%	Theory (%) ……	Practical (%) ……	Other (%) (specify) ……

Recommended Reading:

- Ben Fry (2007). Visualizing Data: Exploring and Explaining Data with the Processing Environment. O'Reilly Media Inc.
- Kieran Healy (2019). Data Visualization: A Practical Introduction (First Edition). Princeton University Press.
- Hadley Wickham (2016). ggplot2: Elegant graphics for data analysis (Second Edition). Springer by Hadley Wickham

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Level III - Semester 1	
Course Code:	DS 3002
Course Name:	Data Ethics and Data Security

<table>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td>30</td><td>55</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

This course introduces activities, techniques and tools needed to secure data/information and systems in order to ensure its ethical use.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

● Understand the need to secure data used in data systems and products.
● Recognize the ethics in collecting, storing and sharing data
● Apply tools and techniques of ethics and security in handling data</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Ethical frameworks for evaluating data, Applying ethics to digital data: Challenges and Opportunities, Privacy of data, Security challenges with Big data, Issues in data collection/data mining, Issues in data exploration & analysis, issues with algorithms & automated systems, Issues in dissemination and evaluation of data, Sri Lankan and International Law & policies related to data collection, acquisition and usage.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions and seminars</td></tr>
<tr><td colspan="5">Assessment Strategy: End-of-semester examination + and at least three case studies</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……50……..%</td></tr>
<tr><td>Details: quizzes %, Mid-term %, other % (Case studies)

…… % ……..% ……50……..%</td><td>Theory (%)

….50…..</td><td>Practical (%)

……</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● K. Davis (2012). Ethics of Big Data, O'Reilly Media Inc.
● G. Hasselbalch & P. Tranberg (2016). Data Ethics: A New Competitive Advantage (1st edition), Publishare, Copenhagen.
● D. Ottenheimer (2020). The Realities of Securing Big Data (1st Edition), Wiley.</td></tr>
</table>

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<table>
<tr><th colspan="5">Level III - Semester 2</th></tr>
<tr><td>Course Code:</td><td colspan="4">ST 3011</td></tr>
<tr><td>Course Name:</td><td colspan="4">Statistical Programming</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>60</td><td>40</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

The ability to find trends in data, visualize and model it, using mathematical and statistical methods is increasingly useful with the recent abundance of data collected. To analyze such data in large volumes, a basic understanding of programming is imperative. ST 3011 provides the foundational programming skills and best practices required to explore, model and visualize various types of data to solve business problems.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

● plot 2D and 3D graphs using Python /R
● solve statistical problems writing Python/R functions
● perform data analysis using Python /R</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to Python. Built-in data types, Arrays and Matrices, Basic Math using Python. Basic functions and Numerical indexing, Special arrays. Advanced selection and Assignment, Flow control, loops and exception handling. Graphics using Python. Introduction to R; Data Management, Descriptive Analysis, Writing functions in R; Statistical Inference.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lab sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 5 lab assignments</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……..%</td></tr>
<tr><td>Details: Lab assignments(At least 5 assignments) %

……100……. %</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
</table>

	…….	…….	……

Recommended Reading:

- Venables, W. N., D.M. Smith, D. M., & the R Core Team (2009). *An Introduction to R: A Programming Environment for Data Analysis and Graphics* (2nd ed). Network Theory

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Level III - Semester 2				
Course Code:	DS 3003			
Course Name:	Machine Learning I			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	100

Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields such as biology, finance, marketing etc. ST presents some important modeling techniques and prediction techniques such as ridge regression, LASSO, elastic net, principle component regressions etc., along with relevant applications.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- explore complex data sets, select appropriate statistical techniques to solve problems involved and justify their choice
- implement these techniques using an appropriate programming language
- evaluate the results and explain the results to non-statisticians using non statistical terms

Course Content: (Main topics, Sub topics)

Introduction to statistical learning; Advanced regression model: understanding models, variable selection, validation and cross validation, Shrinkage method and ridge regression, Lasso, principal component regression and partial least squares; Resembling method: cross validation, bootstrap; Classification: understanding classification problems using logistic regression, multivariate logistic regression, and discriminant analysis.

Teaching /Learning Methods: Interactive lab sessions

Assessment Strategy: 4 group projects and presentations + Attendance

Continuous Assessment	Final Assessment		
……85……..%	……15……%		
Details: quizzes %, mid-term %, other % (group projects & presentations)	Theory (%)	Practical (%)	Other (%) (attendance)
…… % ……..% …….85……..%	……..	……..	……15……
Recommended Reading: ● James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning: with Applications in R* (2013). Springer Science & Business Media			

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Level III - Semester 2				
Course Code:	ST 3083			
Course Name:	Multivariate Data Analysis			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim: In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. For eg., a heart attack may be the result of a combination of factors like excess weight, high blood pressure, high cholesterol, genetic effects, etc. etc. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. [ST 3083 provides a good theoretical as well as practical foundation for commonly used multivariate techniques].				
Intended Learning Outcomes: Upon the successful completion of the course, students will be able to, ● analyze multivariate data and make decisions based on multivariate hypothesis tests ● apply dimension reduction methods; clustering data and discriminate new observations to pre-defined clusters				
Course Content: (Main topics, Sub topics)				

Review of matrix algebra; Mean and variance-covariance of a random vector; correlation matrix; Properties of multivariate normal distribution and applications; Checking for multivariate normality; Hypothesis testing using multivariate tests; MANOVA ; Principal component analysis; Factor analysis; Discriminant analysis; Cluster analysis.			
Teaching /Learning Methods: Interactive classroom sessions			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes %, mid-term %, other % (In-classes) …… % ……..% …….30……..%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Johnson, R. A., & Wichern, D. W. (2012). *Applied multivariate statistical analysis* (6th ed). Phi Learning Private Limited ● Morrison, D. F. (2004). *Multivariate statistical methods* (4th ed). Duxbury Press ● Johnson, D. E. (1998). *Applied multivariate methods for data analysts* (1st ed). Duxbury Press			

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Level III - Semester 2				
Course Code:	ST 3084			
Course Name:	Statistical Inference II			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites	ST 3051			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3084 carries a theoretical foundation for one part of this tool, namely, testing statistical hypotheses].

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the underlying general theory behind testing statistical hypotheses
- apply the necessary techniques to real life situations

Course Content: (Main topics, Sub topics)

Parametric Inference: Introduction to Hypothesis Testing, Errors, Power, Neymann-Pearson Lemma, Most Powerful Tests, Uniformly Most Powerful Tests, Likelihood Ratio Tests, Sequential Tests, Sequential Probability Ratio Test (SPRT), Wald's Identity, Average Sample Number (ASN); Distribution-free Inference: Tests of Randomness, Run Tests, One sample Location Tests for Median, Sign Test; Asymptotic Relative Efficiency (ARE); Two sample Location problem.

Teaching /Learning Methods: Interactive classroom sessions

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment		
……30……..%	……70……..%		
Details: quizzes %, mid-term %, other % (In-classes)	Theory (%)	Practical (%)	Other (%) (specify)
…… % ……..% ……30……..%	…70…..	……..	……

Recommended Reading:

- Mood, A.M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill
- Lindgren, B. W. (1976). *Statistical Theory* (3rd ed). Macmillan
- Hogg, R. V., & Craig, A. T. (1970). *Introduction to Mathematical Statistics* (3rd ed). Macmillan

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Level III - Semester 2				
Course Code:	DS 3004			
Course Name:	Essential Calculus and Linear Algebra for Data Science			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Mathematical theories such as linear algebra, matrices, calculus etc. are required for proofs of most of the higher level statistical theories. ST 3013 provides those tools for students with the required amount of theoretical knowledge.

Intended Learning Outcomes:

After a successful completion, students will be able to,

- apply basic mathematical tools in solving theoretical and practical problems in Statistics

Course Content: (Main topics, Sub topics)

Linear algebra: Linear dependence, rank and the solution of homogeneous equations, characteristic polynomials, eigenvalues , eigenvectors, spectral theorem for symmetric matrices, idempotent matrices and properties, orthogonal projections, trace of a matrix and properties, positive definite/semi definite matrices, quadratic forms, differential calculus in matrix notation, direct product (kronecker)of any two matrices, generalized inverse /conditional inverse ; Calculus: Concepts of functions, limits and continuity, L'Hopital's rule, the fundamental theorem of calculus, approximation of definite integrals, Improper integrals; Series and Sequences: sequences and their convergence, series and convergence of series, power series and their convergence of radius, Taylor series and their application; Several variable calculus: functions of several variables, continuity, differentiability, derivatives, multiple integrals, change of variables

Teaching /Learning Methods: Interactive classroom sessions

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes %, mid-term %, other % (In-classes)	Theory (%)	Practical (%)	Other (%) (specify)
…… % ……..% …….30……..%	…70…..	……..	……

Recommended Reading:

- Graybill, F. A. (2001). *Matrices with applications in Statistics* (2nd ed). Brooks/Cole
- Bonar, D. D., & Khoury, M.J. (2006). *Real Infinite Series* (1st ed). American Mathematical Society
- Courant, R., & John, F. (1965). *Introduction to Calculus and Analysis, Volume 1*. Springer-Verlag
- Lang, S. (1987). *Calculus of several variables* (3rd ed). Springer

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Course Content - Level IV (DS)

Level IV - Semester 1				
Course Code:	ST 4051			
Course Name:	Scientific Writing			
Credit Value:	1C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		30	20	50

Course Aim:

Scientific writing is essential for communication of scientific knowledge in the form of reports, dissertations, journal papers and thesis. It is necessary that students become more effective writers by communicating the results or findings, academically and professionally. Summarizing, literature review, writing articles, referencing and citing are the main aspects focused in this course.

Intended Learning Outcomes:

After a successful completion, students will be able to,

- search, identify, read, and analyze research articles which are relevant to their research activities
- write a quality scientific literature review for a selected research problem

Course Content: (Main topics, Sub topics)

Read and discuss text/papers for a general sense of what research is/are about, how one thinks when doing research, and what the major research activities are; Identify research articles from

different areas of statistics/computer science, involving different methodologies of research, and abstract them; Select an area related to statistics, which is of particular interest to students, write a professional quality literature review for a problem of your choice.			
Teaching /Learning Methods: Interactive lab sessions			
Assessment Strategy: at least 2 Assignments			
Continuous Assessment ……100……..%	Final Assessment ……0……%		
Details: quizzes %, mid-term %, other % (In-classes) …… % ……..% ……100……..%	Theory (%) ……..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Peer reviewed journal papers			

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Level IV - Semester 1				
Course Code:	DS 4001			
Course Name:	Image Analysis			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: Provide essential knowledge of using statistical methods for image analysis to retrieve information from images.				
Intended Learning Outcomes:				

After a successful completion of the course, the students will be able to ● Use proper methods to collect and preprocess images for analysis. ● Understand the use of statistical methods and techniques on images for pattern recognition. ● Apply statistical modeling techniques for image analysis
Course Content: (Main topics, Sub topics) Basic image processing techniques: image filtering, thresholding and segmentation; pattern recognition: image classification, image clustering; statistical image modeling: Markov random field, Bayesian analysis of images, spatial random processes for image analysis
Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions
Assessment Strategy: Continuous assessment (100%) [Group project + at least 2 Inclass assessments]

Continuous Assessment	Final Assessment
……100……..%	……..%

Details: quizzes %, In-classes %, other % (group project)	Theory (%)	Practical (%)	Other (%) (attendance)
…… % ……60…….% …….40……..%	……..	……..	……

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Level IV - Semester 1				
Course Code:	DS 4002			
Course Name:	Machine Learning II			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	

Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields biology, finance, marketing etc. ST4052 presents some important classification and clustering techniques such as discriminant analysis, bagging, random forest, boosting, k-means clustering etc., along with relevant applications.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- explore complex data sets, select the relevant statistical techniques discussed to solve problems involved and justify their choice
- implement these techniques using an appropriate programming language
- evaluate the results and explain the results to non-statisticians using non statistical terms

Course Content: (Main topics, Sub topics)

Moving beyond linearity: polynomial regression, regression splines, smoothing splines; Tree-based methods: the basics of decision tree, bagging, random forest, boosting; Support Vector machines; Unsupervised learning: dimension reduction techniques, clustering

Teaching /Learning Methods: Interactive lab sessions

Assessment Strategy: 4 group projects and presentations + Attendance

Continuous Assessment	Final Assessment		
……85……..%	……15……..%		
Details: quizzes %, mid-term %, other % (group projects and presentations)	Theory (%)	Practical (%)	Other (%) (attendance)
…… % ……..% …….85……..%	……..	……..	……15……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning* (1st ed.). Springer-Verlag New York

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<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">DS 4003</td></tr>
<tr><td>Course Name:</td><td colspan="4">Special Topics for Data Science</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>15</td><td>30</td><td>55</td><td></td></tr>
<tr><td colspan="5">Course Aim:</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Selected topics depending on the availability of teaching staff.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes %, mid-term %, other % (In-classes)

…… % ……..% …….30……..%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Depends on the topic</td></tr>
</table>

<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">DS 4004</td></tr>
<tr><td>Course Name:</td><td colspan="4">Big Data analytics</td></tr>
<tr><td>Credit Value:</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td>30</td><td>90</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Provides students with in-depth knowledge in methods and technologies to store, retrieve and analyze Big data.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

● Identify different forms of Big data and methodologies.
● Apply proper methods of analyzing Big data.
● Evaluate, interpret and communicate the results of Big data analyses</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lab sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: Continuous assessments (100%) [Group project + presentation 50%, at least three assignments 50%]</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……..%</td></tr>
<tr><td>Details: quizzes %, Assignments %, other % (group projects + presentations)

…… % ……50……..% …….50……..%</td><td>Theory (%)

……..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (attendance)

……</td></tr>
</table>

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Level IV - Semester 1				
Course Code:	DS 4005			
Course Name:	Causal Inference			
Credit Value:	1C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		30	20	50

Course Aim:

Learn different techniques related to the analysis of causal effects and practice to implement applicable statistical methods using R software.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- Identify causality
- Illustrate problems using Directed Acyclic Graphs
- Identify the causal inference assumptions and implement appropriate methods

Course Content: (Main topics, Sub topics)

Introduction to causality: Difference between association and causality, potential outcomes, the fundamental problem of causal inference, causal assumptions; Causal graphs: Directed Acyclic Graphs (DAGs), controlling for confounding; Causal Inference methods: matching, propensity score methods, inverse probability of treatment weighting, instrumental variables methods.

Teaching /Learning Methods: Interactive lab sessions

Assessment Strategy: Continuous assessments (100%) [Group project and presentation(50%)+ At least 1 assignments (50%)]

Continuous Assessment	Final Assessment
……100……..%	……..%

Details: quizzes %, In-classes %, other % (group project and presentation)	Theory (%)	Practical (%)	Other (%) (attendance)

…… % ……50…….% …….50……..%	……..	……..	……

Recommended Reading:

- Stephen Morgan & Christopher (2014). WinshipCounterfactuals and Causal Inference: Methods and Principles For Social Research (Second Edition). Cambridge University Press

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Level IV - Semester 2				
Course Code:	DS 4007			
Course Name:	Research Project in DS			
Credit Value:	8C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		240	560	800

Course Aim:

Working on a research project gives the opportunity to work closely with a faculty member who is an experienced researcher. The research project represents the concentration of interests and studies, and possibly, a real contribution to knowledge. It provides an opportunity to learn something new, to improve problem-solving skills and to challenge oneself in new ways.

Intended Learning Outcomes:

Upon successful completion of the project, the students will be able to,

- solve real world problems using appropriate theories and techniques learnt throughout the degree program
- extend and develop existing theories to solve complex statistical problems

Course Content: (Main topics, Sub topics)

Teaching /Learning Methods:

Assessment Strategy: Thesis + Viva

Continuous Assessment	Final Assessment
……..%	……100……..%

Details: quizzes %, mid-term %, other % (specify) …… % ……..% ……..%	Theory (%) ……..	Practical (%) ……	Other (%) (thesis and viva) ……100……
Recommended Reading: ● Depends on the project title			

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Level IV - Semester 2				
Course Code:	DS 4006			
Course Name:	Professional Practice			
Credit Value:	4C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		120	280	400
Course Aim: Industrial training provides first hand experience for the undergraduates to work fulltime in an organization outside the university. The main intention of the programme is to enhance their communication and teamwork skills. They will also be conducting real-time applications using the knowledge they gained at the university while improving their ability to explore new techniques.				
Intended Learning Outcomes: Upon successful completion of Industrial Training, the student will be able to, ● integrate classroom theory with workplace practice ● develop greater clarity about academic and career goals ● recognize administrative functions and company culture ● appreciate the ethical basis of professional practice in relevant industry ● display a capacity for critical reasoning and independent learning ● explore options in career plans and goals				
Course Content: (Main topics, Sub topics) Industrial training provides students to understand and appreciate real-life working experiences. Students may realize their ambition and ascertain their career path from the experience gained during industrial training. The training provides students the opportunity to meet and network				

with people in the industry, and for the industry the opportunity to identify talents and potential skilled employees.			
Teaching /Learning Methods: 3 months training in an industrial placement			
Assessment Strategy: Student Progress & Progress Reports + External supervisor/s + Final Report + Final Presentation.			
Continuous Assessment ……50……..%	Final Assessment ……50……..%		
Details: Student Progress & Progress Reports (25 %) External supervisor/s (25 %)	Theory (%) …….	Practical (%) ……	Other (%) Final Report (25 %) Final Presentation ….(25 %)……
Recommended Reading: ● None			

Course Content - Level III (ST+CS) (for Honours intake 2022)

Level III - Semester 1				
Course Code	ST 3003			
Course Name	Marketing Research			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Marketing research is a widely used approach to gain insights about issues faced by companies. ST 3003 provides an introduction to the methodologies adopted in marketing research with references to real life case studies.				

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- understand and identify key aspects of the marketing research process
- appraise basic methodological frameworks in marketing research in different scenarios
- design and formulate a marketing research along theoretical concepts

Course Content: (Main topics, Sub topics)

Introduction, The Marketing Research Process, Defining the problem with exploratory research, Survey research: Methods of communication with respondents, Test marketing, Measurements and Attitude scaling, Questionnaire design, Sampling procedures, Data analysis, report writing and presentation: Stochastic models of brand choice, Applications of General Linear Models in marketing, Conjoint analysis, Correspondence analysis, Advertising media models, Marketing response models.

Teaching /Learning Methods: Interactive classroom sessions

Assessment Strategy: 2 in-class Assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	…….	……

Recommended Reading:

- Lehmann, D.R., Gupta, S. & Steckel, J.H. (1998). *Marketing Research*. Addison-Wesley
- Crask, M., Fox, R. J, & Stout, R. G. (1995). *Marketing research: principles and applications*. Prentice Hall, Englewood Cliffs, N.J

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Level III - Semester 1	
Course Code	ST 3007
Course Name	Operational Research
Credit Value	3C
Core/Optional	Optional

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Managers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision-making activities in an optimum way. [ST3007 provides a good foundation about some of the widely used operational research techniques]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● describe the fundamental concepts of real world applications in operational research
● model decision making problems, obtain solution/s for the formulated model/s using appropriate techniques and software packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Integer Programming models and solution techniques (Cutting Plane algorithm, Branch-and-Bound algorithm), Zero-one Programming models (mind expanding problems),Transportation models and solution techniques (North-West Corner method, Least Cost method, Vogel's Approximation method, U-V Method), Assignment models and solution techniques(Hungarian method), Inventory Models (Deterministic inventory models with shortages and without shortages),Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models),Solution techniques using suitable OR packages.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td>Continuous Assessment

……30……..%</td><td colspan="4">Final Assessment

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%)(specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Taha, H. A. (1997). Operations research: an introduction (6th ed). Prentice Hall, Upper Saddle River, N.J Verma, A. P. (2009). Operational Research (3rd ed). S. K. Kataria & Sons.
● Panneerselvam, R. (2006). Operational Research (2nd ed). PHI Learning Pvt. Ltd.</td></tr>
</table>

- Wagner,H. M. (1975). *Principles of operations research: with applications to managerial decisions* (2nd ed). University of Michigan
- Hillier, F. S., & Liebermann, G.D. (1980). *Operations research* (3rd ed). Holden-Day

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Level III - Semester 1				
Course Code	ST 3051			
Course Name	Statistical Inference I			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3051 carries a theoretical foundation for one part of this tool, namely, estimation].

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the underlying theory behind statistical estimation
- apply the necessary techniques to find estimates of population parameters
- appraise the properties of estimators

Course Content: (Main topics, Sub topics)

Generating moments using characteristic function; Sampling from Normal population: sampling distributions of sample mean and sample variance (s^2), independence of sample mean and s^2; Properties of estimators: Mean-squared error, Unbiasedness, Consistency, Sufficiency, Completeness, Efficiency; Factorization criterion; Variance Reduction: Cramer-Rao Lower Bound, Rao-Blackwell Theorem, Lehmann-Scheffe' Theorem; Methods of Estimation: Method of moments, Maximum Likelihood and Its Properties, Least Squares; Interval Estimation: Pivotal Method, General Method.

Teaching /Learning Methods: Interactive lectures, practice exercises, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed). Pearson
- Lindgren, B. (2017). *Statistical Theory* (4th ed). CRC Press
- Mood, A. M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill

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Level III - Semester 1				
Course Code	ST 3072			
Course Name	Applied Regression Analysis			
Credit Value	3C			
Core/Optional	Core			
Prerequisites	ST 1004, ST 2004			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Regression analysis is a popular statistical tool used to explore and establish a linear relationship between a specific response variable and several other variables. ST3072 provides the theory and application of linear regression models.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- formulate a suitable regression model to describe a relationship between a response variable and one or more explanatory variables
- apply appropriate diagnostics to evaluate the model and interpret the model to describe the problem

Course Content: (Main topics, Sub topics)

Simple Linear Regression: introduction, correlation, uses of Regression, simple linear Regression model, parameter estimation, inferences about the model, prediction, coefficient of determination; Model Adequacy: residuals, outliers, lack of fit, transformations; Multiple Linear Regression: Multiple Linear Regression model, parameter estimation, inferences about the model, prediction, model adequacy,

variable selection methods, use of categorical variables as predictors, analysis of co-linearity; Transformation of Variables; Polynomial regression; weighted least square.			
Teaching /Learning Methods: Interactive lectures, videos, quizzes, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……

Recommended Reading:

- Draper, N.R., & Smith, H. (1998). *Applied Regression Analysis* (3rd ed). Wiley
- Kleinbaum, D. G., Kupper, L. L., Muller, K. E., & Nizam, A. (1997). *Applied Regression Analysis and Other Multivariable Methods* (3rd ed). Duxbury Press
- Chatterjee, S., & Hadi, A. L. (2012). *Regression Analysis by Example* (5th ed). Wiley
- Montgomery, D. C., Peck E. A., & Vining, G. (2007). *Introduction to Linear Regression Analysis* (4th ed). Wiley

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Level III - Semester 1				
Course Code	ST 3085			
Course Name	Computational Statistics			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim:				

Computational statistics refer to the computational methods that enable statistical methods. This course provides students some widely used such methods and techniques using the free and open source statistical software, R.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- generate random numbers using different distributions
- simulate data from different distributions
- apply bootstrap methods to analyze data

Course Content: (Main topics, Sub topics)

Introduction to Random numbers: pseudo random numbers, properties of random numbers, testing for basic properties, software for random number generation; Introduction to Simulation: simulation of random variables, Monte Carlo simulation methods, simulation of inventory models, simulation of queuing models; Data Re-sampling: Introduction to Bootstrap, Bootstrap estimation of Variance, Bootstrap Confidence Intervals, Introduction to EM algorithm.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	……	……

Recommended Reading:

- Givens, G. H., & Hoeting, J. A. (2012). *Computational Statistics* (2nd ed). Wiley
- Gentle, J. E (2005). *Elements of Computational Statistics*. Springer
- Efron, B., & Tibshirani, R. J. (1993). *An introduction to the bootstrap* (1st ed). Chapman and Hall/CRC

<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 3074</td></tr>
<tr><td>Course Name</td><td colspan="4">Time Series Analysis</td></tr>
<tr><td>Credit Value</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Time series analysis usually studies patterns in data evolving over time (time series data) and use these patterns to forecast the future behavior. For e.g., next month sales of a company can be forecasted by studying patterns in past sales data of that company. ST 3074 provides necessary tools and theories to study and forecast time series data.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to,

● fit suitable models for univariate time series data
● forecast univariate time series</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction: definition, types of time series, components of time series, time plot, time series decomposition, transformation, differencing, autocorrelation; Stationarity: stationary & non-stationary time series, tests for stationarity; Modelling time series: time series models, model identification, parameter estimation, diagnostic checks, forecasting.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practical sessions, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td colspan="2" rowspan="2">Details: quizzes, mid-term, other (in-classes)

..... % .....% .....20.....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

…….</td><td>Other (%) (specify)

……</td></tr>
</table>

Recommended Reading:

- Makridakis, S. G., Weelwright, S. C., & Hyndman, R. J. (1997). *Forecasting Methods and Applications* (3rd ed). Wiley
- Chatfield, C (2003). *The analysis of Time Series: An Introduction* (6th ed). Chapman and Hall/CRC
- Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Forecasting and Control* (3rd ed). Prentice Hall

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Level III - Semester 2				
Course Code	ST 3083			
Course Name	Multivariate Data Analysis			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. For eg., a heart attack may be the result of a combination of factors like excess weight, high blood pressure, high cholesterol, genetic effects, etc. etc. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. [ST 3083 provides a good theoretical as well as practical foundation for commonly used multivariate techniques].

Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to,

- analyze multivariate data and make decisions based on multivariate hypothesis tests
- apply dimension reduction methods; clustering data and discriminate new observations to pre-defined clusters

Course Content: (Main topics, Sub topics)

Review of matrix algebra; Mean and variance-covariance of a random vector; correlation matrix; Properties of multivariate normal distribution and applications; Checking for multivariate normality; Hypothesis testing using multivariate tests; MANOVA ; Principal component analysis; Factor analysis; Discriminant analysis; Cluster analysis.

Teaching /Learning Methods: Interactive lectures, practical sessions, tutorials, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Johnson, R. A., & Wichern, D. W. (2012). *Applied multivariate statistical analysis* (6th ed). Phi Learning Private Limited ● Morrison, D. F. (2004). *Multivariate statistical methods* (4th ed). Duxbury Press ● Johnson, D. E. (1998). *Applied multivariate methods for data analysts* (1st ed). Duxbury Press			

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Level III - Semester 2				
Course Code	ST 3084			
Course Name	Statistical Inference II			
Credit Value	2C			
Core/Optional	Core			
Prerequisites	ST 3051			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject ST 3084 carries a theoretical foundation for one part of this tool, namely, testing statistical hypotheses].				
Intended Learning Outcomes: Upon successful completion of the course, students will be able to, ● recognize the underlying general theory behind testing statistical hypotheses ● apply the necessary techniques to real life situations				
Course Content: (Main topics, Sub topics)				

Parametric Inference: Introduction to Hypothesis Testing, Errors, Power, Neymann-Pearson Lemma, Most Powerful Tests, Uniformly Most Powerful Tests, Likelihood Ratio Tests, Sequential Tests, Sequential Probability Ratio Test (SPRT), Wald's Identity, Average Sample Number (ASN); Distribution-free Inference: Tests of Randomness, Run Tests, One sample Location Tests for Median, Sign Test; Asymptotic Relative Efficiency (ARE); Two sample Location problem.			
Teaching /Learning Methods: Interactive lectures, practice exercises, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Mood, A.M., Graybill, F. A., & Boes, D.C. (1974). *Introduction to the Theory of Statistics* (3rd ed). McGraw-Hill ● Lindgren, B. W. (1976). *Statistical Theory* (3rd ed). Macmillan ● Hogg, R. V., & Craig, A. T. (1970). *Introduction to Mathematical Statistics* (3rd ed). Macmillan			

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Level III - Semester 2				
Course Code	ST 3082			
Course Name	Statistical Learning I			
Credit Value	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	100
Course Aim:				

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields such as biology, finance, marketing etc. ST presents some important modeling techniques and prediction techniques such as ridge regression, LASSO, elastic net, principle component regressions etc., along with relevant applications.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- explore complex data sets, select appropriate statistical techniques to solve problems involved and justify their choice
- implement these techniques using an appropriate programming language
- evaluate the results and explain the results to non-statisticians using non statistical terms

Course Content: (Main topics, Sub topics)

Introduction to statistical learning; Advanced regression model: understanding models, variable selection, validation and cross validation, Shrinkage method and ridge regression, Lasso, principal component regression and partial least squares; Resembling method: cross validation, bootstrap; Classification: understanding classification problems using logistic regression, multivariate logistic regression, and discriminant analysis.

Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations

Assessment Strategy: 4 group projects and presentations + Attendance

Continuous Assessment	Final Assessment		
……85……..%	……15…….%		
Details: quizzes, mid-term, other (group projects and presentations)	Theory (%)	Practical (%)	Other (%)(attendance)
..... % .....% .....85.....%	……..	……..	……15……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning: with Applications in R* (2013). Springer Science & Business Media

<table>
<tr><th colspan="5">Level III - Semester 2</th></tr>
<tr><td>Course Code</td><td colspan="4">ST 3013</td></tr>
<tr><td>Course Name</td><td colspan="4">Essential Mathematics for Statistics</td></tr>
<tr><td>Credit Value</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Mathematical theories such as linear algebra, matrices, calculus etc. are required for proves of most of the higher level statistical theories. ST 3013 provides those tools for students with required amount of theoretical knowledge.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion, students will be able to,

● apply basic mathematical tools in solving theoretical and practical problems in Statistics</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Linear algebra: Linear dependence, rank and the solution of homogeneous equations, characteristic polynomials, eigenvalues , eigenvectors, spectral theorem for symmetric matrices, idempotent matrices and properties, orthogonal projections, trace of a matrix and properties, positive definite/semi definite matrices, quadratic forms, differential calculus in matrix notation, direct product (kronecker)of any two matrices, generalized inverse /conditional inverse ; Calculus: Concepts of functions, limits and continuity, L'Hopital's rule, the fundamental theorem of calculus, approximation of definite integrals, Improper integrals; Series and Sequences: sequences and their convergence, series and convergence of series, power series and their convergence of radius, Taylor series and their application; Several variable calculus: functions of several variables, continuity, differentiability, derivatives, multiple integrals, change of variables</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, quizzes, assignments, discussion sessions based on the given problem set at the end of a topic.</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)		Other (%) (specify)
..... % .....% .....30.....%	…70…..	……..		……

Recommended Reading:

- Graybill, F. A. (2001). *Matrices with applications in Statistics* (2nd ed). Brooks/Cole
- Bonar, D. D., & Khoury, M.J. (2006). *Real Infinite Series* (1st ed). American Mathematical Society
- Courant, R., & John, F. (1965). *Introduction to Calculus and Analysis, Volume 1.* Springer-Verlag
- Lang, S. (1987). *Calculus of several variables* (3rd ed). Springer

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Course Content - Level IV (ST+CS)

Level IV - Semester 1				
Course Code	ST 4051			
Course Name	Scientific Writing			
Credit Value	1C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		30	20	50

Course Aim:

Scientific writing is essential for communication of scientific knowledge in the form of reports, dissertations, journal papers and thesis. It is necessary that students become more effective writers by communicating the results or findings, academically and professionally. Summarizing, literature review, writing articles, referencing and citing are the main aspects focused in this course.

Intended Learning Outcomes:

After a successful completion, students will be able to,

- search, identify, read, and analyze research articles which are relevant to their research activities
- write a quality scientific literature review for a selected research problem

Course Content: (Main topics, Sub topics)

Read and discuss text/papers for a general sense of what research is/are about, how one thinks when doing research, and what the major research activities are; Identify research articles from different areas of statistics/computer science, involving different methodologies of research, and abstract them; Select an area related to statistics, which is of particular interest to students, write a professional quality literature review for a problem of your choice.			
Teaching /Learning Methods: Interactive lectures, forums, videos, quizzes, assignments			
Assessment Strategy: at least 2 Assignments			
Continuous Assessment ……100……..%	Final Assessment ……0……%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....100.....%	Theory (%) ……..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Peer reviewed journal papers			

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Level IV - Semester 1				
Course Code	ST 4054			
Course Name	Linear Models			
Credit Value	3C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim: Linear models describe a continuous response variable as a function (linear in parameters) of one or more predictor variables. For example, we may explain credit card balance as a function (linear in parameters) of average monthly income, gender, student status etc. Linear models can be utilized to describe and				

predict the behavior of complex systems. ST 4052 provides a thorough theoretical foundation for regression and design models with aid of linear algebra.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the fundamentals of the general linear model
- distinguish between different linear models found in real life situations
- appraise the optimal estimation and inference related to different linear models

Course Content: (Main topics, Sub topics)

Elementary linear and matrix algebra: idempotent matrices, trace of matrices, generalized and conditional inverses; Solutions of linear equations; Derivatives of quadratic forms; Expectation of random matrices; Multivariate normal distribution and its properties; Distribution of quadratic forms; General linear model: optimal estimation and hypothesis testing, applications to regression model, continued application of optimal inference, design models, estimability, solving normal equations, components of variance models and mixed models

Teaching /Learning Methods: Interactive lectures, tutorials, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Graybill, F. A. (2000). *Theory and applications of the linear model.* Duxbury
- Graybill, F. A. (2001). *Matrices with Applications in Statistics* (2nd ed.). Brooks/Cole
- Christensen, R. (2013). *Plane answers to complex questions* (2nd ed.). Springer Science & Business Media

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Level IV - Semester 1	
Course Code	ST 4031
Course Name	Stochastic Processes and Application
Credit Value	3C

<table>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Stochastic processes underlie many ideas in statistics such as time series, Markov chains, Markov processes, Poisson Processes etc. Thus, Stochastic Process helps to understand the applications of Statistics in a simpler way and in a more commanding fashion. In addition, it enables to develop models for situations of interest. ST4031 provides a sound theoretical and practical foundation for stochastic processes.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of this course, students will be able to,

● recognize the properties of basic stochastic processes
● apply the knowledge of probability theory and stochastic processes to analyze problems in practice</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Generating function; Basics of Brownian motion; Poisson process; Random walks; Discrete parameter Markov Chains; Continuous parameter Markov Chains; Branching process; Birth and Death processes; Queuing processes.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, videos, tutorials, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class Assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Bailey, N. T. J. (1970). The Elements of Stochastic Processes. John Wiley
● Feller, W. (2008). An Introduction to Probability Theory and Applications (2nd ed). Wiley India Pvt. Limited
● Cox, D. R., & Miller, H. D. (1977). The Theory of Stochastic Processes. Chapman and Hall/CRC</td></tr>
</table>

- Trivedi, K. S. (2016). *Probability and Statistics with Reliability Queues and Computer Science Applications* (2nd ed). Wiley

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Level IV - Semester 1				
Course Code	ST 4052			
Course Name	Statistical Learning II			
Credit Value	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	100

Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields biology, finance, marketing etc. ST4052 presents some important classification and clustering techniques such as discriminant analysis, bagging, random forest, boosting, k-means clustering etc., along with relevant applications.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- explore complex data sets, select the relevant statistical techniques discussed to solve problems involved and justify their choice
- implement these techniques using an appropriate programming language
- evaluate the results and explain the results to non-statisticians using non statistical terms

Course Content: (Main topics, Sub topics)

Moving beyond linearity: polynomial regression, regression splines, smoothing splines; Tree-based methods: the basics of decision tree, bagging, random forest, boosting; Support Vector machines; Unsupervised learning: dimension reduction techniques, clustering

Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations

Assessment Strategy: 4 group projects and presentations + Attendance

Continuous Assessment	Final Assessment
……85……..%	……15……..%

Details: quizzes, mid-term, other (group projects and presentations) ..... % .....% .....85.....%	Theory (%) ……	Practical (%) ……	Other (%) (attendance) ……15……
Recommended Reading: ● James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning* (1st ed.). Springer-Verlag New York			

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Level IV - Semester 1				
Course Code	*ST 4013			
Course Name	Special Topics for ST+CS			
Credit Value	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				
Intended Learning Outcomes:				
Course Content: (Main topics, Sub topics) Selected topics depending on the availability of teaching staff.				
Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments				
Assessment Strategy: 2 in-class assignments + Final Exam				
Continuous Assessment	Final Assessment			

……20……..%	……80……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....20.....%	Theory (%) …80…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Depends on the topic			

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Level IV - Semester 2				
Course Code	ST 4055			
Course Name	Generalized Linear Models			
Credit Value	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150
Course Aim: Generalized Linear models describe a response variable from an exponential family as a linear function of one or more predictor variables. For example, we may have binomial, Poisson, gamma etc distribution for response variables. ST 4055 provides a thorough theoretical and practical foundation in fitting, estimating, interpreting and testing in generalized linear models.				
Intended Learning Outcomes: After a successful completion of the course, the students will be able to, ● identify and apply a suitable generalized linear model for a given dataset ● apply appropriate diagnostics to evaluate the model				
Course Content: (Main topics, Sub topics) Introduction to Statistical modeling; Exponential family and GLMs: estimation, inference; Logistic regression: binary logistic model, link function, over dispersion and bio-assay, multinomial logistic model, ordinal logistic model; Log-linear models: contingency tables, link function; comparison of logistic and log-linear models; Gamma models; Model Adequacy: residuals, outliers, lack of fit.				

Teaching /Learning Methods: Interactive classroom sessions and interactive lab sessions			
Assessment Strategy: at least 2 Assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) …… % ……% ……30……..%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Agresti, A. (2012). *Categorical Data Analysis* (3rd ed). Wiley ● Collett, D. (1991). *Modelling Binary Data* (2nd ed). Taylor & Francis ● McCullah, P., & Nelder, J. A. (1989). *Generalized Linear Models* (2nd ed). Chapman and Hall/CRC ● Aitkin, M., Anderson, D., Francis, B., & Hinde, J. (1989). *Statistical Modelling in GLIM.* Oxford University Press			

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Level IV - Semester 2				
Course Code	*ST 4040			
Course Name	Individual Project			
Credit Value	8C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		240	560	800
Course Aim: Working on a research project gives the opportunity to work closely with a faculty member who is an experienced researcher. The research project represents the concentration of interests and studies, and possibly, a real contribution to knowledge. It provides an opportunity to learn something new, to improve problem-solving skills and to challenge oneself in new ways.				

<table>
<tr><td colspan="4">Intended Learning Outcomes:

Upon successful completion of the project, the students will be able to,

● solve real world problems using appropriate theories and techniques learnt throughout the degree program
● extend and develop existing theories to solve complex statistical problems</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)</td></tr>
<tr><td colspan="4">Teaching /Learning Methods:</td></tr>
<tr><td colspan="4">Assessment Strategy: Thesis + Viva</td></tr>
<tr><td>Continuous Assessment

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

……100……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

..... % .....% .....%</td><td>Theory (%)

……..</td><td>Practical (%)

……</td><td>Other (%) (thesis and viva)

……100……</td></tr>
<tr><td colspan="4">Recommended Reading:

● Depends on the project title</td></tr>
</table>

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<table>
<tr><td colspan="5">Level IV - Semester 2</td></tr>
<tr><td>Course Code</td><td colspan="4">EC 4004</td></tr>
<tr><td>Course Name</td><td colspan="4">Industrial Training</td></tr>
<tr><td>Credit Value</td><td colspan="4">3EC</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td>Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
</table>

		90	210	300

Course Aim:

Industrial training provides first hand experience for the undergraduates to work fulltime in an organization outside the university. The main intention of the programme is to enhance their communication and teamwork skills. They will also be conducting real-time applications using the knowledge they gained at the university while improving their ability to explore new techniques.

Intended Learning Outcomes:

Upon successful completion of Industrial Training, the students will be able to,

- integrate classroom theory with workplace practice
- develop greater clarity about academic and career goals
- recognize administrative functions and company culture
- appreciate the ethical basis of professional practice in relevant industry
- display a capacity for critical reasoning and independent learning
- explore options in career plans and goals

Course Content: (Main topics, Sub topics)

Industrial training provides students to understand and appreciate real-life working experiences. Students may realize their ambition and ascertain their career path from the experience gained during industrial training. The training provides students the opportunity to meet and network with people in the industry, and for the industry the opportunity to identify talents and potential skilled employees.

Teaching /Learning Methods: 8 weeks training in an industrial placement

Assessment Strategy: Student Progress & Progress Reports +External supervisor/s+ Final Report

Continuous Assessment	Final Assessment
……50……..%	……50……..%

Details:	Theory (%)	Practical (%)		Other (%)
Student Progress & Progress Reports (25%),				Final Report (50 %)
External supervisor/s (25%)	……	……		

Recommended Reading:

- None

Course Content - Level III (IS)

<table>
<tr><td colspan="5">Level III - Semester 1</td></tr>
<tr><td>Course Code:</td><td colspan="4">IS 3001</td></tr>
<tr><td>Course Name:</td><td colspan="4">Sampling Techniques</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4">IS 1009</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

This course concentrates on the statistical aspects of taking and analyzing a sample. It gives guidance on how to design and analyze many different forms of sample surveys. [IS 3001 provides a good theoretical as well as practical foundation for sampling techniques used in practice]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● identify the sampling techniques
● effectively use (put in to practice) the sampling techniques that are commonly used in statistics</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Simple Random Sampling (SRS), Sample size determination, Ratio and Regression estimators under SRS, Stratified, Systematic, and Quota sampling. Separate and combined estimators for stratified sampling. Cluster sampling, Multi-stage sampling, Complex sample designs and related issues.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lecture, practical sessions, group work/projects, quizzes, tutorial classes, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
</table>

..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Thompson, S. K. (2002). *Sampling* (2nd ed.). John Wiley & Sons
- Som, R. K. (1995). *Practical sampling Techniques* (2nd ed.). CRC Press
- Rao, P. S. R. S., & Myron J. Katzoff, M. J. (2010). *Hand book of Sampling Techniques and Analysis* (1st ed.). CRC Press

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Level III - Semester 1				
Course Code:	IS 3050			
Course Name:	Statistical Inference			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

In data analysis, statistical inference is an essential tool to determine if an observed difference is really due to chance alone or due to some actual effect/s of a treatment/s or an agent. [The subject IS 3050 carries a theoretical foundation for one part of this tool, namely, estimation].

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- recognize the underlying theory behind statistical estimation
- apply the necessary techniques to find estimates of population parameters
- appraise the properties of estimators

Course Content: (Main topics, Sub topics)

Generating moments using characteristic function; Sampling from Normal population: sampling distributions of sample mean and sample variance (s^2), independence of sample mean and s^2; Properties of estimators: Mean-squared error, Unbiasedness, Consistency, Sufficiency, Completeness, Efficiency; Factorization criterion; Variance Reduction: Cramer-Rao Lower Bound, Rao-Blackwell Theorem,

Lehmann-Scheffe' Theorem; Methods of Estimation: Method of moments, Maximum Likelihood and Its Properties, Least Squares; Interval Estimation: Pivotal Method, General Method.			
Teaching /Learning Methods: Interactive lectures, practice exercises, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……	Other (%) (specify) ……
Recommended Reading: ● Hogg, R. V. (2018). *Introduction to Mathematical Statistics* (8th ed.). Pearson ● Lindgren, B. (1993). *Statistical Theory* (4th ed.). CRC Press ● Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* 3rd Edition (3rd ed.). McGraw-Hill			

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Level III - Semester 1				
Course Code:	IS 3051			
Course Name:	Advanced Statistical Process Control			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Traditional Shewhart's control charts are effective in detecting large shifts in a process but unable to find moderate or small size of shifts quickly. Continuing undetected processes for long periods incur much				

larger total costs than rapidly detecting large shifts. Cumulative sum (CUSUM) and exponentially weighted moving average (EWMA) control charts largely plug this gap, leading to much more effective process monitoring. Apart from the control charts Process and gauge capability and acceptance sampling schemes will be discussed.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- perform analysis of process capability and measurement system capability
- design, use, and interpret cumulative sum control chart control charts
- design, use, and interpret exponentially weighted moving average control charts
- demonstrate the ability to design, use, and interpret operating characteristic curve
- demonstrate the ability to use acceptance sampling for statistical process control

Course Content: (Main topics, Sub topics)

Process and measurement system capability analysis, Cumulative sum control charts, Exponentially weighted moving average control charts, Univariate process monitoring and control systems, Multivariate process monitoring and control systems, Attribute type sampling schemes, Variable type sampling schemes, Taguchi method.

Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…80…..	……	……

Recommended Reading:

- Montgomery, D C. (2009*). Introduction to Statistical Quality Control*. (6th ed.). John Wiley and Sons, Inc.
- Amitava, M (2001). *Fundamentals of Quality Control and Improvement*, (3rd ed.)., Wiley and Sons, Inc.,
- Ryan, T.P. (2011). *Statistical Methods of Quality Improvement*, (3rd ed)., John Wiley & Sons

<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">ST 3006</td></tr>
<tr><td>Course Name:</td><td colspan="4">Regression Analysis</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Regression Analysis is essential when relationships between and among variables are to be studied. Here we focus on developing linear models (both simple and multiple) relating a response variable and one or more other variables. Both quantitative and qualitative variables are considered as explanatory variables. Methods for fitting models, model estimation, interpretation, and model diagnostics are also practiced.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

● analyze relationships among variables for a given situation, using equations or regression models
● carryout appropriate diagnostic tests to validate the model
● interpret and analyze the models that fit the data well</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to regression, Correlation, Uses of regression, Simple linear regression model, Parameter estimation, inferences about the model and prediction, Goodness of fit testing, Residual analysis, Multiple regression.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)</td><td>Theory (%)</td><td>Practical (%)</td><td colspan="2">Other (%) (specify)</td></tr>
</table>

..... % .....% .....30.....%	…70…..	……	……

Recommended Reading:

- Atkinson, A. C. (1985). *Plots, Transformations, and Regression*. Oxford
- Cook, R.D. & Weisberg, S. (1982) *Residuals and Influence in Regression*, Chapman & Hall.
- Draper, N. R. and Smith, H. (1981) *Applied Regression Analysis*. (2nd ed.). New York: Wiley & Sons.
- Draper, N.R. and Smith, H. (1998). *Applied Regression Analysis*, (3rd ed.). New York: John Wiley & Sons.
- Mead, R. and Curnow, R.N. (1993). *Statistical methods in agriculture and experimental biology*. Chapman & Hall

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Level III - Semester 1				
Course Code:	ST 3074			
Course Name:	Time Series Analysis			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Time series analysis usually studies patterns in data evolving over time (time series data) and use these patterns to forecast the future behavior. For e.g., next month sales of a company can be forecasted by studying patterns in past sales data of that company. ST 3074 provides necessary tools and theories to study and forecast time series data.

Intended Learning Outcomes:

Upon the successful completion of the course, students will be able to,

- fit suitable models for univariate time series data
- forecast univariate time series

Course Content: (Main topics, Sub topics)

Introduction: definition, types of time series, components of time series, time plot, time series decomposition, transformation, differencing, autocorrelation; Stationarity: stationary & non-stationary time series, tests for stationarity; Modelling time series: time series models, model identification, parameter estimation, diagnostic checks, forecasting.

Teaching /Learning Methods: Interactive lectures, practical sessions, assignments			
Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……20……..%	Final Assessment ……80……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....20.....%	Theory (%) …80…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Makridakis, S. G., Weelwright, S. C., & Hyndman, R. J. (1997). *Forecasting Methods and Applications* (3rd ed). Wiley ● Chatfield, C (2003). *The analysis of Time Series: An Introduction* (6th ed). Chapman and Hall/CRC ● Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Forecasting and Control* (3rd ed). Prentice Hall			

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Level III - Semester 1				
Course Code:	ST 3085			
Course Name:	Computational Statistics			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: Computational statistics refer to the computational methods that enable statistical methods. This course provides students some widely used such methods and techniques using the free and open source statistical software, R.				
Intended Learning Outcomes: After a successful completion of the course, students will be able to,				

- generate random numbers using different distributions
- simulate data from different distributions
- apply bootstrap methods to analyze data

Course Content: (Main topics, Sub topics)

Introduction to Random numbers: pseudo random numbers, properties of random numbers, testing for basic properties, software for random number generation; Introduction to Simulation: simulation of random variables, Monte Carlo simulation methods, simulation of inventory models, simulation of queuing models; Data Re-sampling: Introduction to Bootstrap, Bootstrap estimation of Variance, Bootstrap Confidence Intervals, Introduction to EM algorithm.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Givens, G. H., & Hoeting, J. A. (2012). *Computational Statistics* (2nd ed). Wiley
- Gentle, J. E (2005). *Elements of Computational Statistics*. Springer
- Efron, B., & Tibshirani, R. J. (1993). *An introduction to the bootstrap* (1st ed). Chapman and Hall/CRC

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Level III - Semester 1				
Course Code:	MS 3002			
Course Name:	Advanced Marketing Research			
Credit Value:	1C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional

	15		35	50

Course Aim:

Quantitative methods are widely used in marketing research where inferences provide key insights to companies. MS 3002 provides an understanding of the advanced quantitative and qualitative methodologies of data analysis in marketing research.

Intended Learning Outcomes:

After the successful completion of the course, the students will be able to,

- analyze the data in marketing research, understanding the advanced quantitative and qualitative methodologies
- evaluate the options available to analyze data gathered from a marketing research process
- apply the data analysis methodologies in a practical scenario

Course Content: (Main topics, Sub topics)

Media Research: Methods of collecting data, Measurements, Media planning, Planning Software, evaluating media schedules (e.g. GRP), Advertising media models, Pricing Research: Types of pricing models (e.g. BPTO), Test Marketing, Simulated Test Marketing, Data Fusion, Application of Multivariate techniques to Marketing (factor, cluster), Application of General Linear Models in Marketing, Conjoint Analysis, Correspondence Analysis

Teaching /Learning Methods: Interactive lectures, group work and presentations

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	…….	……

Recommended Reading:

- Lehmann, D. R., Gupta, S., & Steckel, J. H. (2007). *Marketing Research.* Pearson Education
- Stout, G. R., Fox R. J. & Crask, M.(1997). *Marketing Research*. Prentice Hall
- Aakar, D. A. (2011). *Marketing Research* (10th ed.). Wiley

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<table>
<tr><th colspan="5">Level III - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">MS 3009</td></tr>
<tr><td>Course Name:</td><td colspan="4">Operational Research II</td></tr>
<tr><td>Credit Value:</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td>30</td><td>90</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Mangers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision making activities in an optimum way. [MS3009 is a continuation of MS1003 that extends the theoretical and practical knowledge on operational research techniques]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● describe the fundamental concepts of real world applications in operational research and model decision making problems
● solve the formulated model/s using appropriate techniques and software packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Network Models (Minimal Spanning Tree algorithm, algorithms for Shortest-Route problem, Maximal Flow model), Project Planning (Critical Path Method, Programming Evaluation and Review Technique), Inventory Models (Deterministic inventory models with shortages and without shortages, Probabilistic Inventory models), Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models), Solution techniques using suitable OR packages.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practical sessions, videos, group work, presentation, tutorial classes, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td colspan="2" rowspan="2">Details: quizzes, mid-term, other (in-classes)</td><td>Theory (%)</td><td>Practical (%)</td><td>Other (%) (specify)</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

..... % .....% .....30.....%	…70…..	……..	……

Recommended Reading:

- Taha, H. A. (2016). *Operational Research: An Introduction* (10th ed.). Pearson
- Verma, A. P. (2009). *Operations Research* (3rd ed). S. K. Kataria & Sons
- Panneerselvam, R. (2006) *Operations Research* (2nd ed.). PHI Learning Pvt. Ltd.
- Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall
- Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill

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Level III - Semester 2				
Course Code:	IS 3003			
Course Name:	Special Topics I			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim:				
Intended Learning Outcomes:				
Course Content: (Main topics, Sub topics) Selected topics depending on the availability of teaching staff.				
Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments, group activities				
Assessment Strategy: 2 in-class assignments + Final Exam				
Continuous Assessment ……20……..%	Final Assessment ……80……..%			
Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)	

..... % .....% .....20.....%	…80…..	…….	……
Recommended Reading: ● Depends on the subject			

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Level III - Semester 2				
Course Code:	IS 3052			
Course Name:	Advanced Topics in Experimental Design			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: If one wants to establish cause and effect relationship in experimentation, one needs to have an experiment statistically designed. [IS 3052 provides an in-depth knowledge on this aspect with industrial applications on several commonly used statistical designs].				
Intended Learning Outcomes: After a successful completion of the course, the students will be able to, ● recognize suitable experimental designs for given situations ● analyze experimental data using proper techniques				
Course Content: (Main topics, Sub topics) Treatment comparisons; Factorial treatment designs; $\mathbf{2}^{\boldsymbol{k}}$ and $\mathbf{3}^{\boldsymbol{k}}$ experiments with examples; Confounding and partial confounding; Fractional replication; Response surface designs; Split plot designs, repeated measure designs.				
Teaching /Learning Methods: Interactive lectures, tutes, assignments				
Assessment Strategy: 2 in-class assignments + Final Exam				
Continuous Assessment	Final Assessment			

……30……..%	……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……	Other (%) (specify) ……
Recommended Reading: ● Montgomery, D. C. (2001). *Design and Analysis of Experiments* (5th ed.). John Wiley &sons ● Kuehl, R. O. (1999). *Design of Experiments: Statistical Principles of Research Design and Analysis* 2nd ed.). Duxbury Press ● Box, G. E. P., Hunter, W. G., & Hunter, J. S. (1978). *Statistics for experiments: An introduction to design, data analysis and model building*. Wiley			

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Level III - Semester 2				
Course Code:	IS 3053			
Course Name:	Data Mining Techniques			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100
Course Aim: Data Mining is the process of discovering patterns and relationships in large volumes of data, therein has applications in multiple fields of Science. The subject consists of a combination of tools from Statistics, Machine Learning and Database Management that can be used for this process.				
Intended Learning Outcomes: Upon the successful completion of the course, students will be able to, ● discover the hidden pattern in data				

<table>
<tr><td colspan="4">

- apply the widely used data mining techniques and do prediction/classification based on the discovered patterns

</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Introduction to Data Mining(DM); Introduction to a DM software (Matlab); Selected DM Techniques: Neural Networks, Classification & Regression Trees, Support Vector Machines, K-Nearest Neighbours Algorithm, K-means clustering.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive lectures, practical sessions, group projects, presentations, assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: 3 in-class assignments</td></tr>
<tr><td colspan="2">Continuous Assessment

……100……..%</td><td colspan="2">Final Assessment

……0……%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....100.....%</td><td>Theory (%)

…0…..</td><td>Practical (%)

…….</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

- Kamber, M., & Han, J. (2011). *Data mining: Concepts and Techniques* (3rd ed.). Elsevier
- Larose, D. T., (2005). Discovering knowledge in data: An Introduction to Data Mining. John Wiley and Sons
- Berry, M. J. A., & Linoff, G. S. (2008*). Mastering data mining: The art of science of customer relationship management*. Wiley India Pvt. Limited
- Keedwell, E. & Narayanan, A. (2005). *Intelligent Bioinformatics*. John Wiley & Sons</td></tr>
</table>

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Level III - Semester 2	
Course Code:	ST 3082
Course Name:	Statistical Learning I
Credit Value:	2C
Core/Optional	Core

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>60</td><td>40</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields such as biology, finance, marketing etc. ST presents some important modeling techniques and prediction techniques such as ridge regression, LASSO, elastic net, principle component regressions etc., along with relevant applications.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of this course, student will be able to,

● explore complex data sets, select appropriate statistical techniques to solve problems involved and justify their choice
● implement these techniques using an appropriate programming language
● evaluate the results and explain the results to non-statisticians using non statistical terms</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Introduction to statistical learning; Advanced regression model: understanding models, variable selection, validation and cross validation, Shrinkage method and ridge regression, Lasso, principal component regression and partial least squares; Resembling method: cross validation, bootstrap; Classification: understanding classification problems using logistic regression, multivariate logistic regression, and discriminant analysis.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations</td></tr>
<tr><td colspan="5">Assessment Strategy: 4 group projects and presentations + Attendance</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……15……%</td></tr>
<tr><td>Details: quizzes, mid-term, other (group projects and presentations)

..... % .....% .....85.....%</td><td>Theory (%)

……..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (attendance)

……15……</td></tr>
<tr><td colspan="5">Recommended Reading:

● James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An Introduction to Statistical Learning: with Applications in R (2013). Springer Science & Business Media</td></tr>
</table>

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<table>
<tr><td colspan="5">Level III - Semester 2</td></tr>
<tr><td>Course Code:</td><td colspan="4">ST 3083</td></tr>
<tr><td>Course Name:</td><td colspan="4">Multivariate Data Analysis</td></tr>
<tr><td>Credit Value:</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. For eg., a heart attack may be the result of a combination of factors like excess weight, high blood pressure, high cholesterol, genetic effects, etc. etc. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. [ST 3083 provides a good theoretical as well as practical foundation for commonly used multivariate techniques].</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

● analyze multivariate data and make decisions based on multivariate hypothesis tests
● apply dimension reduction methods; clustering data and discriminate new observations to pre-defined clusters</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Review of matrix algebra; Mean and variance-covariance of a random vector; correlation matrix; Properties of multivariate normal distribution and applications; Checking for multivariate normality; Hypothesis testing using multivariate tests; MANOVA ; Principal component analysis; Factor analysis; Discriminant analysis; Cluster analysis.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practical sessions, tutorials, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Johnson, R. A., & Wichern, D. W. (2012). *Applied multivariate statistical analysis* (6th ed). Phi Learning Private Limited
- Morrison, D. F. (2004). *Multivariate statistical methods* (4th ed). Duxbury Press
- Johnson, D. E. (1998). *Applied multivariate methods for data analysts* (1st ed). Duxbury Press

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Level III - Semester 2				
Course Code:	MS 3004			
Course Name:	Quality Management/Project Management			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

To be employed as a statistician or data scientist, the students should possess managerial skills also such as organizational environment, feasibility analysis, risk management, human resource management etc. MS 3004 provides those tools with some theoretical knowledge and practical examples.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- inspect, manage, control and evaluate the quality of a process
- perform planning, Risk management, Time management, realization, completion, evaluation and transformation of a project

Course Content: (Main topics, Sub topics)

Total Quality Management (TQM) and Quality Management Systems, Tools and Techniques, TQM Through Continuous Improvement, Quality Functions, Economics of quality, Quality management and ethics, Management Role in TQM, Quality Assurance and Quality Cost Analysis; **Project Management:** Phases of the Project Management Life Cycle, Key activities of project close-out , Budgetary considerations Elements of a successful Risk Management Plan, Project reporting tools, Techniques for

creating a project plan, Work Breakdown Structure, Network Logic diagram, and Critical Path analysis , Creating a strong project team			
Teaching /Learning Methods: Interactive lectures, group presentation, quizzes and assignments			
Assessment Strategy: At least 1 case study + presentation + Final exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (case study + presentation) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Evans, J. R., & Lindsay, W. M. (2002). The Management and Control of Quality (5th ed.). South-Western ● Montgomery, D. C. (2008). *Introduction to Statistical Quality Control* (6th ed). Wiley (chapters from 7 to 15) ● Juran, J. M. & Gryna, F. M. (1993*) Quality Planning and Analysis* (1993). ● Goetsch, D. L. & Davis, S. (2006) *Quality Management* (3rd ed.). Prentice Hall			

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Level IV - Semester 1				
Course Code:	IS 4002			
Course Name:	Advanced Statistical Modeling			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150
Course Aim:				

Statistical models are useful tools for determining factors or variables which are most associated with the behaviour of a process. Complexity of these models increase as the relationship of the variables become non-linear or with the inherent distribution of the response variable deviate from the usual normal distribution and for correlated responses. IS 4002 introduces the theory and application of generalized linear models and mixed models.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- identify and apply a suitable statistical model for a given dataset
- apply appropriate diagnostics to evaluate the model

Course Content: (Main topics, Sub topics)

Introduction to statistical modeling; Exponential family of distributions; Generalized linear models: link function, parameter estimation and inferences, hypothesis testing, diagnostics, and adequacy; Logistic regression and over dispersion; multinomial regression; Poisson regression; Mixed models.

Teaching /Learning Methods: Interactive lectures, videos, tutes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment		
……20……..%	……80……..%		
Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	…….	……

Recommended Reading:

- Agresti, A. (2003). *Categorical Data Analysis* (2nd ed.). John Wiley & Sons
- Collet, D. (2002). *Modeling Binary Data* (2nd ed.). CRC Press
- McCullah, P. & Nelder, J. A. (1989) *Generalized Linear Models* (2nd ed.). CRC Press
- Aitkin, M., Anderson, D., Francis, B., & Hinde, J.(1989). *Statistical Modelling in GLIM*. Clarendon Press

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<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">IS 4003</td></tr>
<tr><td>Course Name:</td><td colspan="4">Special Topics II</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Selected topics depending on the availability of teaching staff.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive classroom sessions</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td rowspan="2">Details: quizzes, mid-term, other (in-classes)

..... % .....% .....20.....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="5">Recommended Reading:

● Depends on the topic</td></tr>
</table>

<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">ST 4011</td></tr>
<tr><td>Course Name:</td><td colspan="4">Econometrics</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Analysis of economic and financial data requires the formulation of a unique methodological framework. ST 4011 provides the theoretical as well as a practical foundation for the students to analyze and make accurate projections of economic and financial data.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● apply statistical methods in the context of economics
● carry out a successful econometric analysis</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Linear regression model and properties of least squares estimates; Autocorrelation; Heteroscedasticity; Multicollinearity; Model specification; Simultaneous equations; Unit roots, Non- stationary and Cointegration.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……80……..%</td></tr>
<tr><td rowspan="2">Details: quizzes, mid-term, other (in-classes)

..... % .....% .....20.....%</td><td>Theory (%)

…80…..</td><td>Practical (%)

……..</td><td colspan="2">Other (%) (specify)

……</td></tr>
</table>

Recommended Reading:

- Pindyck, R. S., & Rubinfeld, D. L. (1998). *Econometric Model and Economic Forecasts* (4th ed). Irwin/McGraw-Hill
- Wooldridge, J. M. (2015). *Introductory Econometrics: A Modern Approach* (6th ed). Cengage Learning
- Greene, W.H. (2012). *Econometric Analysis* (7th ed). Pearson Education
- Johnston, J., & DiNardo, J. (1996). *Econometric Methods* (4th ed). McGraw-Hill/Irwin

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Level IV - Semester 1				
Course Code:	ST 4031			
Course Name:	Stochastic Processes and Application			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Stochastic processes underlie many ideas in statistics such as time series, Markov chains, Markov processes, Poisson Processes etc. Thus, Stochastic Process helps to understand the applications of Statistics in a simpler way and in a more commanding fashion. In addition, it enables to develop models for situations of interest. ST4031 provides a sound theoretical and practical foundation for stochastic processes.

Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

- recognize the properties of basic stochastic processes
- apply the knowledge of probability theory and stochastic processes to analyze problems in practice

Course Content: (Main topics, Sub topics)

Generating function; Basics of Brownian motion; Poisson process; Random walks; Discrete parameter Markov Chains; Continuous parameter Markov Chains; Branching process; Birth and Death processes; Queuing processes.

Teaching /Learning Methods: Interactive lectures, videos, tutorials, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……

Recommended Reading:

- Bailey, N. T. J. (1970). *The Elements of Stochastic Processes*. John Wiley
- Feller, W. (2008). *An Introduction to Probability Theory and Applications* (2nd ed). Wiley India Pvt. Limited
- Cox, D. R., & Miller, H. D. (1977). *The Theory of Stochastic Processes.* Chapman and Hall/CRC
- Trivedi, K. S. (2016). *Probability and Statistics with Reliability Queues and Computer Science Applications* (2nd ed). Wiley

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Level IV - Semester 1				
Course Code:	ST 4035			
Course Name:	Data Science			
Credit Value:	3C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150

Course Aim:

Data science is an interdisciplinary field that uses scientific techniques and algorithms to extract information from data. The course is designed to provide students in depth knowledge of data analysis techniques in data science.

Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

- apply basic techniques of Data Science for decision making

Course Content: (Main topics, Sub topics)

Introduction; Ethics; Data Wrangling & Pre-processing; How to deal with large data sets: Parallel computing, Map reduce framework – Hadoop; Data Communication & Visualization; Statistical Methods: Regression, Logistic Regression, Random Forest, Support Vector Machines; Machine Learning Algorithms.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments, group activities			
Assessment Strategy: At least 2 In-class assignments and 1 group project + Final Exam			
Continuous Assessment ……50……..%	Final Assessment ……50……..%		
Details: in-classes, mid-term, other (group projects) .....30... % .....% .....20.....%	Theory (%) …50…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● James, G., Witten, D., Hastie, T., & Tibshirani, R. (2014). *An Introduction to Statistical Learning: With Applications in R.* Springer New York ● Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* (2nd ed). Springer ● Leskovec, J., Rajaraman, A., & Ullman, J. (2014). *Mining Massive Data Sets* (2nd ed). Cambridge University Press ● Provost, F., & Fawcett, T. (2013). *Data Science for Business: What you need to know about data mining and data-analytic thinking* (2nd ed). O'Reilly Media			

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Level IV - Semester 1				
Course Code:	ST 4036			
Course Name:	Time to Event Analysis			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Analysis of duration data is complicated due to the presence of censored observations arising from the non-occurred events in the data. Therefore, specialized methods of analysis are available for analyzing such				

duration data. [ST 4036 provides a fundamental theoretical foundation as well as a practical foundation on statistical methods for analyzing duration data].

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- explain characteristics of time to event data
- identify suitable distributions for time to event data
- describe time to event data using suitable parametric and non-parametric measures
- analyze time to event data using parametric models and non-parametric regression models
- calculate sample sizes
- analyze and interpret time to event data using statistical package/s

Course Content: (Main topics, Sub topics)

Characteristics of time to event data, Distributions for time to event data, Non-parametric methods, Parametric regression, Hazard regression, Power analysis and sample size calculation, fitting parametric and semi parametric models, analysis of time to event data using SAS/R.

Teaching /Learning Methods: Interactive lectures, case studies, tutorials, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment		
……30……..%	……70……..%		
Details: quizzes, mid-term, other (sin-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	……..	……

Recommended Reading:

- Hosmer, D.W., Lemeshow S., & May, S. (2011). *Regression modeling of time to event data* (2nd ed). John Wiley & Sons
- Collet, D. (2015). *Modeling Survival Data in Medical Research* (3rd ed). CRC Press
- Cox, D. R., & Oakes, D. (1984). *Survival Analysis* .Chapman & Hall

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Level IV - Semester 1	
Course Code:	ST 4051
Course Name:	Scientific Writing

<table>
<tr><td>Credit Value:</td><td colspan="4">1C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>30</td><td>20</td><td>50</td></tr>
<tr><td colspan="5">Course Aim:

Scientific writing is essential for communication of scientific knowledge in the form of reports, dissertations, journal papers and thesis. It is necessary that students become more effective writers by communicating the results or findings, academically and professionally. Summarizing, literature review, writing articles, referencing and citing are the main aspects focused in this course.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

● search, identify, read, and analyze research articles which are relevant to their research activities
● write a quality scientific literature review for a selected research problem</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Read and discuss text/papers for a general sense of what research is/are about, how one thinks when doing research, and what the major research activities are; Identify research articles from different areas of statistics/computer science, involving different methodologies of research, and abstract them; Select an area related to statistics, which is of particular interest to students, write a professional quality literature review for a problem of your choice.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, forums, videos, quizzes, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 2 assignments</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……0……..%</td></tr>
<tr><td colspan="2" rowspan="2">Details: quizzes, mid-term, other (in-classes)

..... % .....% .....100.....%</td><td>Theory (%)

……..</td><td>Practical (%)

……..</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="5">Recommended Reading:

● Peer reviewed journal papers</td></tr>
</table>

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<table>
<tr><th colspan="5">Level IV - Semester 1</th></tr>
<tr><td>Course Code:</td><td colspan="4">ST 4052</td></tr>
<tr><td>Course Name:</td><td colspan="4">Statistical Learning II</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>60</td><td>40</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Statistical learning provides an essential modern toolset to analyze vast and complex data sets that have emerged in fields biology, finance, marketing etc. ST4052 presents some important classification and clustering techniques such as discriminant analysis, bagging, random forest, boosting, k-means clustering etc., along with relevant applications.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon completion of this course, student will be able to,

● explore complex data sets, select the relevant statistical techniques discussed to solve problems involved and justify their choice
● implement these techniques using an appropriate programming language
● evaluate the results and explain the results to non-statisticians using non statistical terms</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Moving beyond linearity: polynomial regression, regression splines, smoothing splines; Tree-based methods: the basics of decision tree, bagging, random forest, boosting; Support Vector machines; Unsupervised learning: dimension reduction techniques, clustering</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, videos, group projects, viva, presentations</td></tr>
<tr><td colspan="5">Assessment Strategy: 4 group projects and presentations + Attendance</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……15……..%</td></tr>
</table>

Details: quizzes, mid-term, other (group projects and presentations)	Theory (%)	Practical (%)	Other (%) (attendance)
..... % .....% .....85.....%	……	……..	……15……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning* (1st ed.). Springer-Verlag New York

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Level IV - Semester 1				
Course Code:	MS 4007			
Course Name:	Risk Management			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

The knowledge on capital markets, financial markets and risks involved in management decisions are key concepts for those who work in industries. This course provides the fundamentals of such topics that are required by the statisticians.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- update with current trends, capital markets and risk management
- adapt easily to the corporate environment

Course Content: (Main topics, Sub topics)

Introduction to Capital Markets; Types of financial markets: (debt, equity and derivatives); Introduction to Financial Instruments: (debt, equity and derivatives), Introduction to Time Value of money and interest rates, Risk and Risk aversion, Financial ratios, Portfolio risk, Capital allocation, Market Risk Management, Operational risk, Financial crisis Business case studies and presentations.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorial classes, assignments, case study, group presentations,individual viva			
Assessment Strategy: Business case studies and presentation(at least 1 each) + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (business case study and presentation) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……	Other (%) (specify) ……
Recommended Reading: ● Mishkin, F. S., & Eakins, S. G. (2006). *Financial markets and Institutions* (5th ed). Pearson education ● Hull, J. C. (2017). *Options, Futures, and Other Derivatives* (10th ed). Pearson Education			

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Level IV - Semester 1				
Course Code:	MS 4008			
Course Name:	Industrial Psychology			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				

To be a steady person in the industry, anyone needs some knowledge and skills on organizational behavior, leadership and group behavior skills etc.. This course is designed with the aims of enhancing such skills and career development interfaces for industry personnel.
Intended Learning Outcomes: Upon successful completion of the course, students will be able to, ● apply concepts of psychology in an industrial context to further their career goals and successful work-life balance
Course Content: (Main topics, Sub topics) Introduction to Psychology, Organizational Behavior, Leadership & Group Behavior, Psychological Assessments, Work Motivation and Job Designing, Diversity and Issues in Organizations, Psychology of HRM & Ergonomics, Conflicts at Work & Stress, Career Development/Work –Life Interface.
Teaching /Learning Methods: Interactive lectures, forums, videos, quizzes, assignments
Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:
● Levy, P. (2009). *Industrial/Organizational Psychology* (3rd ed). Worth Publishers

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Level IV - Semester 2	
Course Code:	IS 4011
Course Name:	Professional Practice
Credit Value:	4C
Core/Optional	Core

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>120</td><td>280</td><td>400</td></tr>
<tr><td colspan="5">Course Aim:

Industrial training provides first hand experience for the undergraduates to work fulltime in an organization outside the university. The main intention of the programme is to enhance their communication and teamwork skills. They will also be conducting real-time applications using the knowledge they gained at the university while improving their ability to explore new techniques.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of Industrial Training, the student will be able to,

● integrate classroom theory with workplace practice
● develop greater clarity about academic and career goals
● recognize administrative functions and company culture
● appreciate the ethical basis of professional practice in relevant industry
● display a capacity for critical reasoning and independent learning
● explore options in career plans and goals</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Industrial training provides students to understand and appreciate real-life working experiences. Students may realize their ambition and ascertain their career path from the experience gained during industrial training. The training provides students the opportunity to meet and network with people in the industry, and for the industry the opportunity to identify talents and potential skilled employees.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: 3 months training in an industrial placement</td></tr>
<tr><td colspan="5">Assessment Strategy: Student Progress & Progress Reports + External supervisor/s + Final Report + Final Presentation.</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……50……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

Student Progress & Progress Reports (25%)

External supervisor/s (25%)</td><td>Theory (%)

……..</td><td>Practical (%)</td><td colspan="2">Other (%)

Final Report (25 %)

Final Presentation (25 %)

……</td></tr>
</table>

		……	
Recommended Reading: ● None			

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Level IV - Semester 2				
Course Code:	IS 4006			
Course Name:	Individual Project			
Credit Value:	8C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		240	560	800
Course Aim: Working on a research project gives the opportunity to work closely with a faculty member who is an experienced researcher. The research project represents the concentration of interests and studies, and possibly, a real contribution to knowledge. It provides an opportunity to learn something new, to improve problem-solving skills and to challenge oneself in new ways.				
Intended Learning Outcomes: Upon successful completion of the project, the students will be able to, ● solve real world problems using appropriate theories and techniques learnt throughout the degree program ● extend and develop existing theories to solve complex statistical problems				
Course Content: (Main topics, Sub topics)				
Teaching /Learning Methods:				
Assessment Strategy: Thesis + Viva				
Continuous Assessment	Final Assessment			

……..%	……100…….%		
Details: quizzes, mid-term, other (specify) ..... % .....% .....%	Theory (%) ……..	Practical (%) ……	Other (%) (thesis and viva) ……100……
Recommended Reading: ● Depends on the project title			

Applied Statistics Honours Degree (Industry Orientation)

Level Three

	Pre Req	Course Unit	Title	Credit	Hours	PS	IS
SI		ST 3007	Operational Research	3	45L	o	
SI	ST 2010	ST 3008	Applied Statistical Models	3	30L 30P	x	x
SI		ST 3009	Applied Time Series	2	30L	x	x
SI		ST 3010	Introduction to Health Statistics	2	15L 30P	o	o
SI	IS 1009/ ST 1011	IS 3001	Sampling Techniques	2	30L	x	x
SI		CS 3008	Introduction to Data Structures & Algorithms	3	30L 30P	x	x
SI		MS 3009	Operational Research II	3	30L 30P		o
SI	CS 1001	IT 3003	Advanced Programming Techniques	3	30L 30P	x	x
SII		ST 3011	Statistical Programming	2	60P	x	x
SII	ST 2008/ MS2001	ST 3012	Statistical Process Control	2	30L	o	o
SII		ST 3013	Essential Mathematics for Statistics	3	45L	x	x
SII		IS 3004	Applied Multivariate Methods	2	30L	x	x
SII		IS 3005	Statistics in Practice I	3	90P	x	x
SII		MS 3004	Quality Management/Project Management	2	30L	o	o
SII		IT 3002	Database Systems	3	30L 30p	x	x

Level Four

	Pre Req	Course Unit	Title	Credit	Hours	PS	IS
SI		ST 4011	Econometrics	2	30L	x	x
SI	CS 3008	ST 4035	Data Science	3	30L 30P	x	x
SI		ST 4036	Time to Event Analysis	2	30L	x	x
SI	ST 3010	ST 4037	Epidemiology	2	30L	o	o
SI		IS 4007	Statistics in Practice II	3	90P	x	x
SI		MS 4007	Risk Management	2	30L	o	o
SI		MS 4008	Industrial Psychology	2	30L	x	x
SI		IT 4004	Advanced Database Systems	3	30L 30P	x	x
SI	CS 2002	IT 4005	Advanced Software Engineering	3	30L 30P	o	o
SII		IS 4009	Industrial Training	6	180P	x	x
SII		IS 4010	Industrial Research Project	6	180P	x	x

Course Content - Level III (APST)

<table>
<tr><td colspan="5">Level III - Semester 1</td></tr>
<tr><td>Course Code:</td><td colspan="4">ST 3007</td></tr>
<tr><td>Course Name:</td><td colspan="4">Operational Research</td></tr>
<tr><td>Credit Value:</td><td colspan="4">3C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Optional (PS only)</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>45</td><td></td><td>105</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Managers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision-making activities in an optimum way. [ST3007 provides a good foundation about some of the widely used operational research techniques]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to:

● describe the fundamental concepts of real world applications in operational research
● model decision making problems
● solve the formulated model/s using appropriate techniques and software packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Integer Programming models and solution techniques (Cutting Plane algorithm, Branch-and-Bound algorithm), Zero-one Programming models (mind expanding problems),Transportation models and solution techniques (North-West Corner method, Least Cost method, Vogel's Approximation method, U-V Method), Assignment models and solution techniques(Hungarian method), Inventory Models (Deterministic inventory models with shortages and without shortages),Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models),Solution techniques using suitable OR packages.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes</td></tr>
<tr><td colspan="5">Assessment Strategy: 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) .....70.....	Practical (%) ……	Other (%) (specify) ……

Recommended Reading:

- Taha, H. A. (2016). *Operational Research: An Introduction* (10th ed.). Pearson
- Verma, A. P. (2009). *Operations Research* (3rd ed). S. K. Kataria & Sons
- Panneerselvam, R. (2006) *Operations Research* (2nd ed.). PHI Learning Pvt. Ltd.
- Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall
- Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill

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Level III - Semester 1				
Course Code:	ST 3008			
Course Name:	Applied Statistical Models			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites	ST 2010			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150

Course Aim:

Statistical models describe a response variable as a function of one or more predictor variables. The response variable can have any type of distribution for example, normal, binomial, Poisson etc. The predictors can be either categorical or continuous, also random effects or fixed effects. ST 3008 provides some theoretical foundation and thorough practical knowledge on regression, GLMs, nonlinear models and mixed effects models.

Intended Learning Outcomes:

After successful completion of the course, the students will be able to,

- analyze and interpret categorical and continuous data using appropriate linear and non-linear models using SAS/R
- validate the fitted models using appropriate model diagnostic tools

Course Content: (Main topics, Sub topics)

Introduction to modeling. Continuous models with fixed effects: Simple Linear Regression, Multiple Linear Regression, Non Linear Regression. Data categorization. Contingency table analysis. Categorical models with fixed effects: log linear models, logistic models, Polytomous regression, Ordinal response models, Nominal response models, Analysis of categorical data using a SAS/R, Interpreting parameter estimates, Goodness of fit test. Introduction to random effects and mixed models.				
Teaching /Learning Methods: Interactive lectures, practical sessions, tutorials, in-class assignments, group projects, presentations				
Assessment Strategy: 2 in-class assignments + 1 Case studies/ Group project + Final exam				
Continuous Assessment ……30……..%	Final Assessment ……70……..%			
Details: quizzes, mid-term, other (case study/ group project) ..... % .....20.....% .....10..... %	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……	
Recommended Reading: ● Chatterjee, S., & Hadi, *A*. S. (2006). *Regression Analysis by Example* (4th ed.). John Wiley & Sons ● Agresti, A. (2003). *Categorical Data Analysis* (2nd ed.). John Wiley & Sons ● Dobson, A.J., & Barnett, A. (2008). *An introduction to Generalized Linear Models* (3rd ed.). Taylor & Francis ● Brown, H., & Prescott, R. (2015). *Applied Mixed Models in Medicine* (3rd ed.). John Wiley & Sons ● Collet, D. (2002). *Modeling Binary Data* (2nd ed.). CRC Press				

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Level III - Semester 1				
Course Code:	ST 3009			
Course Name:	Applied Time Series			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional

	30		70	100

Course Aim:

Most of the real-life processes are time related. This course is designed to provide students univariate time series techniques and models in an applied setting.

Intended Learning Outcomes:

After successful completion of the course the students will be able to,

- Fit the appropriate univariate time series models
- Forecast using the fitted models

Course Content: (Main topics, Sub topics)

Introduction: Areas of application, Objectives of time series analysis, Components of time series, Descriptive analysis. Distributional properties: Independence, Autocorrelation, Stationary. Probability models to time series: Random walk, Autoregressive model. Moving Average model, mixed models, parameter estimation, Diagnostics. Forecasting: Optimal forecasts, Forecasts for ARMA models, Exponential Smoothing forecasting method.

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, quizzes, tutorial classes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% ...20.....%	…80…..	…….	……

Recommended Reading:

- Makridakis, S. G., Hyndman, R. J., & Wheelwright, S. C. (1998). *Forecasting: Methods and Applications* (3rd ed.). Wiley
- Chatfield, C. (2016). *The Analysis of Time Series: An Introduction* (6th ed.). CRC Press
- Box, G. E. P., Jenkins, G. M., Reinsell, G. C., & Ljung, G. M. (2015). *Time Series Analysis: Forecasting and Control* (5th ed.). Wiley

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Level III - Semester 1				
Course Code:	ST 3010			
Course Name:	Introduction to Health Statistics			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	15	30	55	100

Course Aim:

Analysis of health data uses specialized descriptive and inferential techniques for evaluating the health status of a population of interest. [ST 3010 provides theory and application of essential statistics for the analysis of health data]

Intended Learning Outcomes:

After successful completion of the course the students will be able to,

- define and compute official health statistics and construct life tables
- compute suitable descriptive statistics and construct confidence intervals and carryout hypothesis tests, calculate sample sizes
- identify Data Science approaches to health data
- analyze and interpret health data using statistical package/s

Course Content: (Main topics, Sub topics)

Introduction to official health Statistics: Mortality, Crude death rate, Standardization, Morbidity, Incidence and prevalence. Introduction to Life tables and applications. Descriptive statistical methods for health data (Summary statistics), Inferential methods (confidence intervals, hypothesis testing) for health data, Sample size calculation. Introduction to Data science for health statistics. Health data analysis using statistical packages.

Teaching /Learning Methods: Interactive lectures, quizzes, in-class assignments , tutorial sessions, practical sessions

Assessment Strategy: At least 2 in-class assignments + 1 Case study + Final exam

Continuous Assessment	Final Assessment

……30……..%	……70……..%		
Details: quizzes, in-classes, other (case studies) ..... % ...20.....% .....10.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Armitage, P., Berry, G., & Mathews, J. N. S. (2004). *Statistical Methods in Medical Research* (4th ed.). John Wiley & Sons ● Altman, D.G. (1990). *Practical Statistics for Medical Research*. CRC Press ● Bland, J. M. (2015). *An Introduction to medical statistics* (3rd ed.). Oxford University Press ● Marasinghe, M. G., & Kennedy, W. J. (2008). *SAS for Data Analysis*. Springer Science & Business Media			

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Level III - Semester 1				
Course Code:	IS 3001			
Course Name:	Sampling Techniques			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites	IS 1009/ ST 1011			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: This course concentrates on the statistical aspects of taking and analyzing a sample. It gives guidance on how to how to design and analyze many different forms of sample surveys. [IS 3001 provides a good theoretical as well as practical foundation for sampling techniques used in practice]				
Intended Learning Outcomes: Upon successful completion of the course the students will be able to,				

<table>
<tr><td colspan="4">

- identify and effectively apply the theory behind sampling techniques that are commonly used in statistics

</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

Simple Random Sampling (SRS), Sample size determination, Ratio and Regression estimators under SRS, Stratified, Systematic, and Quota sampling. Separate and combined estimators for stratified sampling. Cluster sampling, Multi-stage sampling, Complex sample designs and related issues.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive lectures, practical sessions, group work/projects, quizzes, tutorial classes, assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: At least 1 in-class assignment + At least 1 Group project + Final exam</td></tr>
<tr><td colspan="2">Continuous Assessment

……30……..%</td><td colspan="2">Final Assessment

……70……..%</td></tr>
<tr><td>Details: in-classes, mid-term, other (group project)

...10..... % .....% .....20.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td>Other (%) (specify)

……</td></tr>
<tr><td colspan="4">Recommended Reading:

● Thompson, S. K. (2002). Sampling (2nd ed.). John Wiley & Sons
● Som, R. K. (1995). Practical sampling Techniques (2nd ed.). CRC Press
● Rao, P. S. R. S., & Myron J. Katzoff, M. J. (2010). Hand book of Sampling Techniques and Analysis (1st ed.). CRC Press</td></tr>
</table>

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Level III - Semester 1	
Course Code:	MS 3009
Course Name:	Operational Research II
Credit Value:	3C
Core/Optional	Optional (IS only)
Prerequisites	

<table>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td>30</td><td>90</td><td>150</td></tr>
<tr><td colspan="5">Course Aim:

Mangers in any field require to utilize available resources, plan and coordinate activities under many constraints. Operational research techniques can be used to assist such decision making activities in an optimum way. [MS3009 is a continuation of MS1003 that extends the theoretical and practical knowledge on operational research techniques]</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● describe the fundamental concepts of real world applications in operational research and model decision making problems
● solve the formulated model/s using appropriate techniques and software packages</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Network Models (Minimal Spanning Tree algorithm, algorithms for Shortest-Route problem, Maximal Flow model), Project Planning (Critical Path Method, Programming Evaluation and Review Technique), Inventory Models (Deterministic inventory models with shortages and without shortages, Probabilistic Inventory models), Queuing models (Elements of a queuing model, steady-state measures of performance, single-server models, multiple-server models), Solution techniques using suitable OR packages.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, practical sessions, videos, group work, presentation, tutorial classes, assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (in-classes)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

…….</td></tr>
<tr><td colspan="5">Recommended Reading:

● Taha, H. A. (2016). Operational Research: An Introduction (10th ed.). Pearson</td></tr>
</table>

- Verma, A. P. (2009). *Operations Research* (3rd ed). S. K. Kataria & Sons
- Panneerselvam, R. (2006) *Operations Research* (2nd ed.). PHI Learning Pvt. Ltd.
- Wagner, H. M. (1975). *Principles of Operations Research* (2nd ed.). Prentice Hall
- Hillier, F. S., & Lieberman, G. J. (2001). *Introduction to operations research* (7th ed). McGraw-Hill

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Level III - Semester 2				
Course Code:	ST 3011			
Course Name:	Statistical Programming			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		60	40	100

Course Aim:

Rationale: The ability to find trends in data, visualize and model it, using mathematical and statistical methods is increasingly useful with the recent abundance of data collected. To analyze such data in large volumes, a basic understanding of programming is imperative. ST 3011 provides the foundational programming skills and best practices required to explore, model and visualize various types of data to solve business problems.

Intended Learning Outcomes:

After a successful completion of the course, students will be able to,

- plot 2D and 3D graphs using Python /R
- solve statistical problems writing Python/R functions
- perform data analysis using Python /R

Course Content: (Main topics, Sub topics)

Introduction to Python. Built-in data types, Arrays and Matrices, Basic Math using Python. Basic functions and Numerical indexing, Special arrays. Advanced selection and Assignment, Flow control, loops and exception handling. Graphics using Python. Introduction to R; Data Management, Descriptive Analysis, Writing functions in R; Statistical Inference.

Teaching /Learning Methods: Interactive lectures, practical sessions, videos, group work/projects, presentation, assignments

Assessment Strategy: At least 5 lab assignments

Continuous Assessment ……100……..%	Final Assessment …….%		
Details: quizzes, mid-term, other (lab assignments - at least 5) .....100..... %	Theory (%) …….	Practical (%) ……	Other (%) (specify) ……
Recommended Reading: ● Venables, W. N., D.M. Smith, D. M., & the R Core Team (2009). *An Introduction to R: A Programming Environment for Data Analysis and Graphics* (2nd ed). Network Theory			

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Level III - Semester 2				
Course Code:	ST 3012			
Course Name:	Statistical Process Control			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites	ST 2008/ MS 2001			
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim: Cumulative sum (CUSUM) and exponentially weighted moving average (EWMA) Control Charts are capable of detecting small shifts in process parameters, leading to more effective process monitoring, as opposed to traditional Shewhart's control charts which misjudge the occurrence of small process shifts. When there is more than one process parameter, to detect shifts in these, Multivariate Control Charts are used. In addition to these Control Charts capability analysis, acceptance sampling schemes and process optimization techniques will also be discussed.				
Intended Learning Outcomes: Upon successful completion of the course the students will be able to ,				

- investigate and analyze process capability, advanced charts and control charts for correlated data
- recognize the statistical quality control methods using acceptance sampling, response surface approach for optimizing the process

Course Content: (Main topics, Sub topics)

Capability analysis; Cumulative Sum (CUSUM) control charts; Exponentially Weighted Moving Average (EWMA) Charts; Acceptance sampling: double, sequential, multiple; Decision theory approach; Multivariate control charts; Process optimization with design experiment.

Teaching /Learning Methods: Interactive lectures, tutorial sessions, practice exercises, assignments, quizzes

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……20……..%	……80……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....20.....%	…80…..	……	……

Recommended Reading:

- Montgomery, D. C. (2008). *Introduction to Statistical Quality Control* (6th ed). Wiley
- Duncan, A. J. (1986). *Quality Control and Industrial Statistics* (5th ed.). Irwin

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Level III - Semester 2	
Course Code:	ST 3013
Course Name:	Essential Mathematics for Statistics
Credit Value:	3C
Core/Optional	Core
Prerequisites	

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	45		105	150

Course Aim:

Mathematical theories such as linear algebra, matrices, calculus etc. are required for proofs of most of the higher level statistical theories. ST 3013 provides those tools for students with the required amount of theoretical knowledge.

Intended Learning Outcomes:

Upon the successful completion of the course the students will be able to,

- apply basic mathematical tools in solving theoretical and practical problems in Statistics

Course Content: (Main topics, Sub topics)

Linear algebra: Linear dependence, rank and the solution of homogeneous equations, characteristic polynomials, eigenvalues , eigenvectors, spectral theorem for symmetric matrices, idempotent matrices and properties, orthogonal projections, trace of a matrix and properties, positive definite/semi definite matrices, quadratic forms, differential calculus in matrix notation, direct product (kronecker) of any two matrices, generalized inverse /conditional inverse; Calculus 1: Concepts of functions, limits and continuity, L'Hopital's rule, the fundamental theorem of calculus, approximation of definite integrals, Improper integrals; Series and Sequences: sequences and their convergence, series and convergence of series, power series and their convergence of radius, Taylor series and their application; Several variable calculus: functions of several variables, continuity, differentiability, derivatives, multiple integrals, change of variables

Teaching /Learning Methods: Interactive lectures, quizzes, assignments, discussion session based on the given problem set at the end of a topic

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (specify)	Theory (%)	Practical (%)	Other (%) (specify)
.....30..... % .....% .....%	…70…..	…….	……

Recommended Reading:

- Kaplan, W., & Lewis, D. J. (1970). *Calculus and Linear Algebra*: *Vectors in the Plane and One-Variable Calculus*. Wiley

- Axler, S. (2014). *Linear Algebra Done Right* (3rd ed.). Springer
- Larson, R., & Edwards, B. H. (2009). *Calculus* (9th ed.). Cengage Learning

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Level III - Semester 2				
Course Code:	IS 3004			
Course Name:	Applied Multivariate Methods			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

In real life, many processes are affected by the actions of not only one variable but several variables simultaneously. Multivariate analysis is a natural tool to analyze several variables (possibly correlated) at the same time to have insight of the combined effect, if any. This course provides some theoretical background as well as a good practical foundation for commonly used multivariate techniques.

Intended Learning Outcomes:

Upon successful completion of the course the students will be able to,

- apply the related multivariate techniques to data with multiple measurements satisfying the underlying theories and assumptions
- demonstrate basic computer skills in analyzing such data with the help of appropriate statistical packages

Course Content: (Main topics, Sub topics)

Overview, examples and introduction. multivariate normal distribution ; mean vector and variance covariance matrix, correlation matrix; bivariate normal distribution and density, missing values and outliers, summary statistics, standardized data; sample correlations; multivariate data plots, checking for multivariate normality; eigen-values and eigenvectors; geometric descriptions; principal components analysis, factor analysis, discriminant analysis, cluster analysis; multivariate inference; inference for one and two independent samples, profile analysis, repeated measurements, manova, canonical variates analysis, canonical correlations.

Teaching /Learning Methods: Interactive lectures, discussion of examples within lectures, exercises, in-class assignments

Assessment Strategy: 2 in-class assignments + Final Exam			
Continuous Assessment ……30……..%	Final Assessment ……70……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) ……..	Other (%) (specify) ……
Recommended Reading: ● Johnson, D. E. (1998). *Applied Multivariate Methods for Data Analysts* (1st ed.). Duxbury Press ● Johnson, R. A., & Wichern, D. W. (2013*). Applied Multivariate Statistical Analysis* (3rd ed.). Pearson Education Limited ● Afifi, A., May, S., & Clark, V. A. (2003). *Computer Aided Multivariate Analysis* (4th ed.). CRC Press			

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Level III - Semester 2				
Course Code:	IS 3005			
Course Name:	Statistics in Practice I			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		90	60	150
Course Aim: To be employed as a Statistician, a Data Analyst or a Data Scientist, apart from the technical and theoretical knowledge, one should possess and acquire skills to solve real world problems and communicate findings effectively. Through this module, such exposure is provided in a classroom environment.				
Intended Learning Outcomes:				

<table>
<tr><td colspan="4">After the successful completion of this course, students will be able to,

● employ the complex process of problem-solving a massing various areas in the field of statistics
● formulate the problems, improve on report-writing and research skills, their communication, personnel and business skills</td></tr>
<tr><td colspan="4">Course Content: (Main topics, Sub topics)

This course deals with general principles involved with statistical methods covered in levels I, II in solving real-life statistical problems.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Interactive practical sessions, lectures, group work/projects, presentations, assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: Presentations on topics + 2 in-class assignments + 2 Case studies + Writing Newspaper article + Interim workshop participation + Industry Group project + Attendance</td></tr>
<tr><td colspan="2">Continuous Assessment

……95……..%</td><td colspan="2">Final Assessment

……5……..%</td></tr>
<tr><td>Details: quizzes(test on Data Analysis,test on statistical modelling), presentations on topics, Case studies(two with 10% & 5%), writing Newspaper article, interim workshop participation, industry group project

...30... % ...10...% ...15...% ...5...% ...5...% ...30...%</td><td>Theory (%)

…….</td><td>Practical (%)

……</td><td>Other (%) (Attendance)

……5……</td></tr>
<tr><td colspan="4">Recommended Reading:

● Chatfield, C. (1995). Problem Solving: A Statistician's Guide (2nd ed.). CRC Press</td></tr>
</table>

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Level III - Semester 2	
Course Code:	MS 3004
Course Name:	Quality Management/Project Management
Credit Value:	2C
Core/Optional	Optional

<table>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

To be employed as a statistician or data scientist, the students should possess managerial skills also such as organizational environment, feasibility analysis, risk management, human resource management etc.. MS 3004 provides those tools with some theoretical knowledge and practical examples.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

● apply key theoretical concepts on quality control and project management practiced by the corporate world</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Quality Management: Macro and Micro organizational Environment (PESTEL, Resource Based View)Market Analysis(Porter’s Five Forces Analysis, SWOT Analysis) Project Feasibility Analysis (Johnson & Schole’s SFA Framework) Stakeholder Analysis, Organizational Change Management; Project Management: Project Selection, Approach Selection, The Work Breakdown Structure, The Network Diagram, Cost Effort Estimation, Optimizing the Network, Gantt Chart, Risk Management, Cost Estimation, Contract Management, Productivity Improvement, Project Management Steps, Making the Budget, Project Monitoring and Control, Human Resource Management, Project Termination.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, group presentation, quizzes and assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 1 case study + presentation + Final exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
<tr><td>Details: quizzes, mid-term, other (case study and presentation)

..... % .....% .....30.....%</td><td>Theory (%)

…70…..</td><td>Practical (%)

…….</td><td colspan="2">Other (%) (specify)

……</td></tr>
<tr><td colspan="5">Recommended Reading:

● Heagney, J. (2016). Fundamentals of Project Management. AMACOM</td></tr>
</table>

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Course Content - Level IV (APST)

<table>
<tr><td colspan="5">Level IV - Semester 1</td></tr>
<tr><td>Course Code:</td><td colspan="4">ST 4011</td></tr>
<tr><td>Course Name:</td><td colspan="4">Econometrics</td></tr>
<tr><td>Credit Value:</td><td colspan="4">2C</td></tr>
<tr><td>Core/Optional</td><td colspan="4">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td>30</td><td></td><td>70</td><td>100</td></tr>
<tr><td colspan="5">Course Aim:

Analysis of economic and financial data requires the formulation of a unique methodological framework. ST 4011 provides the theoretical as well as a practical foundation for the students to analyze and make accurate projections of economic and financial data.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the course, the students will be able to,

● apply statistical methods in the context of economics and carry out a successful econometric analysis</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

The application of linear regression model and the interpretations of properties of least squares estimates in the context of economic theory, an introduction to violations of OLS assumptions in economics, Simultaneous equations, Time Series Econometrics, Case studies.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods: Interactive lectures, illustrative data analyses within lectures, exercises, in-class assignments</td></tr>
<tr><td colspan="5">Assessment Strategy: At least 2 in-class assignments + Final Exam</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……70……..%</td></tr>
</table>

Details: quizzes, mid-term, other (in-classes) ..... % .....% .....30.....%	Theory (%) …70…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Gujarati, D. N. (2009). *Basic Econometrics* (5th ed). McGraw Hill			

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Level IV - Semester 1				
Course Code:	ST 4035			
Course Name:	Data Science			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30	30	90	150
Course Aim: Data science is an interdisciplinary field that uses scientific techniques and algorithms to extract information from data. The course is designed to provide students in depth knowledge of data analysis techniques in data science.				
Intended Learning Outcomes: After a successful completion of the course, students will be able to, ● apply basic techniques of Data Science for decision making				
Course Content: (Main topics, Sub topics) Introduction; Ethics; Data Wrangling & Pre-processing; How to deal with large data sets: Parallel computing, Map reduce framework – Hadoop; Data Communication & Visualization; Statistical Methods: Regression, Logistic Regression, Random Forest, Support Vector Machines; Machine Learning Algorithms.				

Teaching /Learning Methods: Interactive lectures, quizzes, tutorials, assignments, group activities			
Assessment Strategy: At least 2 in-class assignments + 1 Group project + Final exam			
Continuous Assessment ……50……..%	Final Assessment ……50……..%		
Details: in-classes, mid-term, other (group project) .....30... % .....% .....20.....%	Theory (%) …50…..	Practical (%) …….	Other (%) (specify) ……

Recommended Reading:

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2014). *An Introduction to Statistical Learning: With Applications in R.* Springer New York
- Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* (2nd ed). Springer
- Leskovec, J., Rajaraman, A., & Ullman, J. (2014). *Mining Massive Data Sets* (2nd ed). Cambridge University Press
- Provost, F., & Fawcett, T. (2013). *Data Science for Business: What you need to know about data mining and data-analytic thinking* (2nd ed). O'Reilly Media

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Level IV - Semester 1				
Course Code:	ST 4036			
Course Name:	Time to Event Analysis			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100
Course Aim:				

Analysis of duration data is complicated due to the presence of censored observations arising from the non-occurred events in the data. Therefore, specialized methods of analysis are available for analysing such duration data. [ST 4036 provides a fundamental theoretical foundation as well as a practical foundation on statistical methods for analysing duration data].

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- explain characteristics of time to event data
- identify suitable distributions for time to event data
- describe time to event data using suitable parametric and non-parametric measures
- analyze time to event data using parametric models and non-parametric regression models
- calculate sample sizes
- analyze and interpret time to event data using statistical package/s

Course Content: (Main topics, Sub topics)

Characteristics of time to event data, Distributions for time to event data, Non-parametric methods, Parametric regression, Hazard regression, Power analysis and sample size calculation, fitting parametric and semi parametric models, analysis of time to event data using SAS/R.

Teaching /Learning Methods: Interactive lectures, case studies, tutorials, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	…70…..	…….	……

Recommended Reading:

- Hosmer, D.W., Lemeshow S., & May, S. (2011). *Regression modeling of time to event data* (2nd ed). John Wiley & Sons
- Collet, D. (2015). *Modeling Survival Data in Medical Research* (3rd ed). CRC Press
- Cox, D. R., & Oakes, D. (1984). *Survival Analysis* .Chapman & Hall

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Level IV - Semester 1				
Course Code:	ST 4037			
Course Name:	Epidemiology			
Credit Value:	2C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

Statistics is essential in Epidemiology which studies the distribution of diseases and risk factors for diseases in human populations. Therefore, it is important for students to be able to identify best study designs, statistical analysis and ethics in Epidemiological studies. ST 4037 provides essential theory and application of statistical concepts and ethics in epidemiology.

Intended Learning Outcomes:

After a successful completion of the course, the students will be able to,

- describe basic designs for epidemiological studies
- compute relative risk and odds ratio
- identify confounding and interaction
- fit suitable models for epidemiological data using SAS/R
- perform bioassay
- plot and interpret ROC curve for epidemiological data
- identify ethics in health data analysis

Course Content: (Main topics, Sub topics)

Introduction to epidemiology. Basic Epidemiological designs: surveys, cohort studies, case control studies. Relative risk and odds ratio. Confounding and interaction. Modeling epidemiological data using SAS/R: logistic regression and other models. Bioassay. ROC analysis. Ethics in health data analysis.

Teaching /Learning Methods: Interactive, quizzes,practical sessions, in-class assignments , tutorial sessions

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment

……20……..%	……80……..%		
Details: quizzes, mid-term, other (in-classes) ..... % .....% .....20.....%	Theory (%) …80…..	Practical (%) …….	Other (%) (specify) ……
Recommended Reading: ● Schlesselman, J.J. (1982). *Case control studies: Design, Conduct, Analysis*. Oxford University Press ● Collet, D. (1991). *Modeling binary data* (2nd ed). Taylor & Francis ● Woodward, M. (2014). *Epidemiology* (3rd ed). CRC Press			

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Level IV - Semester 1				
Course Code:	IS 4007			
Course Name:	Statistics in Practice II			
Credit Value:	3C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		90	60	150
Course Aim: Continuing the experience acquired in a classroom environment on skills required for employment through IS3005, the students are trained to work at a higher level in terms of solving complex problems through consultancies, and expose them to the management level of the industry, grooming them to be better employable.				
Intended Learning Outcomes: After successful completion of the course, students will be able to, ● solve real-world problems currently faced by the industry by using various areas in the field of statistics ● communicate the findings to the industry in both oral and written form				
Course Content: (Main topics, Sub topics)				

<table>
<tr><td colspan="4">This course deals with general principles involved with statistical methods covering levels I, II and III in solving real-life statistical problems. It is aimed at students who have exposure to these areas but are unsure what to do when faced with real data, especially if the data are 'messy' or the objectives are unclear.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: Practical sessions, interactive lectures, videos, group work/projects, presentations, assignments</td></tr>
<tr><td colspan="4">Assessment Strategy: 3 Case studies + 1 in-class assignment + Presentations on Statistical Topics + Laboratory Based test on Data Analysis + Industry Group project + Attendance</td></tr>
<tr><td>Continuous Assessment

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

……5……..%</td></tr>
<tr><td>Details: quizzes, case studies (on exploratory data visualization, based on Excel, on data analysis), presentations on statistical topics, laboratory based test on data analysis, industry group project)

...10... % ...30...%(10 each) ...5...% ...20...% ...30...%</td><td>Theory (%)

……..</td><td>Practical (%)

……</td><td>Other (%) (Attendance)

……5……</td></tr>
<tr><td colspan="4">Recommended Reading:
● Chatfield, C. (1995). Problem Solving: A Statistician's Guide (2nd ed). Chapman & Hall</td></tr>
</table>

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Level IV - Semester 1	
Course Code:	MS 4007
Course Name:	Risk Management
Credit Value:	2C
Core/Optional	Optional
Prerequisites	

Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

The knowledge on capital markets, financial markets and risks involved in management decisions are key concepts for those who work in industries. This course provides the fundamentals of such topics that are required by the statisticians.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- update with current trends, capital markets and risk management
- adapt easily to the corporate environment

Course Content: (Main topics, Sub topics)

Introduction to Capital Markets; Types of financial markets: (debt, equity and derivatives); Introduction to Financial Instruments: (debt, equity and derivatives), Introduction to Time Value of money and interest rates, Risk and Risk aversion, Financial ratios, Portfolio risk, Capital allocation, Market Risk Management, Operational risk, Financial crisis Business case studies and presentations.

Teaching /Learning Methods: Interactive lectures, quizzes, tutorial classes, assignments, case study, group presentations,individual viva

Assessment Strategy: At least 1 business case study + At least 1 presentation + Final exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (business case studies and presentation)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	….70…..	……	……

Recommended Reading:

- Mishkin, F. S., & Eakins, S. G. (2006). *Financial markets and Institutions* (5th ed). Pearson education
- Hull, J. C. (2017). *Options, Futures, and Other Derivatives* (10th ed). Pearson Education

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Level IV - Semester 1				
Course Code:	MS 4008			
Course Name:	Industrial Psychology			
Credit Value:	2C			
Core/Optional	Core			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
	30		70	100

Course Aim:

To be a steady person in the industry, anyone needs some knowledge and skills on organizational behavior, leadership and group behavior skills etc.. This course is designed with the aims of enhancing such skills and career development interfaces for industry personnel.

Intended Learning Outcomes:

Upon successful completion of the course, students will be able to,

- apply concepts of psychology in an industrial context to further their career goals and successful work-life balance

Course Content: (Main topics, Sub topics)

Introduction to Psychology, Organizational Behavior, Leadership & Group Behavior, Psychological Assessments, Work Motivation and Job Designing, Diversity and Issues in Organizations, Psychology of HRM & Ergonomics, Conflicts at Work & Stress, Career Development/Work –Life Interface.

Teaching /Learning Methods: Interactive lectures, forums, videos, quizzes, assignments

Assessment Strategy: 2 in-class assignments + Final Exam

Continuous Assessment	Final Assessment
……30……..%	……70……..%

Details: quizzes, mid-term, other (in-classes)	Theory (%)	Practical (%)	Other (%) (specify)
..... % .....% .....30.....%	….70…..	……	……

Recommended Reading:

- Levy, P. (2009). *Industrial/Organizational Psychology* (3rd ed). Worth Publishers

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Level IV - Semester 2				
Course Code:	IS 4009			
Course Name:	Industrial Training			
Credit Value:	6C			
Core/Optional	Optional			
Prerequisites				
Hourly Breakdown	Theory	Practical	Independent Learning	Notional
		180	420	600

Course Aim:

Industrial Training provides necessary experience for a graduate to be better employed. In a field related to "Applied Statistics", being an intern gives an opportunity to experience what problems are being solved in the industry, while also acquiring necessary skills to work to meet targets, communicating and liaising with other industry personnel in a professional manner.

Intended Learning Outcomes:

Upon successful completion of Industrial Training, the students will be able to,

- integrate classroom theory with workplace practice
- develop greater clarity about academic and career goals
- recognize administrative functions and company culture
- appreciate the ethical basis of professional practice in relevant industry
- display a capacity for critical reasoning and independent learning
- explore options in career plans and goals

Course Content: (Main topics, Sub topics)

<table>
<tr><td colspan="4">Industrial training provides students to understand and appreciate real-life working experiences. Students may realize their ambition and ascertain their career path from the experience gained during industrial training. The training provides students the opportunity to meet and network with people in the industry, and for the industry the opportunity to identify talents and potential skilled employees.</td></tr>
<tr><td colspan="4">Teaching /Learning Methods: 3 months internship training in an Industrial place</td></tr>
<tr><td colspan="4">Assessment Strategy: Attendance + Academic Mentor’s progressive evaluation through log book and progress reports + Industry Mentor’s Evaluation on the training + Final Presentation and Viva + Collection of progress reports</td></tr>
<tr><td>Continuous Assessment

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

……20……..%</td></tr>
<tr><td>Details:
Attendance - Academic Mentor’s Meetings – 10%,
Academic Mentor’s progressive evaluation through log book and progress reports (FORM A & FORM B) - 25%,
Industry Mentor’s Evaluation on the training – 25%,
Collection of progress reports - 20%</td><td>Theory (%)

……..</td><td>Practical (%)

……</td><td>Other (%)

Final Presentation and Viva– Mark
20 %</td></tr>
<tr><td colspan="4">Recommended Reading:
None</td></tr>
</table>

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Level IV - Semester 2	
Course Code:	IS 4010
Course Name:	Industry Research Project
Credit Value:	6C
Core/Optional	Core
Prerequisites	

<table>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td><td>Notional</td></tr>
<tr><td></td><td>180</td><td>420</td><td>600</td></tr>
<tr><td colspan="5">Course Aim:

Working on an industry research project gives the opportunity to work closely with a faculty member who is an experienced researcher and an industry personnel who is an expert in the industry. The research project provides an opportunity to learn something new, to improve problem-solving skills and to challenge oneself in new ways.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes:

Upon successful completion of the industrial project, the students will be able to

● solve real world problems using appropriate theories and techniques learnt throughout the degree program</td></tr>
<tr><td colspan="5">Course Content: (Main topics, Sub topics)

Students will be allocated to solve an industrial based problem using statistical/ computational techniques and they are expected to work independently to solve it.</td></tr>
<tr><td colspan="5">Teaching /Learning Methods:</td></tr>
<tr><td colspan="5">Assessment Strategy: Industry Research Report + Final presentation/VIVA</td></tr>
<tr><td colspan="2">Continuous Assessment

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

……100……%</td></tr>
<tr><td>Details: quizzes, mid-term, other (specify)

..... % .....% .....%</td><td>Theory (%)

…….</td><td>Practical (%)

……</td><td colspan="2">Other (%)

Industry Research Report– (Marks from the Academic Mentor (15%) + Industry Mentor (15%)) – 30%

Industry Research Report(Mark from examiner) – 50%

Presentation/VIVA Examination(Panel of Examiners) – 20%</td></tr>
<tr><td colspan="5">Recommended Reading:

● Statistics textbooks related to the research project</td></tr>
</table>