DEPARTMENT OF STATISTICS

M.Sc. - STATISTICS

SYLLABUS

Effective from the Academic Year 2016-2017

LOYOLA COLLEGE (Autonomous)

Ranked 2 in INDIA RANKING 2017 - NIRF
'College of Excellence' Status Conferred by UGC in 2014
Re-accredited with 'A' Grade (3.70 CGPA) by NAAC in 2013
Chennai - 600 034
## RESTRUCTURING-2016 (2016-17 batch ONWARDS)
### PG - Arts / Science / Commerce / Social Work

<table>
<thead>
<tr>
<th>Part</th>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Summer Vacation</th>
<th>Summer 3</th>
<th>Summer 4</th>
<th>Total Hours</th>
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<td>Major Core (MC)</td>
<td>30(20 C)</td>
<td>24(20 C)</td>
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<td>20(15 C)</td>
<td>30(24 C)</td>
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<td>6(5 C)</td>
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<td>Outside class hours(2C)</td>
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<td>LEAP</td>
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<td>(3 C)</td>
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<td>30+2# (23+5 C)</td>
<td>(1 C)</td>
<td>30 (23+2 C)</td>
<td>30 (24 C)</td>
<td>120+2# (90+6+2*)C</td>
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Note: A theory paper shall have 5 to 6 contact hours and a practical session shall have 3 to 5 contact hours.
New format of the subject codes from the 2016 regulation

Subject codes are 10 characters long:

<table>
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<tr>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
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- 1st & 2nd digits – last two digits of regulation year in YY format (If 2016, it will be 16).
- 3rd alphabet: U – UG / P – PG / M – M.Phil. / D – Ph.D.
- 4th & 5th alphabets: department wise program code (example – MT / CO / HT…..)
- 6th digit: Semester for UG/ PG / M.Phil. and year for Ph.D.
- 7th & 8th alphabet: Category of paper or group of category of papers (GE/RL/OL/HE/OR/AL/ES/SK/MS/CM/CC/ ……)
- 8th & 9th digits: subject number range (01 to 99).

For example,

**Example 1:16UCH1MC01**

- 16 – Admitted in 2016
- U – UG student
- CH – Chemistry Student
- 1 – 1st Semester subject
- MC01 – Major paper

**Example 2:16PCO2ID01**

- 16 – Admitted in 2016
- P – PG student
- CO – Commerce Student
- 2 – 2nd Semester subject
- ID01 – Inter disciplinary paper

- For subjects which are carried forward from one regulation to the next, the first two digits representing the regulation alone will change.
- Subjects which are not carried forward from one regulation to the next, will not appear in the new regulation.
- For new subjects which need to be added to a regulation, a new subject code must be created in continuation of the last created code under that type/category.
- Subject codes which are identical (except for the first two digits which represent the regulation year) are treated as equivalent for the purpose of syllabus / question paper setting / conducting examination / etc.
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<thead>
<tr>
<th>Sl. No</th>
<th>Sub. Code</th>
<th>Title</th>
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<tbody>
<tr>
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<td>16PST1MC01</td>
<td>ADVANCED DISTRIBUTION THEORY</td>
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<tr>
<td>2</td>
<td>16PST1MC02</td>
<td>APPLIED REGRESSION ANALYSIS</td>
</tr>
<tr>
<td>3</td>
<td>16PST1MC03</td>
<td>STATISTICAL MATHEMATICS</td>
</tr>
<tr>
<td>4</td>
<td>16PST1MC04</td>
<td>STATISTICAL DATA ANALYSIS USING SAS</td>
</tr>
<tr>
<td>5</td>
<td>16PST1MC05</td>
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</tr>
<tr>
<td>6</td>
<td>16PST2MC01</td>
<td>ESTIMATION THEORY</td>
</tr>
<tr>
<td>7</td>
<td>16PST2MC02</td>
<td>TESTING STATISTICAL HYPOTHESES</td>
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<td>8</td>
<td>16PST2MC03</td>
<td>SAMPLING THEORY</td>
</tr>
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<td>9</td>
<td>16PST2MC04</td>
<td>CATEGORICAL DATA ANALYSIS</td>
</tr>
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</tr>
<tr>
<td>11</td>
<td>16PST2ES01</td>
<td>ACTUARIAL STATISTICS</td>
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<tr>
<td>12</td>
<td>16PST2ES02</td>
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<td>16PST3MC01</td>
<td>MULTIVARIATE ANALYSIS</td>
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<td>STOCHASTIC PROCESSES</td>
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<td>STATISTICAL QUALITY CONTROL</td>
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<td>ADVANCED OPERATIONS RESEARCH</td>
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<td>METHODS</td>
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<td>19</td>
<td>16PST3ID01 MATHEMATICAL AND STATISTICAL COMPUTING</td>
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<td>20</td>
<td>16PST4MC01 APPLIED EXPERIMENTAL DESIGNS</td>
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<td>21</td>
<td>16PST4MC02 DATA WAREHOUSING AND DATA MINING</td>
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<tr>
<td>22</td>
<td>16PST4MC03 BIOSTATISTICS AND SURVIVAL ANALYSIS</td>
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<td>23</td>
<td>16PST4MC04 STATISTICS LAB – IV</td>
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<tr>
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<td>16PST4PJ01 PROJECTS</td>
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16PST1MC01 ADVANCED DISTRIBUTION THEORY

SEMESTER  I  CREDITS  5  
CATEGORY  MC(T)  NO.OF HOURS/ WEEK  6

Objectives:
1) To impart knowledge on the construction of statistical models  
2) To apply statistical models which are relevant to real life problems


Unit 2: Multivariate discrete distributions : Trinomial and Bivariate Poisson distribution, their properties, Multinomial and Multivariate Poisson distributions.

Unit 3: Multivariate continuous distributions : Bivariate normal and Bivariate exponential (Marshall and Olkin) distributions, properties, Multivariate extensions.

Unit 4: Non-central distributions : Non-central Chi-square, Non-central t and Non-central F distributions and their properties. Compound distributions and Mixtures of distributions, order statistics, their distributions and properties.

Unit 5: Quadratic forms in Normal variates, properties of idempotent matrices. Quadratic forms, definiteness of a quadratic form. Generalized inverse (elementary ideas only). Necessary and Sufficient condition for a Quadratic form to be distributed as a Chi-square, Cochran’s theorem.

Books for study

Books for reference:


16PST1MC02 APPLIED REGRESSION ANALYSIS

SEMESTER  I                          CREDITS  5
CATEGORY     MC(T) NO.OF HOURS/ WEEK   6

Objectives:

1. To study linear and non linear relationships between variables.
2. To train students in applications of regression models in real life situations.

Unit 1: Multiple Linear Regression. Estimation of model parameters, Hypothesis testing, Confidence intervals, Prediction, Residual analysis, PRESS statistic, Lack of fit.

Unit 2: Correcting Model Inadequacies. Variance stabilizing transformations, Linearizing a model, Selection of transformation, Generalized and weighted least squares, Indicator variables.


Unit 4: Polynomial and Non Linear Regression. Polynomial regression model in one variable – Piecewise polynomial fitting (Splines), Non-parametric regression, IVM-Linear regression models, Non-linear least squares, Transformation to a linear model, Inference problem in non-linear regression.

Unit 5: Auto correlation, Partial Auto Correlation, Stationarity, Unit Root Test, Non Stationarity in Variance, Random Walk,

Books for Study:


Books for reference:


16PST1MC03 STATISTICAL MATHEMATICS

SEMESTER I CREDITS 4
CATEGORY MC(T) NO.OF HOURS/ WEEK 6

Objectives:

1. To train students in the mathematical foundation for postgraduate studies in Statistics.
2. To expose students the mathematical pre-requisites of statistics.


Infinite series – convergence – tests for convergence

Unit 2: Real functions – Boundedness, monotonicity , continuity. Differentiable functions – Extreme Values.


Unit 5: Eigen values and vectors – Quadratic forms – Diagonal forms – Matrix square root. Gram-Schmidt Orthogonalization (Notion only)

Books for Study:


Unit – I : Sections 2.1, 2.3 to 2.8, 3.1 to 3.4, 3.6

Unit – II : Sections 4.2, 4.3, 4.4, 4.5, 7.1, 7.3, 9.2

Unit – III : Sections 8.1, 8.3, 8.4, 8.5


Unit V : Sections 8.1 to 8.4


Books for Reference:


16PST1MC04 STATISTICAL DATA ANALYSIS USING SAS

SEMESTER  I   CREDITS  3
CATEGORY  MC(L)    NO.OF HOURS/ WEEK  6

Objective
1. To enable students to use SAS for Data processing
2. To expose students on the applications of Statistical Analysis using SAS

~ 6 ~
Unit 1: Data step and Proc Step, SAS Data Libraries, Creating dataset using data lines, Importing data using INFILE statement, Importing data using Proc Import, Creating HTML Output, Sub setting observations using conditional statements, Sub setting variables using Keep/Drop, Creating variables using IF-THEN else statements, Retain statement, FIRST, LAST, Date functions, Character functions.

Unit 2: SAS procedures, Sub setting in Procedures with the WHERE Statement, Sorting Data with PROC SORT, Printing Data with PROC PRINT, Summarizing Your Data Using PROC MEANS, Writing Summary Statistics to a SAS Data Set, Counting Data with PROC FREQ, Producing Tabular Reports with PROC TABULATE, PROC SORT, PROC SUMMARY

Unit 3: Modifying a Data Set Using the SET Statement, Stacking Data Sets Using the SET Statement, Interleaving Data Sets Using the SET Statement, Combining Data Sets Using a One-to-One Match Merge, Combining Data Sets Using a One-to-Many Match Merge, Merging Summary Statistics with the Original Data, Writing Multiple Data Sets Using the OUTPUT Statement, Changing Observations to Variables Using PROC TRANSPOSE

Unit 4: SAS Macro Concepts, Substituting Text with Macro Variables, Creating Modular Code with Macros, Adding Parameters to Macros, Writing Macros with Conditional Logic, Writing Data-Driven Programs with CALL SYMPUT, Proc SQL, Using Proc SQL to create tables, Modifying tables, Aggregating tables, Stacking and Merging tables

Unit 5: PROC UNIVARIATE, PROC MEANS, PROC CORR, PROC PLOT, PROC FREQ, PROC TTEST, PROC NPAR, PROC ANOVA, PROC REG, PROC ARIMA.

Books for Reference:

SEMESTER  I  
CREDITS  3 
CATEGORY  MC(L) 
NO.OF HOURS/ WEEK  6 

Objectives: 

1) To expose students on the applications of Statistical Model Building using R-Programming 

2) To develop statistical model building skills through analyzing real life problems 

Basics of R Programming 

1. Importing and Exporting Datasets 
2. Usage of Inbuilt Mathematical, Statistical and Special Functions in R 
3. Subset Observations , Variables from Datasets 
4. Creating new variables from existing variables 
5. Merging Datasets – Inner Joins, Outer Join, Left Outer Join, Left Inner Join 
6. Coding user defined functions in R Language 
7. Linear and Matrix Algebra 
8. Linear Dependency and Linear Independency 
9. Determining Matrix Determinant and Matrix Inverse 
10. Determining Characteristic Roots and Characteristic Vectors 
11. Determining Rank, Index and Signature of a Quadratic form 

Advanced Distribution Theory 

1. Fitting of Binomial and Poisson Distribution 
2. Fitting of Truncated Binomial and Truncated Poisson Distribution 
3. Fitting of Mixture of Geometric and Poisson 
4. Fitting of Mixture of Two Poisson 
5. Generating Samples from Discrete and Continuous Distributions 

~ 8 ~
Applied Regression Analysis

1. Building Linear Regression Model with Categorical Explanatory Variable
2. Testing for Overall Model fit and Individual Regression Coefficients
3. Determining R-Square, Adjusted R-Square, MAE and MAPE
4. Study of Interaction Effects and outlier detection
5. Testing for Multicollinearity using VIF and Conditional Index
6. Transformation and Combining Variables to deal Multicollinearity
7. Residual Analysis – Normality of Residuals, Transformation, Functional form
8. Autocorrelation, Partial Autocorrelation, Stationarity
9. Constructing ARIMA model and measuring model performance
10. Model Validation, Bootstrap Regression Methods

16PST2MC01 ESTIMATION THEORY

SEMESTER II  CREDITS  5
CATEGORY  MC(T)  NO.OF HOURS/ WEEK  5

Objectives:

1) To provide a strong theoretical foundation to aid in optimal inference strategies.
2) To illustrate the real life applications of estimation procedures.


Unit 2: Sufficiency, Fisher-Neyman factorization theorem, examples. Rao-Blackwell theorem,

Unit 4: Method of maximum likelihood, consistent asymptotic normal (CAN) estimators, examples. Invariance property of CAN estimators.

Unit 5: Baye’s and minimax estimation, examples. M-estimation, Jack knife and Bootstrap methods.

Books for study:


Books for reference:


16PST2MC02 TESTING STATISTICAL HYPOTHESES

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Objectives:

1. To impart knowledge on techniques for testing of hypotheses towards decision support based on sample characteristics.
2. To illustrate the real life applications of testing problems and procedures

Unit 1: Statistical hypotheses, Neyman – Pearson fundamental lemma, distributions with monotone likelihood ratio, Generalization of the fundamental lemma (without proof).

~ 10 ~
Unit 2: Two-sided hypotheses, Unbiasedness for hypothesis testing. Applications to one-parameter exponential family. Similarity and completeness.

Unit 3: UMP unbiased tests for multiparameter exponential family and applications. Confidence Intervals. Unbiased confidence sets.

Unit 4: Symmetry and invariance, maximal invariants, most powerful invariant tests, unbiasedness and invariance.

Unit 5: Likelihood ratio tests, large sample properties, asymptotic distribution of LRT statistic for simple null hypothesis.

Books for study:


Books for reference


16PST2MC03 SAMPLING THEORY
SEMESTER II CREDITS 4
CATEGORY MC(T) NO.OF HOURS/WEEK 5

Objectives:
1. To impart knowledge on various sampling techniques useful in survey methodology.
2. To demonstrate sampling inspection procedures using sampling techniques.


Unit 3: Stratified sampling – estimation of the population mean – allocation problems. Systematic sampling – Methods for populations with linear trend – Comparison with SRSWOR and stratified sampling for standard populations.

Unit 4: Multi stage sampling- Multi phase sampling - Ratio estimation - approximation to bias and MSE – regression estimation - approximation to bias and MSE - Double sampling for ratio and regression. Cluster sampling and multistage sampling under SRS methods.

Unit 5: Non-response – effects of non-response, Warner’ model, Simmons randomized response technique. Planning and organization of large scale surveys

Books for Study:


Books for Reference:

Objectives:

1. To introduce students to the exciting new area of analysis of categorical data
2. To equip students with knowledge and techniques required to handle data-modeling situations involving categorical data.


Unit 2: Generalized Linear Model – For binary data & count data. Inference for & Fitting of GLMs.


Book for Study:

Book for Reference:

Objectives:

2. To Provide hands on experience in implementation of concepts in Estimation theory, Testing of Statistical Hypothesis and Categorical Data Analysis
3. To apply advanced statistical software for relevant applications Estimation Theory
   - Estimation of unknown parameter through MLE Procedure
   - Deriving Confidence Intervals for the unknown parameter
   - Bayesian Estimation Procedure
   - Bootstrap and Jackknife Procedures

Testing of Statistical Hypothesis

1. Basic Parametric and Non Parametric Tests
2. Determining Test Function, Level and Power of Test Function, Power Curve
3. MP Test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased test

Sampling Theory

1. Simple Random Sampling With and Without Replacement
2. Stratified Random Sampling, Midzuno Sampling
3. Horwitz – Thompsonn Estimator
4. Hansen – Horwitz Estimator
5. Desraj Ordered Estimator
6. Calculation of Inclusion Probabilities in Fixed and Varying Sampling Designs

Categorical Data Analysis

1. Building Binary Logistic Regression Model
2. Obtaining Estimated Probability, Optimal Cut Point
3. Deriving Classification Table, Sensitivity and Specificity, AUC Measures
4. Model Validation through AUC and Gains Chart
5. Probit Model
6. Multinomial Logistic Regression Model
7. Cumulative / Ordinal Logistic Regression Model
8. Poisson Regression Model

16PST2ES01 ACTUARIAL STATISTICS

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<td>CATEGORY</td>
<td>MC(T)</td>
<td>NO. OF HOURS/ WEEK</td>
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Objectives:

1. To educate interested students about the applications of statistics in insurance industry.
2. To compute several measures which are relevant to actuarial statistics.

Unit 1: Compound Interest-Accumulated value and present value annuities certain, present values, amounts, annuities, perpetuities, Redemption of loans.

Unit 2: Further compound interest and Annuities certain, Nominal and effective rates of discount – capital redemption of policies

Unit 3: Mortality tables – construction of mortality tables comparison of different mortality tables.


Unit 5: Office premiums – policy values – Further life contingencies - methods of valuation – Data for valuation – special reserves and adjustments

Books for Study:


Books for reference:


16PST2ES02 MODERN PROBABILITY THEORY

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<th>CREDITS</th>
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<td>CATEGORY MC(T)</td>
<td>NO.OF HOURS/ WEEK 6</td>
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Objectives:

1. To impart knowledge in the advanced probability theory
2. To illustrate probabilistic pre-requisites which are required for building statistical models.


Unit 3 : Modes of Convergence of Random Variables : Limits of Random Variables, Convergence in Probability, Convergence Almost Surely, Convergence in Distribution, Convergence in rth mean,
Unit 4: Laws of Large Numbers: Weak and Strong law of large Numbers


Book for Study:


Books for Reference:


16PHE2FC01 LIFE SKILLS TRAINING

SEMESTER II CREDITS 2
CATEGORY FC(T) NO.OF HOURS/ WEEK 2+2

OBJECTIVES OF PG SYLLUBUS

1. To improve and sustain the primal level of competence and performance of PG students through an advanced training of holistic development of oneself.
2. To empower through various skills and strengthen them to face the future life issues and challenges.
3. To equip them with practical and value based learning of soft skills for a better life in future.

INSIDE CLASS HOURS (2 hrs)

~ 17 ~
Unit – I: Constructing Identity


Unit – II: Capacity Building

Motivation – Definition, types (Intrinsic and Extrinsic), Theories (Maslow’s hierarchical needs, etc), Factors that affect motivation, Challenges to motivation, Strategies to keep motivated, motivational plan. Time Management Skills– steps to improve time management, overcoming procrastination, assessing and planning weekly schedule, challenges, goal settings, components of goal settings, consequences of poor time management, control of interruption and distractions. Communication, public speaking, talents, creativity, learning,

Unit – III: Professional Skills

Leadership development skills – difference between leader and manager, different styles and their utilities, functions of leadership, application of knowledge, overcoming from obstacles, influential skills and Leadership qualities. Application skills – Managing Career and self-direction, Visionary thinking, formulating strategies, shaping strategies, building organizations relationships, change management. Project Management Skills, Independent working skills, Writing skills, Public Speaking, analytical Skills, Neo Research and Development. Problem solving skills – Process, approaches and its components, creative problem solving, Tools and techniques, application of SMART analysis and barriers to problem solving.

Unit – IV: Life Coping Skills

Life skills – Personal and reproductive Health, love, sex, marriage and family – family life education – Gender Equity - child bearing and Childrearing practices, Geriatric Care - adjustability Human Relationship – formal and informal - peer group – friends – same
and other gender - family – Colleagues – community – emotional intelligence - Stress Coping skills – Definition of stress, strategies to alleviate stress, problem and emotion focused coping, techniques to reduce stress, stress reaction phases, crisis intervention steps, creating positive affirmations, Signs, Symptoms and Reactions of Stress.

Unit – V: Social Skills


Reference books

1. Healing Your Emotional Self: A Powerful Program to Help You Raise Your Self-Esteem, Quiet Your Inner Critic, and Overcome Your Shame by Beverly Engel
2. Self-knowledge and self-discipline by B. W. Maturin
3. Motivation: Biological, Psychological, and Environmental (3rd Edition) by Lambert Deckers
4. Getting Things Done: The Art of Stress-Free Productivity by David Allen
5. Managerial Skills in Organizations by Chad T. Lewis

<table>
<thead>
<tr>
<th>Competence building</th>
<th>Career Preparatory Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power talk</td>
<td>Interview Guidance</td>
</tr>
<tr>
<td>Emotional Intelligence</td>
<td>Group Dynamics</td>
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<td>Stress management</td>
<td>Leadership skills</td>
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<td>Decision Making</td>
<td>Negotiation Skills</td>
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<td>Positive image building</td>
<td>Creative writing</td>
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OUTSIDE THE CLASS HOURS (2 hrs)

- Each student will choose either of the above-mentioned modules and is expected to undergo a training/workshop in that module.
- She/he will have to accomplish ten hrs outside the class hours to fulfill the 2 credits.

Methodology

Inputs, ABL model, Documentaries, group activities and Interaction, Special workshop by professionals.

Evaluation

There will be end test and a Project for ‘inside the class hours’. Viva Voce will be conducted for the ‘Outside the class hours’.

16PST3MC01 MULTIVARIATE ANALYSIS

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>III</th>
<th>CREDITS</th>
<th>5</th>
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<td>CATEGORY</td>
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Objectives:

1. To provide students the requisite knowledge and skills to handle multi-dimensional data and extract useful information from the data.
2. To derive statistical inference based on multivariate statistical analysis

Unit 1: (Basic Preparation): Multivariate Normal distribution – Properties, Distributions of linear combinations, independence, marginal distributions, conditional distributions, Partial and Multiple correlation coefficient. Moment generating function.

Unit 2: (Inference Means of MV normal populations)): Estimation of Mean and Var-Cov matrix. Distributions of Sample correlation coefficient, partial correlation coefficient & Multiple correlation coefficient. The Generalized T2Statistic – Distribution & Applications.
Unit 3: (Inference for several populations): Paired comparisons & Repeated Measures design, Multivariate ANOVA – One way & Two way. Profile analysis.


Books for study:

Books for Reference:

16PST3MC02 STOCHASTIC PROCESSES

SEMESTER III CREDITS 5
CATEGORY MC(T) NO.OF HOURS/ WEEK 6

Objectives:
1. To introduce the variety of situations that can be handled by the theory of Stochastic Processes
2. To expose students to several processes in disciplines like Biology, Engineering and Economics that are stochastic in nature.


Unit 5: Branching process – generating function relations, estimation probabilities, two – type branching process – Description of continuous time branching process. Stationary process – mean square distance, prediction and covariance stationary process.

Books for study:


Books for Reference


16PST3MC03 STATISTICAL QUALITY CONTROL

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>III</th>
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<tr>
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| CREDITS | 3 |

Objectives:

1. To train students in modern statistical process control techniques.
2. To detect variation in production process and suggests inspection plans
Unit 1: Meaning and Scope of Statistical process control (SPC), Shewart Control Charts for X-bar, R, np, p, c charts. and their uses. OC and ARL of control charts. Uses of runs and related patterns of points.

Unit 2: Control charts based on C.V. extreme values, moving averages, geometric moving averages, modified control charts CUSUM procedures, use of V mask, derivation of ARL. Multivariate control charts.

Unit 3: Process capability, tolerance limits, beta content and beta expectation, Normal theory and non-parametric approaches.

Unit 4: Sampling inspection plans. Classification and general properties Sampling plans by variables, estimation of lot defective and plan parameter determination in known and unknown cases. Continuous sampling plans – CSP- 1 and its modifications. Derivation of AOQL for CSP-1, operations of MLP’s and Wald-Wolfowitz plans.

Unit 5: Implementing six sigma. Six sigma overview and implementations- smarter six sigma solutions(S4) measurements : converting defect rates (DPMO or PPM) to six sigma quality levels- six sigma relationships- six sigma assumptions- S4 assessment- basic control charts and S4 assessments- examples.

Books for study :

1. Duncan A.J. – Quality Control and Industrial Statistics (2010), 2nd edition, Homewood,

Books for reference:


16PST3MC04 STATISTICS LAB – III

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<tr>
<th>SEMESTER</th>
<th>III</th>
<th>CREDITS</th>
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<td>CATEGORY</td>
<td>MC(L)</td>
<td>NO. OF HOURS/ WEEK</td>
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Objectives:

1. To enable students to use statistical packages for analyzing Multivariate Data, Stochastic process and Quality Control.
2. To expose students to interpret the output and provide recommendations

Multivariate Analysis

1. Computation of Means, Variances, Covariance and Correlations from a Multivariate dataset.
2. Computation of Partial correlation coefficients from the Var-Cov matrix of a multivariate normal population.
3. Computation of Multiple Correlation coefficients from the Var-Cov matrix of a multivariate normal population.
4. Tests for significance of correlation coefficient using samples from multivariate normal populations— Simple Correlation, Partial correlation and Multiple correlation coefficients.
5. Applications of T2 Statistics to different situations – Test for mean of a single MV normal population, Test for equality of mean vectors of two MV normal populations with equal var-cov matrices & unequal var-cov matrices, Special Applications.
6. MANOVA – One-way & Two-way models.
7. Principal component analysis.
8. Factor Analysis
9. Canonical Correlation Analysis
10. Fishers Discriminant Analysis – Two populations, several populations. Classification with Prior Probabilities.
Statistical Process Control

1. Control Chart for Attributes – p-chart, np-chart, c-chart, u-chart.
2. Control charts for variables – X-chart, R-chart, S-chart.
4. Special charts – Moving range chart, CUSUM charts, Exponentially Weighted Moving Average charts.
5. OC Curves for various charts.
7. Double Sampling Plan – OC curve, ASN curve, AOQ curve, ATI curve.

Stochastic Process:

1. Determination of Pn for a transition probability matrix.
2. Determination of stationary distribution.
3. Generating a Poisson process; waiting time distribution.
4. Extinction probability in a branching process.

16PST3ES01 ADVANCED OPERATIONS RESEARCH

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<th>SEMESTER</th>
<th>III</th>
<th>CREDITS</th>
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<td>ES(T)</td>
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Objectives:

1. To introduce students the statistical and mathematical formulations for handling a range of business based problems.
2. To develop a broad appreciation of different types of decision-making environments.

Unit 1: General Linear programming problem-Formulation-Solution through Graphical, Simplex, Big-M and Two phase Methods – Duality in Linear programming – Goal programming problem.

Unit 2: Non-linear programming-Kuhn Tucker theorem-Lagrangian multipliers method-Wolfe’s and Beale’s algorithm for solving Quadratic programming problems.
Unit 3: Inventory control: Deterministic Models – Economic Order Quantity – Problems with no shortages – The fundamental EOQ Problems, EOQ problems with several production runs of unequal length – Problems with price breaks – One price break, More than one price break - Probabilistic models – Single Period Problem without set-up cost – I and II.

Unit 4: Queuing theory- (M/M/1): (GD/∞/∞), (M/M/1): (GD/N/∞), (M/M/C): (GD/∞/∞), (M/M/C): (GD/N/∞).

Unit 5: Integer Programming-Branch and Bound and Cutting plane methods- Dynamic Programming - Solution of LPP by DPP. Simulation- Formulating and Implementing a Simulation model.

Books for study:

Books for reference:

16PST3ES02 NON-PARAMETRIC METHODS

<table>
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<tr>
<th>SEMESTER III</th>
<th>CREDITS</th>
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Objectives:

1. To explore knowledge in the advanced methods of non-parametric inference.

~ 26 ~
1. To derive inference for samples drawn from distribution free population

**Unit 1:** Introduction, Run test for randomness. $\chi^2$ goodness of fit test. Kolmogrov – Smirnov one sample test, Kolmogrov – Smirnov two sample test, Binomial test, Point estimator and confidence interval for probability of success.

**Unit 2:** One sample location problems – Wilcoxon signed rank test. Fishers sign test. Asymptotic test of symmetry – Estimators and confidence interval.

**Unit 3:** Two sample problems – Wilcoxon rank sum test for location parameter (Mann – Whitney).

Test for dispersion parameter – Rank test, Rank like test (Moses), Millers asymptotic test based on Jackknife.

**Unit 4:** One way layout – Kruskal Wallis test. Test for ordered alternatives, Multiple comparison based on Kruskal Wallis rank sums. Two way layout - Friedman’s rank sums test. Test for ordered alternatives, multiple comparisons.

**Unit 5:** Kendals test for independence. Theil’s test for regression coefficients. Hollander’s test for parallelism of two regression lines.

**Books for Study:**


**Book for Reference:**

Objective:

To introduce the software skills to apply the statistical and mathematical tools.

Unit 1: Python Statements and Comments, Keywords and Identifier, Python Data types, Python I/O and Import, Python operators, Precedence and Associativity, If else statement, For loop, While loop, Break and Continue, Pass, Looping techniques

Unit 2: Function, Argument, Recursion, Modules, Python package, Data types, Numbers, List, Tuple, String, Set, Dictionary, File Operation, Directory, Exception, Exception Handling, User-defined exception, Namespace, Class, Inheritance, Multiple Inheritance, Operator overloading

Unit 3: Data visualization in Python, Fitting of Distributions – Graphical and Statistical Procedures, Statistical Measures, User defined functions for Parametric tests and Non parametric tests, Fitting Statistical Models - Multiple Linear regression, Binary logistic regression.

Unit 4: The MATLAB environment, basic commands, data types, variables, Assignment statement, mathematical operators, Managing workspace, Handling of Arrays, Matrix operations and analysis, program structures - if statement, for loop, while loop, break statement, Creating-saving and running m-files, Functions based on arguments, Nested functions, File I/O handling, Debugging techniques

Unit 5: Elementary Mathematics - Trigonometry, exponentials, logarithms, rounding, remainders, descriptive statistics, Polynomials, Data visualization - 2D and 3D plotting, Random number generation, Integration, Double Integration, Differentiation, Partial Differentiation, Matrix Operations, Linear Equations, Eigen values and Eigen vectors, Matrix Analysis Books for Reference
1. Python programming for Absolute Beginner, Third Edition
   By Michael Dawson – Cengage Learning
2. Matlab A practical introduction to programming and
   problem solving, Third edition By Stormy Attaway, Elsiver,
   Butterworth Heinemann Publication

Books for Study

1. Python Data Analytics, Fabio Nelli – Apress
2. Python for Data Analysis , Wes McKinney – O’Reilly
3. Modeling Techniques in Predictive Analytics By Thomas
   W.Miller, Pearson Education
4. Matlab with applications to engineering, physics and
   finance By David Baez-Lopez, CRC Press
5. Solving Applied Mathematical Problems with MATLAB
   By Dingyu Xue Yangquan chen, CRC Press

16PST3ID02 STATISTICAL AND MATHEMATICAL
COMPUTING

SEMESTER III                  CREDITS  5
CATEGORY ID(L)              NO.OF HOURS/ WEEK  2

Objective:

To introduce the software skills to apply the statistical and
mathematical tools.

Data Analysis using Python

1. Importing and Exporting Datasets
2. Sub setting Dataset
3. Aggregating dataset
4. Stacking and Merging dataset
5. For and While loop
6. Diagrammatic representation
7. Parametric Tests
8. Non-parametric tests
9. Multiple Linear Regression
10. Binary Logistic Regression

~ 29 ~
MATLAB environment

1. MATLAB commands
2. Matrix operations
3. Eigen values and Eigen vectors
4. Evaluation of Integral
5. Differentiation
6. Convergence of Sequence
7. Convergence of Infinite Series
8. 2D and 3D Plots

Books for Reference

1. Python programming for Absolute Beginner, Third Edition
   By Michael Dawson – Cengage Learning
   By Stormy Attaway, Elsiver, Butterworth Heinemann Publication

Books for Study

1. Python Data Analytics, Fabio Nelli – Apress
2. Python for Data Analysis , Wes McKinney – O’Reilly

16PST4MC01 APPLIED EXPERIMENTAL DESIGNS

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>IV</th>
<th>CREDITS</th>
<th>5</th>
</tr>
</thead>
<tbody>
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<td>CATEGORY</td>
<td>MC(T)</td>
<td>NO. OF HOURS/ WEEK</td>
<td>6</td>
</tr>
</tbody>
</table>

Objectives:

1. To provide both basic and advanced experimental designs applied in Agriculture, Pharmaceutical, Industrial and Biological sciences.
2. To derive solutions for statistical inference problems


~ 30 ~
**Unit 2:** Factorial Design – 2n; 3n factorial designs. Finite fields and design of experiments. Partial confounding and complete confounding – confounding in more than two blocks. Fractional factorials – construction and analysis-concept of resolution plans.

**Unit 3:** Asymmetrical factorial designs (AFD)- AFD- confounded asymmetrical factorial design construction of balanced confounded asymmetrical factorials-split and strip-plot experiment.

**Unit 4:** Incomplete block designs – varietal Trials – incomplete block design balanced incomplete block designs (BIBD) construction of BIBD – analysis of BIBD, Youden square design – Lattice designs. Partially balanced incomplete block design (PBIBD) – analysis and construction of PBIBD - Group divisible-simple-triangular- Latin square type and cyclic PBIBD.

**Unit 5:** Orthogonal Latin square – maximum number of orthogonal Latin squares – construction of orthogonal Latin squares – construction of BIBD using orthogonal Latin squares. Response surface designs- definition of response surface design – first order and second order response surface design.

**Books for study:**


**Books for reference:**

16PST4MC02 DATA WAREHOUSING AND DATA MINING

SEMESTER IV CREDITS 5
CATEGORY MC(T) NO.OF HOURS/ WEEK 6

Objectives:

1. To recourse knowledge discovery through database which leads to Business Intelligence.
2. To illustrate the applications of data mining and statistical tools


Unit 3: Naive Bayes Classification Method, Bayesian Networks, Path Analysis, Back Popagation Algorithm, Building Predictive Model using Artificial Neural Network, Support Vector Machine, Decision Tree Methods - Classification Tree, Regression Tree, Decision tree based on Statistical Significance - Chi Square

**Unit 4 :** Construction of Gains Chart, ROC Curve, Leave one out validation and N fold validation, Construction of Logit Model Tree, K th Nearest Neighbourhood Classification, Bagging and Boosting Principles, Adaptive Boosting Algorithm, Decision Stumps and Random Forest, Apriori Algorithm and Association Rule Mining

**Unit 5 :** Additive Regression, Logit Boost, Multi Class Classifier, Ordinal Class Classifier, Expectation Maximization Algorithm, Genetic Algorithm, Combining Classifiers, Cost Sensitive Classifier, Text Mining – Methods and Models

**Books for Study:**


**Books for Reference:**


**16PST4MC03 BIOSTATISTICS AND SURVIVAL ANALYSIS**

**SEMESTER** IV  
**CREDITS** 5  
**CATEGORY** MC(T)  
**NO.OF HOURS/ WEEK** 6

**Objectives:**

1. To develop sound judgment about data applicable to clinical care
2. To emphasize study design and interpretation of results of medical research
Unit 1: Introduction to Medical research – Study Designs – Observational studies; Experimental Studies & Clinical trials; Meta Analysis, Research questions about mean of a group & proportions in a group. Repeated measures design – Paired comparison of means; Kappa statistic; McNemar test. Sign test for median; Wilcoxon Signed Rank test.

Unit 2: Research questions about means and variances of two groups; Levene test; Wilcoxon Rank Sum test. Decisions on proportions in two groups – z-test; Chi-Square test. Diagnostic Procedures with Threshold model. Measuring the accuracy of diagnosis – Sensitivity, Specificity; ROC curve.


Unit 4: Kaplan Meier Survival Curve, Life Table Analysis, Comparison of Survival Distribution – Log Rank Test for comparing two groups, Log rank test for comparing n-groups.

Unit 5: Cox Proportional Hazard Model, Meaning of PH Assumption, ML Estimation of Cox Proportional PH Model, Adjusted Survival Curves using Cox PH Models, Evaluating the Proportional Hazard Assumption – Graphical Approach, Goodness of fit test approach,

Book for Study and Reference:


Book for Reference:


~ 34 ~
Objectives:

1. To Provide Practical Knowledge in Analysing problems in Design of Experiments, Operations Research, Biostatistics and Survival Analysis
2. To demonstrate hands on experience for problems using statistical software

Design of Experiments

1. Complete Randomized Design, Randomized Block Design, Latin Square Design
2. Balanced Incomplete Block Design, Split Plot Design
3. Factorial Design - 22, 23, 24, 32, 33, 34
5. ANOCOVA

Data mining Techniques

1. Segmentation using CART and CHAID
2. Classification and prediction using Random Forest
3. Predictive model building using ANN, SVM and KNN
4. Market Basket Analysis
5. Prediction using Adaboost and Bayesian Network

Biostatistics and Survival Analysis

1. Paired comparison of means; Kappa statistic; McNemar test. Sign test for median
2. Wilcoxon Signed Rank test, Levenetest, Wilcoxon Rank Sum test, Chi-Square test
4. Odds Ratio, Sensitivity and Specificity, Mortality Rates, Adjusted Rates,
5. Kaplan – Meier Survival Curves, Life Table Method
6. Log Rank Test, Wilcoxon Test, Likelihood Ratio Test
7. Cox Proportional Hazard Model, Cox Model with time dependent Covariates