VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

# SCHOOL OF ADVANCED SCIENCES

# DEPARTMENT OF MATHEMATICS

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.) (CS&DA)

## Curriculum & Syllabus

## (2019–2020 Admitted Students)

## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

## VISION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

To be an internationally renowned science school in research and innovation by imparting futuristic education relevant to the society.

## MISSION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

- To nurture students from India and abroad by providing quality education and training to become scientists, technologists, entrepreneurs and global leaders with ethical values for a sustainable future.

- To enrich knowledge through innovative research in niche areas.

- To ignite passion for science and provide solutions for national and global challenges.

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO_01: Graduates will be practitioners and leaders in their chosen field.

PEO_02: Graduates will function in their profession with social awareness and responsibility.

PEO_03: Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country.

PEO_04: Graduates will be successful in pursuing higher studies in their chosen field.

PEO_05: Graduates will pursue career paths in teaching or research.

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## PROGRAMME OUTCOMES (POs)

PO_01: Having a clear understanding of the subject related concepts and of contemporary issues .

PO_02: Having an ability to design and conduct experiments, as well as to analyze and interpret data .

PO_03: Having an ability to use techniques, skills and modern tools necessary for solving scientific problems .

PO_04: Having problem solving ability- solving social issues and societal problems Having cross cultural competency exhibited by working in teams.

PO_05: Having adaptive thinking and adaptability.

PO_06: Having a clear understanding of professional and ethical responsibility .

PO_07: Having cross cultural competency exhibited by working in teams .

PO_08: Having a good working knowledge of communicating in English .

PO_09: Having a good cognitive load management [discriminate and filter the available data] skills.

PO_10: Having interest in lifelong learning.

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO_01: On completion of M.Sc. Integrated Computational Statistics and Data Analytics (5 yr.) Programme, graduates will be able to

PSO_02: Apply knowledge of quantitative aptitude, computing techniques, programming knowledge to analyse real-world problems and requirements.

PSO_03: Provide solutions to the computing problems and reaching conclusions using principles of statistics, computational Science and data analytic tools.

PSO_04: Create, select, adapt and apply suitable Statistical techniques and modern computing tools for Data Analysis.

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## CREDIT STRUCTURE

### Category-wise Credit distribution

| Category | Credits |
|---|---|
| University core (UC) | 66 |
| Programme core (PC) | 68 |
| Programme elective (PE) | 64 |
| University elective (UE) | 12 |
| Total credits | 210 |

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## DETAILED CURRICULUM

| University Core (UC) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
| 1 | CHY1003 | Environmental Studies | 2 | 0 | 0 | 4 | 3 |
| 2 | CHY1005 | Allied Chemistry | 3 | 0 | 0 | 0 | 3 |
| 3 | CSE1012 | Introduction to Computers and their Applications | 2 | 0 | 2 | 0 | 3 |
| 4 | MAT1023 | Computational Thinking for Data Analytics | 3 | 0 | 0 | 0 | 3 |
| 5 | ENG3000 | English for Beginners | 1 | 0 | 2 | 0 | 2 |
| 6 | ENG1911 | General English - I | 1 | 0 | 2 | 0 | 2 |
| 7 | ENG1912 | General English - II | 1 | 0 | 2 | 0 | 2 |
| 7 | HUM1032 | Ethics and Values | 1 | 0 | 0 | 4 | 2 |
| 8 | MAT1001 | Fundamentals of Mathematics | 3 | 1 | 0 | 0 | 4 |
| 9 | MAT1024 | Real Analysis and its Applications | 3 | 0 | 0 | 0 | 3 |
| 10 | MGT1022 | Lean Start-up Management | 1 | 0 | 0 | 4 | 2 |
| 11 | PHY1003 | Physics | 3 | 0 | 2 | 4 | 5 |
| 12 | FLC4097 | Foreign Language Course Basket | 0 | 0 | 0 | 0 | 2 |
| 13 | SET4001 | Science, Engineering and Technology Project – I | 0 | 0 | 0 | 0 | 2 |
| 14 | SET4002 | Science, Engineering and Technology Project – II | 0 | 0 | 0 | 0 | 2 |
| 15 | EXC4097 | Co-Extra-Curricular Basket | 0 | 0 | 0 | 0 | 2 |
| 16 | STS5097 | Soft Skills Course Basket | 0 | 0 | 0 | 0 | 8 |
| 17 | MIY4098 | Comprehensive Examination | 0 | 0 | 0 | 0 | 2 |
| 18 | MIY6099 | Master's Thesis | 0 | 0 | 0 | 0 | 16 |

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## DETAILED CURRICULUM

| Programme Core (PC) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No** | **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
| 1 | MAT1005 | Fundamentals of Statistics | 3 | 0 | 2 | 0 | 4 |
| 2 | MAT1018 | Probability and Random Variables | 3 | 2 | 0 | 0 | 4 |
| 3 | MAT1019 | Statistical Methods for Data Analysis | 3 | 2 | 0 | 0 | 4 |
| 4 | MAT1020 | Sampling Techniques | 3 | 0 | 0 | 0 | 3 |
| 5 | MAT1025 | Data base management systems | 3 | 0 | 2 | 0 | 4 |
| 6 | MAT1026 | Discrete Mathematics | 3 | 2 | 0 | 0 | 4 |
| 7 | MAT1027 | Design and analysis of algorithms | 3 | 0 | 2 | 0 | 4 |
| 8 | MAT1028 | Operation Research for Data Analysis | 3 | 2 | 0 | 0 | 4 |
| 9 | MAT1029 | Statistical Quality Control | 3 | 0 | 2 | 0 | 4 |
| 10 | MAT1030 | Statistical Computing for Data Analysis | 0 | 0 | 4 | 0 | 2 |
| 11 | MAT2006 | Distribution Theory and its applications | 3 | 0 | 2 | 0 | 4 |
| 12 | MAT2007 | Linear Algebra and Numerical Methods | 3 | 0 | 0 | 0 | 3 |
| 13 | MAT5013 | Statistical Inference | 3 | 0 | 2 | 0 | 4 |
| 14 | MAT5016 | Time Series Analysis and Forecasting | 3 | 0 | 2 | 0 | 4 |
| 15 | MAT5017 | Multivariate Data Analysis | 3 | 0 | 2 | 0 | 4 |
| 16 | MAT6002 | Regression Analysis and Predictive Models | 3 | 0 | 2 | 0 | 4 |
| 17 | MAT6004 | Computational Statistics for Data Science | 0 | 0 | 4 | 0 | 2 |
| 18 | MAT6009 | Design and Analysis of Experiments | 3 | 0 | 2 | 0 | 4 |
| 19 | MAT6012 | Programming for Data Analysis | 2 | 0 | 4 | 0 | 4 |

# M.Sc. Integrated Computational Statistics & Data Analytics (5yr.)

## DETAILED CURRICULUM

| Programme Elective (PE) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **J** | **C** |
| 1 | CSEXXXX | Introduction to IoT | 3 | 0 | 2 | 0 | 4 |
| 2 | CSEXXXX | Web Technologies | 2 | 0 | 2 | 0 | 3 |
| 3 | CSEXXXX | Cloud Computing Techniques | 3 | 2 | 0 | 0 | 4 |
| 4 | CSE1008 | Programming in C | 3 | 0 | 2 | 0 | 4 |
| 5 | CSEXXXX | Object Oriented Programming | 3 | 0 | 2 | 0 | 4 |
| 6 | CSEXXXX | Java Programming | 3 | 0 | 2 | 0 | 4 |
| 7 | MAT5022 | Modelling and Simulation | 3 | 0 | 2 | 0 | 4 |
| 8 | MAT5024 | Decision Support Systems | 2 | 0 | 0 | 4 | 3 |
| 9 | MAT6005 | Machine learning for Data Science | 3 | 0 | 2 | 0 | 4 |
| 10 | MAT6007 | Deep Learning | 2 | 0 | 2 | 0 | 3 |
| 11 | MAT6008 | Artificial Intelligence for Data | 2 | 0 | 2 | 0 | 3 |
| 12 | MAT6015 | Big Data Analytics and | 2 | 0 | 2 | 0 | 3 |
| 13 | MATXXXX | Econometric Analysis | 3 | 0 | 2 | 0 | 4 |
| 14 | MAT3010 | Total Quality Management | 3 | 0 | 0 | 4 | 4 |
| 15 | MATXXXX | Non-Parametric Tests | 3 | 0 | 2 | 0 | 4 |
| 16 | MAT1031 | Biostatistics | 3 | 0 | 2 | 0 | 4 |
| 17 | MAT1032 | Decision Modelling Techniques | 2 | 0 | 2 | 0 | 3 |
| 18 | MATXXXX | Actuarial Statistics | 3 | 0 | 0 | 0 | 3 |
| 19 | MATXXXX | Data Warehousing and Data | 3 | 0 | 0 | 0 | 3 |
| 20 | MATXXXX | Data Engineering for Analytics | 2 | 0 | 2 | 4 | 4 |
| 21 | MATXXXX | Software Quality and Testing | 2 | 0 | 0 | 4 | 3 |

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# University Core

| Course code | Environmental Studies | L | T | P | J | C |
|---|---|---|---|---|---|---|
| CHY1003 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

The course is aimed at

- To make students understand and appreciate the unity of life in all its forms and the implications of lifestyle on the environment.
- To broaden the understanding of global climate changes and the importance of renewable sources of energy.
- To give students a basic understanding of the major causes of environmental degradation on the planet, with specific reference to the Indian situation.
- To inspire students to find ways in which they can contribute personally and professionally to prevent and rectify environmental problems.

**Course Outcomes: (CO):**

At the end of the course, the student should be able to

- Know the importance of environment and awareness on natural resources to find the causes, effects, and consequences if not protected.
- Acquire knowledge of renewable and non-renewable energy resources to solve future problems on energy demand.
- Enriching the understanding of the need for eco-balance and the importance of biodiversity conservation.
- Identify the numerous causes for environmental pollutions, hazards, their management, and control methods.
- Find ways to protect the environment on global climatic changes and their mitigation.
- Recognise some of the social issues and gaining knowledge on the protection of the environment.
- Develop adequate knowledge of population, which enabling them to make better in life decisions as well as enter a career in an environmental profession or higher education.

| Module:1 | Environment and Natural Resources | 7 hours |
|---|---|---|

Definition, scope, importance, the need for public awareness on natural resources Forest resources – use, exploitation, causes, and consequences of deforestation. Water resources – use of surface and subsurface water; dams - effect of drought, water conflicts. Land resources - Land degradation, soil erosion, and desertification. Indian Case studies. Food resources – Definition, world food problems, Traditional and modern agriculture, and its impacts and remedies.

| Module:2 | Energy Resources | 7 hours |
|---|---|---|

Definition of renewable and non-renewable energy resources. Non-renewable energy resources - oil, Natural gas, Coal, Nuclear energy. Renewable energy - Solar energy, Hydroelectric power, Ocean thermal energy, wind, and geothermal energy. Biomass energy and Bio Gas.

| Module:3 | Ecosystem and Biodiversity | 5 hours |
|---|---|---|

| | | |
|---|---|---|
| Concept of ecosystem, Structure, and functions of an ecosystem, Food chains, food webs. Energy flow in an ecosystem, ecological pyramids, and ecological succession. Case studies: Bio magnification of DDT. Biodiversity-Bio-geographical classification of India, hotspots, values of biodiversity. Threats to biodiversity - a Case study. Conservation of biodiversity. GM Crops | | |
| **Module:4** | **Environmental changes and Remediation** | **6 hours** |
| Air, water, soil, Thermal Pollution: Causes, effects and control measures; Nuclear hazard. Solid waste Management- Causes, Effects and control measures. Floods, earthquakes, cyclones, tsunami and landslides, Case studies. | | |
| **Module:5** | **Global Climatic Change and Mitigation** | **5 hours** |
| Global climate change and the greenhouse effect – Kyoto Protocol, Carbon sequestration, Acid rain, Ozone depletion problem – Montreal Protocol. | | |
| **Module:6** | **Social Issues and the Environment** | **6 hours** |
| Urban problems related to energy and sustainable development, Water conservation, Rainwater harvesting, Wasteland Reclamation. Environment Protection Act - Prevention and control of Pollution of Air and Water. Wildlife protection and Forest Conservation Acts. | | |
| **Module:7** | **Human Population and the Environment** | **7 hours** |
| Population growth, variation among nations, population explosion, Family Welfare Programme, Environment, Women and Child Welfare, Human rights, HIV/AIDS, Role of information technology on the environment and human health. Discussion on current environmental issues/topics by an Industrial expert or faculty | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 2016, 5th Edition, ISBN: 978-81-224-4013-3, New Age International.
- G. Tyler Miller Jr and Scott E. Spoolman, Living in the Environment, 2012. 17th Edition, ISBN-13: 978-0-538-73534-6, Brooks / Cole.

**Reference Books**

- Environmental Science and Engineering by Anjali Bagad, 2014, 1st Edition, ISBN-10: 9350997088, Technical Publications.
- Introduction to Environmental Engineering by Masters, 2015, 3rd Edition, ISBN-10: 9332549761, Pearson Education India.
- Basic Environmental Sciences For Undergraduates by Dr. Tanu Allen, Dr. Richa K. Tyagi Dr. Sohini Singh, 2014, 1st Edition, ISBN-10: 938375827, Vayu Education of India.

| | | | |
|---|---|---|---|
| Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT | | | |
| Recommended by Board of Studies | 12-8-2017 | | |
| Approved by Academic Council | No.47 | Date | 05-10-2017 |

| Course code | Allied Chemistry | L | T | P | J | C |
|---|---|---|---|---|---|---|
| CHY1005 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | Chemistry at 12th standard or equivalent | Syllabus version | | | | |
| | | 2.0 | | | | |

**Course Objectives**

The course is aimed at

- To understand the interdependency of chemistry and biological systems and the relationship between chemical structure and biological activity.
- To introduce analytical and separation techniques essential for biologists.

**Expected Course Outcomes:**

At the end of the course, the students will

- be able to acquire knowledge about the stereochemistry of organic and biomolecules.
- be able to acquire knowledge on various electronic effects in biological systems.
- be familiar with the fundamental chemistry of the biomolecules.
- be familiar with the fundamental chemistry of chlorophyll and Haemoglobin.
- be able to acquire knowledge on the various functions of several metal ions and the complexes in the biological systems.
- be able to acquire knowledge about the uses, mechanism of action of essential drugs, and their SAR.
- Demonstrate basic knowledge of the separation and analytical techniques.

| | | |
|---|---|---|
| **Module:1** | **Introduction to Stereochemistry** | **6 hours** |
| Isomerism in organic compounds – structural, stereo, geometrical and optical isomerism-Chirality-Racemisation–Specific optical rotation-Enantiomeric Excess-Optical purity-Resolution–R-S notation–E-Z nomenclature | | |
| **Module:2** | **Electronic effects** | **6 hours** |
| Intermolecular bonding forces-ionic bonds, hydrogen bonds, Van der Waals interactions, Dipole-dipole and Ion-dipole interactions, Repulsive interactions, water, and hydrophobic interactions – Importance of these effects in biological systems. | | |
| **Module:3** | **Chemistry of Biomolecules** | **6 hours** |
| Amino acids, Proteins, and Enzymes - Chemical structure and function. | | |
| **Module:4** | **Molecules of Life** | **4 hours** |
| Structure and functions of Haemoglobin and Chlorophyll. | | |
| **Module:5** | **Role of metal ions in Biology** | **6 hours** |
| Essential and toxic metals – metal ions deficiency and its treatment – metal ion toxicity – Fe, Cu, Cr, Pb, As, Hg, Cd – Natural detoxification – chelating drugs for detoxification – examples for Chelating drugs – Anti-arthritic gold drugs – psychiatric drug – Lithium – Anticancer drugs - Platinum complexes. | | |
| **Module:6** | **Antibiotics, Anti-ulcer and Analgesic drugs** | **9 hours** |

| | | |
|---|---|---|
| Structure-activity relationship (SAR) – cell wall synthesis inhibitors - Penicillins, Cephalosporin-Protein synthesis inhibitors– tetracycline, chloramphenicol. SAR–$H_2$ antagonist–Ranitidine–Proton pump inhibitors – Pantoprazole –Omeprazole. NSAID- SAR – paracetamol – diclofenac sodium – ibuprofen. | | |
| **Module:7** | **Separation and Analytical Techniques** | **6 hours** |
| Chromatography – Adsorption, Absorption, Partition- HPLC, GC -Spectroscopy – the interaction of electromagnetic radiation with matter, type of interaction, the origin of IR, UV – Visible, Emission spectroscopy (fluorescence) and applications. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture Hours:** | **45 hours** |

**Text Book(s):**

- An Introduction to Medicinal Chemistry, Graham L. Patrick, VI$^{th}$ edition, Oxford University Press, 2017.
- Organic Chemistry, Solomon, and Fryhle. Eighth Edition, Wiley India (P) Ltd. 2009.
- Bioinorganic Chemistry, Asim K. Das, Books and Allied (P) Ltd, 2010.
- Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, and F. J. Holler, S.R. Crouch,9$^{th}$ Edition, Thomson Asia (P) Ltd., Singapore, 2014.

**Reference Book(s):**

- Stereochemistry of Organic Compounds by L. Eliel, Samuel H. Wilen, Wiley India (P) Ltd, 2010.
- Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, 24$^{th}$ edition,2005.
- Basic Concepts of Analytical Chemistry, S. M. Khopkar, New Age International Publishers, 2009.

**Mode of evaluation:** Internal assessment (CAT, Quizzes, Digital Assignment) and FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | | 12-08-2017 | |
| Approved by Academic Council | No.46 | Date | 24-08-2017 |

| Course code | Introduction to Computers and their Applications | L | T | P | J | C |
|---|---|---|---|---|---|---|
| CSE1012 | | 2 | 0 | 2 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

- Gaining foundation in the fundamentals of computers concerning computer components and their usage
- Making students understand different web technologies and computer networks
- Exploring the application suite of software for the betterment of presentation and management of data

**Expected Course Outcome:**

- The students will have the knowledge and skills to describe the software and hardware components
- Explain some of the web technologies and illustrate how these can be used to manage scientific data
- Obtain and analyse information and data relating to specific word applications for fine document preparation and report writing.
- Data computation using spreadsheet application and presentation application for scientific findings.
- Perform practical data management techniques, including DDL and DML and database querying.

| Module:1 | History of Computers | 4 hours |
|---|---|---|

History of Computers, Basic Components of Computer Systems, CPU, Memory, I/O Devices, Operating system, DOS and Unix system commands

| Module:2 | Web Technologies | 4 hours |
|---|---|---|

Introduction to Internet - URL, WWW, HTML, Internet Protocols- HTTP, TCP/IP, E-Mail & FTP.

| Module:3 | Computer Networks | 3 hours |
|---|---|---|

Networks and Data Communications: LAN, MAN & WAN – Network Topologies. Basics of Network, Uses of the network, types of networks, Network topologies.

| Module:4 | Word Processing | 4 hours |
|---|---|---|

Word basics, Editing and formatting a document, layout and inserting and managing graphics, formatting tables

| Module:5 | Spreadsheets | 4 hours |
|---|---|---|

Spreadsheet basics, Editing worksheets, Form cells – formatting worksheets, formulas and function, data filtering and sorting, chart, and graphs.

| Module:6 | Presentation | 5hours |
|---|---|---|

Presentation basics, Creation of Presentation, editing presentation, formatting presentation, working with multimedia.

| | | |
|---|---|---|
| **Module:7** | **Database Management** | **4 hours** |
| Database basics, advantages of Database, create a database, updating and manipulating data, DDL and DML command, database querying. | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **30 hours** |

| **Text Book(s)** | |
|---|---|
| • | Peter Norton, 2017, Introduction to Computers, 7th Edition, Tata McGraw Hill Publications. |
| • | Joan Lambert, and Curtis Frye, 2017 Microsoft Office 2016 Step by Step, Microsoft Press |
| **Reference Books** | |
| • | Rajaraman V, and Adabala N, 2014, Fundamentals of Computers, PHI Publication |

Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

| **List of Experiments** | | **No. of Hours** |
|---|---|---|
| 1. | Unix and DOS commands | 2 hours |
| 2. | Creating and Formatting Word document | 2 hours |
| 3. | Creating and Manipulating Tables in a document | 2 hours |
| 4. | Inserting any Graphics in a document | 2 hours |
| 5. | Create a Personal Resume | 2 hours |
| 6. | Using the Excel Formula and Functions | 2 hours |
| 7. | Representing Data in a Chart | 2 hours |
| 8. | Excel Using Pivot Table | 2 hours |
| 9. | Excel Using Functions | 2 hours |
| 10. | Working with Design Templates and Auto Content wizards by using PowerPoint | 2 hours |
| 11. | Formatting and editing slides | 2 hours |
| 12. | PowerPoint Slide design | 2 hours |
| 13. | Slide transition effects | 2 hours |
| 14. | Creating and querying a recipe database using a database program | 2 hours |
| 15. | Updating and manipulating database | 2 hours |
| | Total Laboratory Hours | 30 hours |

**Mode of Evaluation:** Assignments, Continuous assessment tests and Final assessment test.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 12-8-2017 | | |
| Approved by Academic Council | No. 53. | Date | 13-12-2018 |

| Course code | Computational Thinking for Data Analytics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1023 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To provide a working definition for the concept of computational thinking.
- To understand that logic is necessary and how it can be applied to solve a variety of real-world problems
- To understand the central role algorithms play in computational problem solving and explore many forms of algorithms
- To explore many forms of abstraction that are significant to computer science
- To Understand how algorithms are modularized and often involves the repetition of statements
- To be able to create basic activity diagrams for simple algorithms
- To understand how a computing system organizes data in memory

**Expected Course Outcome:**

At the end of the course students will be able to:

- explain the stored program concept and the role it plays in software execution and the manipulation of data
- describe how the logic of natural language is expressed symbolically
- interpret state diagrams including do, entry, and exit actions
- examine divide and conquer as a key problem-solving strategy, useful in outlining and top-down design
- model sequential algorithms of ten or fewer states
- understand how linking is used to organize data in memory

| Module:1 | Computational Thinking – Introduction | 6 hours |
|---|---|---|

Introduction: What is computational Thinking? - Computational Thinking in real world; Moore's Law; Logical Thinking: Logic – Inductive vs Deductive Arguments – Boolean logic – Propositions – Logical Operators – Symbolic Logic – Venn Diagrams – Applications of Propositional Logic

| Module:2 | Problem Solving and Decomposition | 6 hours |
|---|---|---|

Problem Definition and Devising Solution; Decomposition – Recursion – Tree Structure; Critical Thinking – Solve a concrete instance – Problem of drawing smiley face; Patterns and Generalisation – Complex Patterns – Loops, Subroutines, Rules

| Module:3 | Abstraction | 6 hours |
|---|---|---|

Abstraction: From generalisation to abstraction – Importance – Examples – Class Diagrams – Use Case Diagrams

| Module:4 | Algorithmic Thinking | 6 hours |
|---|---|---|

Algorithmic Thinking: Algorithms – Intuition vs Precision – Defining Algorithms - Control of Algorithm Execution – Example Algorithm - Name Bindings - Selection - Repetition – Modularization

| Module:5 | Modelling Solutions | 7 hours |
|---|---|---|

Modelling: Motivation – Basics – Static vs Dynamic Models – Uses of Models – Koningsberg Bridge Example; Activity Diagrams: Selection – Repetition – Control Abstraction; States and State Diagrams: Including Behaviour in State Diagrams

| Module:6 | Data Organisation | 7 hours |
|---|---|---|

| | | |
|---|---|---|
| Names, Lists, Arrays, Linking, Graphs, Hierarchies | | |
| **Module:7** | **Error Handling** | **5 hours** |
| Error Handling and Complex Conditionals; Errors: Typos – Poor Grammar and Ambiguities – Inconsistencies – Logical and Mathematical Errors; Mitigating Errors; Testing and Debugging | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture Hours** | **45 hours** |

**Text Book(s)**

- David D. Riley, Kenny A. Hunt, Computational Thinking For the Modern Problem Solver, CRC Press, 2014

**Reference Book(s)**

- John V. Guttag, Introduction to Computation and Programming using Python, The MIT Press, 2016
- Paolo Ferragina, Fabrizio Luccio, Compuational Thinking – First Alogorithms, Then Code, Springer, 2018
- Karl Beecher, Computational Thinking – A beginner's guide to problem-solving and programming, BCS Learning & Development Limited, 2017.
- Eric Freeman, Head First - Learn to Code, O'Reilly, 2018

**Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No.:59 | Date | 24-09-2020 |

| Course code | Ethics and values | L | T | P | J | C |
|---|---|---|---|---|---|---|
| HUM1021 / HUM1032 | | 2 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

- To understand and appreciate the ethical issues faced by an individual in profession, society, and polity
- To understand the negative health impacts of certain unhealthy behaviours
- To appreciate the need and importance of physical, emotional health and social health

**Expected Course Outcome:**

- Students will be able to:
- Follow sound morals and ethical values scrupulously to prove as good citizens
- Understand various social problems and learn to act ethically
- Understand the concept of addiction and how it will affect the physical and mental health
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use, and citation of sources, the objective presentation of data, and the treatment of human subjects
- Identify the main typologies, characteristics, activities, actors, and forms of cybercrime

| Module:1 | Being Good and Responsible | 5 hours |
|---|---|---|

Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society

| Module:2 | Social Issues 1 | 4 hours |
|---|---|---|

Harassment – Types - Prevention of harassment, Violence, and Terrorism

| Module:3 | Social Issues 2 | 4 hours |
|---|---|---|

Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices; White collar crimes - Tax evasions – Unfair trade practices

| Module:4 | Addiction and Health | 5 hours |
|---|---|---|

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases

| Module:5 | Drug Abuse | 3 hours |
|---|---|---|

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws, and prevention

| Module:6 | Personal and Professional Ethics | 4 hours |
|---|---|---|

Dishonesty - Stealing - Malpractices in Examinations – Plagiarism

| | | |
|---|---|---|
| **Module:7** | **Abuse of Technologies** | **3 hours** |
| Hacking and other cybercrimes, Addiction to mobile phone usage, Video games and Social networking websites | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **30 hours** |

**Reference Books**


- Dhaliwal, K.K, "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts,2016, Writers Choice, New Delhi, India.
- Vittal, N, "Ending Corruption? - How to Clean up India?" 2012, Penguin Publishers, UK.
- Pagliaro, L.A., and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological, Developmental and Clinical Considerations," 2012Wiley Publishers, U.S.A.
- Pandey, P. K (2012), "Sexual Harassment and Law in India," 2012, Lambert Publishers, Germany.


**Mode of Evaluation:** CAT, Assignment, Quiz, FAT, and Seminar

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2017 | | |
| Approved by Academic Council | No. 46 | Date | 24-08-2017 |

| Course code | Real Analysis and its Applications | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1024 | | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To acquaint the students with basic concepts and knowledge of real analysis
- To train the students in problem solving, occurring in the field of science and technology

**Expected Course Outcomes(CO's):**

- Students are able to understand the real number system and countable concepts in real number system
- Students are expected to recognize the difference between pointwise and uniform convergence of a sequence of functions.
- Students are able to determine the continuity and differentiability of functions defined on subsets of the real line
- Students are able to know the Fundamental theorems of Calculus
- Students are able to understand the concepts of Connectedness, Completeness and Compactness

| Module:1 | Sets and Functions | 6 hours | |
|---|---|---|---|

The Real Number System -Mathematical Induction -The Real Line-Sets and elements – Operations on sets – least upper bounds – Sequence of real numbers – Functions-Composition and inverses of functions-Relations-Equivalence Relations- Countable and uncountable sets

| Module:2 | Sequences | 6 hours | |
|---|---|---|---|

Definition of sequence and sub sequence – Limit of a sequence - Convergent sequence – Bounded sequence –Monotone sequence – Operations on convergent sequence.

| Module:3 | Series | 6 hours | |
|---|---|---|---|

Series of real numbers – Convergence and divergence – Series with non-negative terms – Alternating series – Conditional convergence and absolute convergence – Tests for absolute convergence

| Module:4 | Limits and Continuity | 6 hours | |
|---|---|---|---|

Limit of a Function – Algebra of Limits – Continuity of a function –Types of discontinuities – Elementary properties of continuous functions –Uniform continuity of a function-Applications.

| Module:5 | Derivatives | 7 hours | |
|---|---|---|---|

Functions continuous at a point on the real line – The Derivative – Rolle's theorem - Mean value theorem – Taylor's theorem – Maclaurin theorem – simple problems

| Module:6 | Integration | 6 hours | |
|---|---|---|---|

Riemann Integrability – Upper and Lower sums – Upper and Lower integral – The Riemann integral – Riemann criterion for integrability – Fundamental theorem of calculus –Improper integral – simple problems

| Module:7 | Functions of Several Variables | 6 hours | |
|---|---|---|---|

Limits and continuity Partial derivatives and Differentiability - Properties of differentiable

| | | | |
|---|---|---|---|
| functions Higher order derivatives and differentials - Maxima and Minima-Extrema under constraints | | | |
| **Module:8** | **Contemporary issues:** | **2 hours** | |
| Lecture by Industry Experts | | | |
| | **Total Lecture hours:** | **45 hours** | |
| **Text Book(s)** | | | |
| • Goldberge, Richard R, Methods of Real Analysis, Oxford & IBHP Publishing Co., New Delhi, 1970<br>• M.K,Singhal & Asha Rani Singhal , A First Course in Real Analysis, R.Chand & Co., June 1997 Edition | | | |
| **Reference Books** | | | |
| • Apostol T.M., Mathematical Analysis, 2nd Edition, Pearson, 1974.<br>• Shanthi Narayan, A Course of Mathematical Analysis, S. Chand & Co., 1995<br>• Rudin W., Principles of Mathematical Analysis, 3rd Edition, McGraw Hill Education (India), 2013.<br>• Robert G.Bartle and Donald R.Sherbert Introduction to Real Analysis, 4th Edition, Robert, Wiley-2014. | | | |
| Mode of evaluation: CAT / Digital Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course Code | Fundamentals of Mathematics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1001 | | 3 | 2 | 0 | 0 | 4 |
| Pre-requisite | None | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives**

The course is aimed at providing

- necessary and relevant background to understand the other important engineering mathematics courses
- basic knowledge for the non-mathematics students to learn further topics and apply it in solving real-world engineering problems

**Course Outcomes**

At the end of the course, the student should be able to

- Solve a system of linear equations by matrix method
- Apply the techniques of differentiation to find maxima and minima, and techniques of integration to evaluate areas and volumes of revolution
- Understand the concept of ordinary differential equations, and first and second-order linear differential equations
- Have a clear understanding of analytic geometry and vector algebra
- Apply concepts of mathematical logic and elementary probability to real-life problems

| Module:1 | Matrices | 5 hours |
|---|---|---|

Matrices - types of matrices - operations on matrices - determinants - adjoint matrix – Inverse of a matrix - solution of a system of linear equations by inversion method – elementary transformations – the rank of a matrix - consistency, and inconsistency of the system of equations

| Module:2 | Differential Calculus | 6 hours |
|---|---|---|

Differentiation of functions of a single variable – differentiation techniques physical interpretations - differentiation of implicit functions – higher-order derivatives – Taylor's, McClaurin's series - maxima and minima of functions of a single variable

| Module:3 | Integral Calculus | 6 hours |
|---|---|---|

Partial fractions - Integration- integration techniques- integration by parts- definite integrals – properties- evaluation of area and volume by integration

| Module:4 | Linear Ordinary Differential Equations | 6 hours |
|---|---|---|

Differential equations-definition and examples- formation of the differential equation- solving differential equations of the first order - solving second order homogenous differential equations with constant coefficients

| Module:5 | Analytic geometry | 5 hours |
|---|---|---|

Analytic geometry of three dimensions - direction cosines and direction ratios - plane, straight line and sphere, distance between points, distance to a plane

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| **Module:6** | **Vector Algebra** | **7 hours** |
| Vectors–operations on vectors-angle between two vectors-projection of one vector on another vector –equations of the plane, straight line, and sphere in vector forms-shortest distance between two skew lines - equation of a tangent plane to a sphere | | |
| | | |
| **Module:7** | **Logic and Probability** | **8 hours** |
| Mathematical logic – propositions – truth table – connectives– tautology – contradiction. Permutations and combinations – probability – classical approach – addition law - conditional probability - multiplicative law - Bayes' theorem and applications | | |
| | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| Tutorial | • A minimum of 10 problems to be worked out by students in every Tutorial Class<br>• Another 5 problems per Tutorial Class to be given as homework<br>Mode: Individual Exercises, Team Exercises, Online Quizzes, Online Discussion Forums | **30 hours** |

**Text Book(s)**

- Engineering Mathematics, K. A. Stroud, and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013).

**Reference Books**

- Elementary Engineering Mathematics, B. S. Grewal, 43rd edition, Khanna Publications, (2015).
- Discrete Mathematics, Seymour Lipschutz and Marc Lipson, 6th Edition, Tata McGraw - Hill (2017).
- Introduction to Probability and Statistics, Seymour Lipschutz and John Schiller, 3rd Indian Edition, Tata McGraw -Hill (2017).

Mode of Evaluation: Digital Assignments (Solutions by using a soft skill), Quiz, Continuous Assessments, Final Assessment Test

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 25-02-2017 | | |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |

| Course code | Lean Start up Management | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MGT1022 | | 1 | 0 | 0 | 4 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:** To develop the ability to

- Learn methods of company formation and management.
- Gain practical skills in and experience of stating business using a pre-set collection of business ideas.
- Learn the basics of entrepreneurial skills.

**Expected Course Outcome:** On the completion of this course, the student will be able to:

- Understand developing business models and growth drivers
- Use the business model canvas to map out key components of the enterprise
- Analyze market size, cost structure, revenue streams, and value chain
- Understand build-measure-learn principles Foreseeing and quantifying business and financial risks

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|---|---|---|
| **Module:1** | | **2 Hours** |
| Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity) | | |
| **Module:2** | | **3 Hours** |
| Minimum Viable Product (Value Proposition, Customer Segments, Build- measure-learn process) | | |
| **Module:3** | | **3 Hours** |
| Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model- templates) | | |
| **Module:4** | | **3 Hours** |
| Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, a Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money) | | |
| **Module:5** | | **3 Hours** |
| Legal, Regulatory, CSR, Standards, Taxes | | |
| **Module:6** | **Contemporary Issues** | **2 Hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture** | **15 hours** |

**Text Book(s)**

- The Startup Owner's Manual: The Step-By-Step Guide for Building a Great

| | |
|---|---|
| | Company, Steve Blank, K & S Ranch; 1st edition (March 1, 2012) |
| • | The Four Steps to the Epiphany, Steve Blank, K&S Ranch; 2nd edition (July 17, 2013) |
| • | The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business; (13 September 2011) |
| **Reference Books** | |
| • | Holding a Cat by the Tail, Steve Blank, K&S Ranch Publishing LLC (August 14, 2014) |
| • | Product Design and Development, Karal T Ulrich, SD Eppinger, McGraw Hill |
| • | Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business(2014) |
| • | Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), Alistair Croll & Benjamin Yoskovitz, O'Reilly Media; 1st Edition (March 21, 2013) |
| • | Inspired: How To Create Products Customers Love, Marty Cagan, SVPG Press; 1st edition (June 18, 2008) |

**Website References:**

1. http://theleanstartup.com/
2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries
3. http://businessmodelgeneration.com/
4. https://www.leanstartupmachine.com/
5. https://www.youtube.com/watch?v=fEvKo90qBns
6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref
7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms
8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/
9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything
10. chventures.blogspot.in/ platformsandnetworks.blogspot.in/p/saas-model.html

**Mode of Evaluation**: Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks

| **Project** | | |
|---|---|---|
| 1. | Project | **60 hours** |
| | **Total Project** | **60 hours** |

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| Recommended by Board of Studies | 08-06-2015 | | |
| Approved by Academic Council | No. 37 | Date | 16-06-2015 |

| Course code | Physics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| PHY1003 | | 3 | 0 | 2 | 4 | 5 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

To enable the student to understand the basic principles of Physics behind (a) those latest areas of biotechnology such as nanobiotechnology and (b) medical applications involving lasers, ultrasound and fiber optics

**Expected Course Outcome: Students will be able to**

- Understand the concept of dual nature of the electromagnetic radiation and its verification
- Understand the quantum physics concept by studying the behavior of the particle in a box.
- Study the material properties as a function of particle size, especially at the nano level.
- Explore the properties and types of LASERs and its application.
- Understand the properties, production, and detection of Ultrasonic waves.
- Get insight into the communication system through fiber optics.
- Learn the applications of LASER, Ultrasonic and Fiber optics in the medical field and to appreciate the contemporary issues.
- Demonstrate the ideas of quantum nature and ultrasonic waves-LAB
- Carry out a mini project in the abovementioned topics-J COMPONENT

| Module:1 | Quantum Physics | 7 hours |
|---|---|---|

Dual nature of electromagnetic radiation, Compton effect (Qualitative), experimental verification- deBroglie waves- Davisson-Germer Experiment, Heisenberg uncertainty principle - Schrödinger equation.

| Module:2 | Applications of Quantum Physics | 6 hours |
|---|---|---|

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative), Scanning Tunneling Microscope, Atomic Force Microscope.

| Module:3 | Nanotechnology | 6 hours |
|---|---|---|

Introduction to Nano-materials, Properties of Nano-materials, Bionanomaterials, membranes, electrical properties of nano membranes, CNT, Applications of nanobiotechnology- longer-lasting medical implants, nanodrugs

| Module:4 | Lasers | 6 hours |
|---|---|---|

Laser characteristics, Einstein's theory of stimulated emission, pumping mechanisms-population inversion, three-level, four-level lasers, Nd-YAG, He-Ne-laser, CO2 laser.

| Module:5 | Ultrasonics | 6 hours |
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Properties of ultrasonics, generation- Magnetostriction method, Piezoelectric method, detection of ultrasonics.

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| **Module:6** | **Fiber Optics** | **6 hours** |
| Light propagation through fiber, Acceptance angle, numerical aperture, types of fiber. | | |
| **Module:7** | **Application of Lasers, Ultrasonics and Fiber Optics** | **6 hours** |
| Laser in surgery, ophthalmology, dentistry, ultrasonogram, POT-sensors- fiber-optic-biosensors, keyhole surgery. | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Concepts of Modern Physics, Arthur Besier, Shobhit Mahajan, S. Rai Choudhury, 7th Edition, Tata - McGraw
- Laser Fundamentals, William Silfvast, 2nd edition, Cambridge University Press, Cambridge. 2008 [a Classic book on the subject of Laser]
- Fiber Optic Communication Technology, Djafar K. Mynbaev, and Lowell L. Scheiner, Addison Wesley Longman, Singapore, 2011
- Ultrasonics: Fundamentals, Technologies, and Application, Dale Ensminger, Leonard J. Bond, 3rd Edition, CRC Press, London, 2011

**Reference Books**

- Modern Physics, Raymond A. Serway, Clement J. Mosses, Curt A. Moyer, 3rd Edition, Cengage Learning, Boston, 2010
- Laser Systems and Applications, Nityanand Choudhary and Richa Verma, PHI Learning Private Ltd., New Delhi, 2011
- Lasers and Optical Instrumentation, S. Nagabhushana and B. Sathyanarayana, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010
- Fundamentals and Applications of Ultrasonic Waves, J. David N. Cheeke, 2nd Edition, CRC Press, London, 2012

Mode of Evaluation: Quizzes, Digital Assignments, CAT-I and II and FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 13.05.2017 | | |
| Approved by Academic Council | No. 45 | Date | 15.06.2017 |

**List of Challenging Experiments (Indicative)**

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|---|---|---|
| 1. | Calculation of interplanar spacing of polycrystalline graphite from electron diffraction pattern (Module 1) | 2 hrs |
| 2. | Fabry Perot Interferometer: Determination of wavelength of the laser beam and finding spacing of the etalon (Module 4) | 2 hrs |
| 3. | Determination of wavelength of the laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction technique (Module 4) | 2 hrs |
| 4. | Integrated optics: Determination of refractive index of the prism (Module 6) | 2 hrs |
| 5. | Determination of refractive index of various liquids (Module 6) | 2 hrs |

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|---|---|---|
| 6. | Optical Fiber Characterization: determination of numerical aperture of a given multimode optical fiber (Module 6) | 2 hrs |
| 7. | Determination of the size of the fine particle using laser diffraction (Module 4) | 2 hrs |
| 8. | Determination of the track width (periodicity) in a written CD (Module 4) | 2 hrs |
| 9. | Analysis of crystallite size and strain in a nano-crystalline film using a given X-ray diffraction pattern (Module 3) | 2 hrs |
| 10. | Ultrasonic interferometer: Determination of velocity of the ultrasonic wave in different liquids and its adiabatic compressibility (Module 5) | 2 hrs |
| 11. | Numerical solutions of Schrödinger equation (e.g., particle in a box problem) (can be given as an assignment) (Module 1) | 2 hrs |
| 12. | Exploring the link between quantum confinement and Heisenberg's uncertainty principle (can be given as assignment). (Module 1+3) | 2 hrs |
| | Total Laboratory Hours | 24 hrs |

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| Recommended by Board of Studies | 13.05.2017 | | |
| Approved by Academic Council | No. 45 | Date | 15.06.2017 |

| Course code | ESPAÑOL FUNDAMENTAL | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ESP1001 | | 2 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

The course gives students the necessary background to:

- Demonstrate proficiency in reading, writing, and speaking in basic Spanish. Learning vocabulary related to profession, education centers, day-today activities, food, culture, sports and hobby, the family set up, workplace, market, and classroom activities is essential.
- Demonstrate the ability to describe things and will be able to translate into English and vice versa.
- Describe in simple terms (both in written and oral form) aspects of their background, immediate environment, and matters in areas of immediate need.

**Expected Course Outcome:**

The students will be able to

- Remember greetings, giving personal details and Identify genders by using correct articles
- Apply the correct use of SER, ESTAR and TENER verb for describing people, place, and things
- Create opinion about time and weather conditions by knowing months, days and seasons in Spanish
- Create opinion about people and places by using regular verbs
- Apply reflexive verbs for writing about the daily routine and create small paragraphs about hometown, best friend and family

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|---|---|---|
| **Module:1** | Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Profesión | **3 hours** |

Competencia Gramática: Vocales y Consonantes. Artículos definidos e indefinidos (Numero y Genero). Competencia Escrita: Saludos y Datos personales

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| **Module:2** | Edad y posesión. Números (1-20) | **3 hours** |

Competencia Gramática: Pronombres personales. Adjetivos. Los verbos SER y TENER. Competencia Escrita: Escribe sobre mismo/a y los compañeros de la clase

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|---|---|---|
| **Module:3** | Vocabulario de Mi habitación. Colores. Descripción de lugares y cosas. | **5 hours** |

Competencia Gramática: Adjetivos posesivos. El uso del verbo ESTAR. Diferencia entre SER y ESTAR.
Competencia Escrita: Mi habitación

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| **Module:4** | Mi familia. Números (21-100). Direcciones. Expresar la hora. Los meses del año. | **4 hours** |

Competencia Gramática: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR Competencia Escrita: Mi familia. Dar opiniones sobre tiempo

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| **Module:5** | Expresar fechas y el tiempo. Dar opiniones sobre personas y lugares. | **5 hours** |
| Competencia Gramática: Los verbos regulares (-AR, -ER, -IR) en el presente. Adjetivos demostrativos.<br>Competencia Escrita: Mi mejor amigo/a. Expresar fechas. Traducción ingles a español y Español a Ingles. | | |
| **Module:6** | Describir el diario. Las actividades cotidianas. | **3 hours** |
| Competencia Gramática: Los Verbos y pronombres reflexivos. Los verbos pronominales con e/ie, o/ue, e/i, u/ue. Competencia Escrita: El horario. Traducción ingles a español y Español a Ingles. | | |
| **Module:7** | Dar opiniones sobre comidas y bebidas. Decir lo que está haciendo. Describir mi ciudad y Ubicar los sitios en la ciudad. | **5 hours** |
| Competencia Gramática: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo.<br>Competencia Escrita: Conversación en un restaurante. Traducción ingles a español y Español a Ingles. Mi ciudad natal. Mi Universidad. La clase. Mi fiesta favorita. | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

- **Text Book**:**"Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication ; reprinted Edition, (2010)**

**Reference Books**

- "¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006.
- "Practice makes perfect: Spanish Vocabulary," Dorothy Richmond, McGraw Hill Contemporary, USA,2012.
- "Practice makes perfect: Basic Spanish," Dorothy Richmond, McGraw Hill Contemporary, USA 2009.
- "Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010.

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|---|---|---|---|
| Recommended by Board of Studies | 22-02-2016 | | |
| Approved by Academic Council | No. 41 | Date | 17-06-2016 |

| Course code | Français Progressif | L | T | P | J | C |
|---|---|---|---|---|---|---|
| FRE2001 | | 2 | 0 | 1 | 0 | 3 |
| Pre-requisite | Français quotidian | Syllabus version | | | | |
| | | | | | | |

**Course Objectives:**

The course gives students the necessary background to:

- Understand isolated sentences and frequently used expressions in relation to immediate priority areas (personal or family information, shopping, close environment, work).
- Communicate in simple and routine tasks requiring only a simple and direct exchange of information on familiar and habitual topics.
- Enable students to describe with simply means his training, his immediate environment and evoke familiar and habitual subjects, evoke subjects that correspond to immediate needs.

**Expected Course Outcome:**

The students will be able to :

- Understand expressions in French.
- Create sentences by using frequent lexicon related to himself, his family, his close environment (family, shopping, work, school, etc).
- Understand simple, clear messages on the internet, authentic documents.
- Analyze predictable information in common documents, such as advertisements, flyers, menus, schedules, simple personal letters.
- Create simple and routine tasks.
- Create a simple and direct exchange of information on familiar activities and topics.

| Module:1 | Expressions simples | 8 hours |
|---|---|---|

La vie quotidiennes - Le verbe pronominal - Le passé composé avec l'auxiliaire - avoir et être- le passé récent : venir de + infinitif - Le comparatif - Le superlatif - Les mots interrogatifs (les trois formes)

**Savoir-faire pour** : Faire des achats, faire des commandes dans un restaurant, poser des questions.

| Module:2 | Les activitiés quotidiennes | 6 hours |
|---|---|---|

La vie privée et publique (Les achats, Les voyages, les transports-La nourriture, etc.) - Les lieux de la ville - Les mots du savoir-vivre - Les pronoms indéfinis - Les pronoms démonstratifs - Les pronoms compléments objets directs/ indirects - La formation du future simple et future proche

**Savoir-faire pour :** Réserver les billets pour le voyage, réserver les chambres dans un hôtel, S'informer sur les lieux de la ville, indiquer la direction à un étranger.

| Module:3 | Les activités de loisirs | 7 hours |
|---|---|---|

Les loisirs (sports/spectacles/activités) - Les moments de la journée, de l'année- La fête indienne et française – Les goûts - L'impératif - La négation de l'impératif-La place du pronom à l'impératif avec un verbe pronominal.

**Savoir-faire pour :** Parler de ses goûts, raconter les vacances, formuler des phrases plus

| | | |
|---|---|---|
| compliquées, Raconter les souvenirs de l'enfance, parler sur la tradition de son pays natal. | | |
| | | |
| **Module:4** | **La Francophonie** | **7 hours** |
| L'espace francophone - Première approche de la société française – La consommation alimentaire – caractériser un objet – décrire une tenue - Le pronom relatif (qui/que/dont/où)<br>**Savoir-faire pour :**<br>Articles de la presse-Portrait d'une personne-Cartes et messages d'invitation, d'acceptation ou de refus -Article de presse - rédaction d'un événement. | | |
| | | |
| **Module:5** | **La culture française** | **5 hours** |
| Parler de ses activités quotidiennes - les fêtes en France – Parler de sa famille – réserver un billet à l'agence - la gastronomie française | | |
| | | |
| **Module:6** | **La description** | **5 hours** |
| Décrire physiquement une personne – les vacances – les achats – réserver une chambre dans un hôtel – les plus grands français - raconter des évènements passés | | |
| | | |
| **Module:7** | **S'exprimer** | **5 hours** |
| Parler du climat - parcours francophone – placer une commande au restaurant –- la mode - parler de son projet d'avenir. | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| • | Alter Ego 1, Méthode de français, Annie Berthet, Hachette, Paris 2010. |
| • | Alter Ego 1, Cahier d'exercices, Annie Berthet, Hachette, Paris 2010. |
| **Reference Books** | |
| • | CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2010. |
| • | CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010 |
| • | Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010. |

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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 22-02-2016 | | |
| Approved by Academic Council | No.41 | Date | 17-06-2016 |

| Course code | Grundstufe Deutsch | L | T | P | J | C |
|---|---|---|---|---|---|---|
| GER1001 | | 2 | 0 | 0 | 0 | 2 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1 | | | | |

**Course Objectives:**

The course gives students the necessary background to:

- Demonstrate proficiency in reading, writing, and speaking in basic German. Learning vocabulary related to profession, education centers, day-to-day activities, food, culture, sports and hobby, the family set up, workplace, market, and classroom activities are essential.
- Make the student's industry-oriented and make them adapt to the German culture.

**Expected Course Outcome:**

The students will be able to

- Remember greeting people, introducing oneself, and understanding basic expressions in German.
- Understand necessary grammar skills to use these in a meaning way.
- Remember beginner's level vocabulary
- Create sentences in German on a variety of topics with significant precision and detail.
- Apply good comprehension of written discourse in areas of special interests.

| Module:1 | | 3 hours |
|---|---|---|

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen, wohnen, lernen, Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel - Bestimmter- Unbestimmter Artikel)

**Lernziel :**

Sich vorstellen, Grundlegendes Verständnis von Deutsch, Deutschland in Europa

| Module:2 | | 3 hours |
|---|---|---|

Konjugation der Verben (regelmässig /unregelmässig),das Jahr- Monate, Jahreszeiten und die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit ,,Sie''

Lernziel:

Sätze schreiben, über Hobbys, Berufe erzählen, usw

| Module:3 | | 6 hours |
|---|---|---|

Possessivpronomen, Negation, Kasus (Bestimmter- Unbestimmter Artikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, Getränkeund Essen, Farben, Tiere

**Lernziel :**

Sätze mit Modalverben, Verwendung von Artikel, Adjektiv beim Verb

| Module:4 | | 4 hours |
|---|---|---|

Übersetzung: (Deutsch – Englisch / Englisch – Deutsch)

| | | |
|---|---|---|
| **Lernziel :**<br>Die Übung von Grammatik und Wortschatz | | |
| | | |
| **Module:5** | | **5 hours** |
| Leserverständnis. Mindmap machen, Korrespondenz- Briefe und Email<br>**Lernziel:**<br>Übung der Sprache, Wortschatzbildung | | |
| | | |
| **Module:6** | | **5 hours** |
| **Aufsätze :**Die Familie, Bundesländer in Deutschland, Ein Fest in Deutschland,<br>**Lernziel :**<br>Aktiver, selbständiger Gebrauch der Sprache | | |
| | | |
| **Module:7** | | **4 hours** |
| Dialoge:<br>a) Gespräche mit einem/einer Freund /Freundin.<br>b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ;<br>c) in einem Hotel - an der Rezeption ; ein Termin beim Arzt.<br>d) Ein Telefongespräch ; Einladung–Abendessen | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| • | Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-Langenscheidt Verlag, München : 2013 |
| **Reference Books** | |
| • . | Lagune, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012. |
| • | Deutsche Sprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, 2013 |
| • | Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin :2010 |
| • | Tangram Aktuell-I, Maria-Rosa, SchoenherrTil, Max Hueber Verlag, Muenchen :2012 |
| | www.goethe.de<br>wirtschaftsdeutsch.de<br>hueber.de<br>klett-sprachen.de<br>www.deutschtraning.org |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 04-03-2016 | | |
| Approved by Academic Council | No. 41 | Date | 17-06-2016 |

| Course code | ESPAÑOL INTERMEDIO | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ESP2001 | | 2 | 0 | 2 | 0 | 3 |
| Pre-requisite | | Syllabus version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

The course gives students the necessary background to:

- Enable students to read, listen and communicate in Spanish in their day to day life.
- Enable students to describe situations by using present, past, and future tenses in Spanish.
- Enable to develop comprehension skill in Spanish language.

**Expected Course Outcome:**

The students will be able to

- Create sentences in near future and future tenses and correctly using the prepositions like POR and PARA
- Create sentences in preterito perfecto and correctly use the direct and indirect object pronouns
- Create sentences related to likes and dislikes and also give commands in a formal and informal way
- Create sentences in past tense by using imperfecto and idefinido forms and describe past events
- Create conversations in Spanish at places like restaurants, hotels, Shops and Railway stations
- Understand different Spanish speaking countries and its culture and traditions.

| Module:1 | Números (101 – 1 millón). Expresar los planes futuros. Los números ordinales. | 7 hours |
|---|---|---|

Competencia Gramática: Futuros cercanos (Ir+a+Infinitivo). Futuros (Verbos regulares e irregulares). Uso del POR y PARA.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

| Module:2 | Las ropas, colores y tamaños. Costar, valer, descuentos y rebajas | 8 hours |
|---|---|---|

Competencia Gramática: Pronombres objetivos directos e indirectos. El verbo Gustar y Disgustar.
Competencia Escrita: Traducción ingles a español y español a Ingles. Comprensión - Los textos y Videos

| Module:3 | Escribir un Correo electrónico formal e informal. | 7 hours |
|---|---|---|

Competencia Gramática: Imperativos formales e informales. Pretérito perfecto.
Competencia Escrita: Traducción ingles a español y español a Ingles.
Comprensión - Los textos y Videos

| Module:4 | Currículo Vitae. Presentarse en una entrevista informal. | 6 hours |
|---|---|---|

| | | |
|---|---|---|
| Competencia Gramática: Pretérito imperfecto. Pretérito indefinido.<br>Competencia Escrita: Traducción ingles a español y español a Ingles.<br>Comprensión - Los textos y Videos | | |
| **Module:5** | **Introducción personal, Expresar los planes futuros.** | **5 hours** |
| Comprensión oral: Introducción personal, Expresar los planes futuros. ¿Qué vas a hacer en las próximas vacaciones?<br>Comprensión auditiva: Las preguntas sobre un cuento auditivo. Relacionar el audio con las imágenes. Las preguntas basadas en canciones.<br>Medio de transporte: Comprar y Reservar billetes. | | |
| | | |
| **Module:6** | **Diálogos entre dos** | **5 hours** |
| Comprensión oral: Diálogos entre dos (cliente y tendero de ropas, pasajero y empleado, en un restaurante, Reservación de habitación en un hotel). Presentación en una entrevista.<br>Comprensión auditiva: Las preguntas basadas en canciones. Las preguntas basadas en diálogos. | | |
| | | |
| **Module:7** | **Presentación de los países hispánicos.** | **5 hours** |
| Comprensión oral: Dialogo entre un médico y paciente. Presentación de los países hispánicos. Describir su infancia. Describir vacaciones últimas o las actividades de último fin de semana.<br>Comprensión auditiva: Rellenar los blancos del cuento en pasado. Las preguntas basadas en el cuento. Las preguntas basadas en un anuncio | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |
| **Text Book(s)** | | |
| • | "Aula Internacional 1", Jaime Corpas, Eva Garcia, Agustin Garmendia, Carmen Soriano Goyal Publication; reprinted Edition, Delhi (2010) | |
| **Reference Books** | | |
| • | "¡AcciónGramática!", Phil Turk and Mike Zollo, Hodder Murray, London 2006. | |
| • | "Practice makes perfect: Spanish Vocabulary", Dorothy Richmond, McGraw Hill Contemporary, USA,2012. | |
| • | "Practice makes perfect: Basic Spanish", Dorothy Richmond, McGraw Hill Contemporary, USA 2009. | |
| • | "Pasaporte A1 Foundation", Matilde Cerrolaza Aragón, Óscar Cerrolaza Gili, Begoña Llovet Barquero, Edelsa Grupo, España, 2010. | |
| | Authors, book title, year of publication, edition number, press, place | |

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|---|---|---|---|
| Recommended by Board of Studies | 04-03-2016 | | |
| Approved by Academic Council | No. 41 | Date | 17-06-2016 |

| Course code | Introduction to Soft skills | L | T | P | J | C |
|---|---|---|---|---|---|---|
| STS 1021 | | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | None | Syllabus version | | | | |
| | | | | | | |

**Course Objectives:**

- To enhance critical thinking and innovative skills
- To have a working knowledge of communicating in English
- To have critical thinking and innovative skills

**Expected Course Outcome:**

- Students will be able to exhibit appropriate presentation skills
- Students will be able to exhibit appropriate analytical skills
- The students will be able to deliver impactful presentations

| Module:1 | Lessons on excellence | 10 hours |
|---|---|---|

**Ethics and integrity**

Importance of ethics in life, Intuitionism vs. Consequentialism, Non-consequentialism, Virtue ethics vs. situation ethics, Integrity - listen to conscience, Stand up for what is right

**Change management**

Who moved my cheese?, Tolerance of change and uncertainty, Joining the bandwagon, Adapting change for growth - overcoming inhibition

**How to pick up skills faster?**

Knowledge vs. skill, Skill introspection, Skill acquisition, "10,000 hours rule" and the converse

**Habit formation**

Know your habits? How habits work? - The scientific approach, How habits work? - The psychological approach, Habits and professional success, "The Habit Loop," Domino effect, Unlearning a bad habit

**Analytic and research skills.**

Focused and targeted information seeking, How to make Google work for you, Data assimilation

| Module:2 | Team skills | 11 hours |
|---|---|---|

**Goal setting**

SMART goals, Action plans, Obstacles -Failure management

**Motivation**

Rewards and other motivational factors, Maslow's hierarchy of needs, Internal and external motivation

**Facilitation**

Planning and sequencing, Challenge by choice, Full Value Contract (FVC), Experiential learning cycle, Facilitating the Debrief

**Introspection**

Identify your USP, Recognize your strengths and weakness, Nurture strengths, Fixing weakness, Overcoming your complex, Confidence building

**Trust and collaboration**
Virtual Team building, Flexibility, Delegating, Shouldering responsibilities

| **Module:3** | **Emotional Intelligence** | **12 hours** |
|---|---|---|

**Transactional Analysis**
Introduction**,** Contracting, Ego states**,** Life positions
**Brain storming**
Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming
**Psychometric Analysis**
Skill Test, Personality Test
**Rebus Puzzles/Problem Solving**
More than one answer, Unique ways

| **Module:4** | **Adaptability** | **12 hours** |
|---|---|---|

**Theatrix**
Motion Picture, Drama, Role Play, Different kinds of expressions
**Creative expression**
Writing, Graphic Arts, Music, Art and Dance
**Flexibility of thought**
The 5'P' framework (Profiling, prioritizing, problem analysis, problem-solving, planning)
**Adapt to changes(tolerance of change and uncertainty)**
Adaptability Curve, Survivor syndrome

| | **Total Lecture hours:** | **45 hours** |
|---|---|---|

**Text Book(s)**

- Chip Heath, How to Change Things When Change Is Hard (Hardcover**)**, 2010, First Edition, Crown Business.
- Karen Kindrachuk, Introspection**,** 2010, 1st Edition.
- Karen Hough, The Improvisation Edge: Secrets to Building Trust and Radical Collaboration at Work, 2011, Berrett-Koehler Publishers

**Reference Books**

- Gideon Mellenbergh, A Conceptual Introduction to Psychometrics: Development, Analysis, and Application of Psychological and Educational Tests, 2011, Boom Eleven International.
- Phil Lapworth, An Introduction to Transactional Analysis, 2011, Sage Publications (CA)

**Mode of Evaluation**: FAT, Assignments, Projects, Case studies, Roleplays,3 Assessments with Term End FAT (Computer Based Test)

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|---|---|---|---|
| Recommended by Board of Studies | | 09-06-2017 | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| STS1022 | Introduction to Personal Skills | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | | Syllabus version | | | | |
| | | 2 | | | | |

**Course Objectives:**

1. 1. To Identify and develop personal skills to become a more effective team member/leader.
2. To Examine, Clarify and apply positive values and ethical principles.
3. To Develop habits which promote good physical and mental health.

**Expected Course Outcome:**

- Enabling students to exhibit appropriate presentation and analytical skills

| Module:1 | Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions | 7 hours |
|---|---|---|

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

| Module:2 | Analytical Writing – Articulate and support complex ideas | 6 hours |
|---|---|---|

30 minute - Analyse an Issue, 30 minute - Analyse an Argument, Construct and Evaluate arguments, Focused and Coherent discussion

| Module:3 | Speed Reading and Things to avoid during speed reading | 6 hours |
|---|---|---|

Skimming, Meta guiding, Auditory reading, Visual reading, Eye span expansion, Pareto principle, Applications of Pareto principle, Sub-vocalization, Regression, Pen Tracing

| Module:4 | Debate | 8 hours |
|---|---|---|

Idea generation, Research, Articulating, Style, Preparation of arguments –Rebuttal, Use of statistics, Practice rounds

| Module:5 | PEST Analysis | 7 hours |
|---|---|---|

SLEPT, STEEPLE, 360 Feedback

| Module:6 | Lean Concepts | 3 hours |
|---|---|---|

Product life cycle, Waste reduction, Technology change, Product support

| Module:7 | Listening | 8 hours |
|---|---|---|

Types of Listening, Hearing, Focus, Voice, Verbal and Non-verbal messages

| | Total Lecture hours: | 45 hours |
|---|---|---|

**Reference Books**

1. Dale Carnegie,(1936) How to Win Friends and Influence People. New York City. Gallery Books
2. Joyce Aemstrong and Carroll(1992) Integrated Teaching of Reading, Writing, Listening, Speaking, Viewing and Thinking. Korea. Libraries Unlimited Inc.
3. Theo Theobald(2011) Develop your Presentation Skills. New Delhi. Kogan Page Limited.

**Websites:**

| | | | |
|---|---|---|---|
| www.chalkstreet.com<br>www.skillsyouneed.com<br>www.mindtools.com<br>www.thebalance.com<br>www.eguru.ooo | | | |
| Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test) | | | |
| Recommended by Board of Studies | 09-06-2017 | | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| STS2021 | Fundamentals of Aptitude | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | | Syllabus version | | | | |
| | | 2.0 | | | | |

**Course Objectives:**

1 To develop the students' vocabulary knowledge
2 To learn the strategies of solving quantitative ability problems
3 3 To enrich the verbal ability of the students
4 To enhance students communication skills

**Expected Course Outcome:**

- To open up the wide area of social interaction and improving business vocabulary.

| | | |
|---|---|---|
| **Module:1** | **Building personal lexicon** | **6 hours** |
| Benefits of becoming a logophile, Etymology – Root words, Prefix and suffix, Cue card technique, Mnemonic technique of learning words, word games | | |
| **Module:2** | **Social interaction** | **4 hours** |
| Accountability, Commitment, Interdependency | | |
| **Module:3** | **Audit** | **6 hours** |
| Questioning, IT auditing, System audit, Process audit, Audit cycle, Quality audit | | |
| **Module:4** | **Thinking Skills and Introduction to problem solving process and Introduction to decision making and decision making process** | **6 hours** |
| Steps to solve the problem, Simplex process, Steps involved from identification to implementation, Decision making model | | |
| **Module:5** | **Quantitative ability – Speed Maths** | **8 hours** |
| Multiplication Shortcuts, Cubes and squares, Cube root and square root, Vedic maths, Maths magic, puzzles, Brain teasers | | |
| **Module:6** | **Logical ability – Logical Links** | **3 hours** |
| Logic based questions-based on numbers and alphabets | | |
| **Module:7** | **Verbal ability – Strengthening Grammar Fundamentals** | **6 hours** |
| Parts of speech, Tenses, Verbs( Gerunds and infinitives) | | |
| **Module:8** | **Communication and Attitude – Self managing:** | **6 hours** |
| Concepts of self management and self motivation, Greet and Know, Choice of words, Giving feedback, Taking criticism | | |
| | **Total Lecture hours:** | **45 hours** |

**Reference Books**


1. David Allen (2002) Getting Things done : The Art of Stress -Free productivity. New York City. Simon and Schuster.
2. M. Tyra (2013) Magical Book On Quicker Maths. New Delhi. BSC Publishing

| | | | | |
|---|---|---|---|---|
| 3. | FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications | | | |
| 4. | ETHNUS(2013) Aptimithra. Bangalore. sMcGraw-Hill Education Pvt. Ltd. | | | |
| **Websites:** | | | | |
| 1. | www.chalkstreet.com | | | |
| 2. | www.skillsyouneed.com | | | |
| 3. | www.mindtools.com | | | |
| 4. | www.thebalance.com | | | |
| 5. | www.eguru.ooo | | | |
| Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test) | | | | |
| Recommended by Board of Studies | | 09-06-2017 | | |
| Approved by Academic Council | | No. 45 | Date | 15-06-2017 |

| STS2022 | Introduction to Business Communication | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 2.0 | | | | |

**Course Objectives:**

1 To develop the students' logical thinking skills
2 To learn the strategies of solving quantitative ability problems 3 To enrich the verbal ability of the students

**Expected Course Outcome:**

- Enabling students enhance knowledge of relevant topics and evaluate the information

| Module:1 | Study skills | 10 hours |
|---|---|---|

Memory techniques
Relation between memory and brain, Story line technique, Learning by mistake, Image-name association, Sharing knowledge, Visualization
Concept map
Mind Map, Algorithm Mapping, Top down and Bottom Up Approach
Time management skills
Prioritization - Time Busters, Procrastination, Scheduling, Multitasking, Monitoring
6. Working under pressure and adhering to deadlines

| Module:2 | Emotional Intelligence (Self Esteem ) | 6 hours |
|---|---|---|

Empathy
Affective Empathy and Cognitive Empathy
Sympathy
Level of sympathy (Spatial proximity, Social Proximity, Compassion fatigue)

| Module:3 | Business Etiquette | 9 hours |
|---|---|---|

Social and Cultural Etiquette
Value, Manners, Customs, Language, Tradition
Writing Company Blogs
Building a blog, Developing brand message, FAQs', Assessing Competition
Internal Communications
Open and objective Communication, Two way dialogue, Understanding the audience
Planning
Identifying, Gathering Information, Analysis, Determining, Selecting plan, Progress check, Types of planning
Writing press release and meeting notes
Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph, Body – Make it relevant to your audience

| Module:4 | Quantitative Ability | 4 hours |
|---|---|---|

Numeracy concepts
Fractions, Decimals, Bodmas, Simplifications, HCF, LCM, Tests of divisibility

| | | | |
|---|---|---|---|
| Beginning to Think without Ink<br>Problems solving using techniques such as: Percentage, Proportionality, Support of answer choices, Substitution of convenient values, Bottom-up approach etc. | | | |
| | | | |
| **Module:5** | **Reasoning Ability** | | **3 hours** |
| Interpreting Diagramming and sequencing information<br>Picture analogy, Odd picture, Picture sequence, Picture formation, Mirror image and water image | | | |
| | | | |
| **Module:6** | **Verbal Ability** | | **3 hours** |
| Reinforcements of Grammar concepts<br>Subject Verb Agreement, Active and Passive Voice, Reported Speech | | | |
| | | | |
| **Module:7** | **Communication and Attitude** | | **10 hours** |
| Writing<br>Writing formal & informal letters, How to write a blog & knowing the format, Effective ways of writing a blog, How to write an articles & knowing the format, Effective ways of writing an articles, Designing a brochures<br>Speaking skills<br>How to present a JAM, Public speaking | | | |
| | | | |
| | **Total Lecture hours:** | | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | FACE, Aptipedia, Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi. |
| 2. | ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt. Ltd. |
| **Reference Books** | |
| 1. | Alan Bond and Nancy Schuman, 300+ Successful Business Letters for All Occasions, 2010, Third Edition, Barron's Educational Series, New York. |
| 2. | Josh Kaufman, The First 20 Hours: How to Learn Anything ... Fast , 2014, First Edition, Penguin Books, USA. |

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|---|---|---|---|
| Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test) | | | |
| Recommended by Board of Studies | 09-06-2017 | | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| STS3021 | Reasoning Skill Enhancement | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| **Pre-requisite** | **None** | **Syllabus version** | | | | |
| | | 2.0 | | | | |

**Course Objectives:**

1. To accomplish a very specific and measurable terms that supports social media and interaction.
2. To cultivate a positive outlook on responsibility, Delegation and Compliance.
3. To enhance their Quantitative, reasoning and Verbal ability.

**Expected Course Outcome:**

- Understanding the various strategies of conflict resolution among peers and supervisors and respond appropriately

| **Module:1** | **Social Interaction and Social Media** | **6 hours** |
|---|---|---|

Effective use of social media
Types of social media, Moderating personal information, Social media for job/profession, Communicating diplomatically
Networking on social media
Maximizing network with social media, How to advertise on social media
Event management
Event management methods, Effective techniques for better event management
Influencing
How to win friends and influence people, Building relationships, Persistence and resilience, Tools for talking when stakes are high
Conflict resolution
Definition and strategies , Styles of conflict resolution

| **Module:2** | **Non Verbal Communication** | **6 hours** |
|---|---|---|

Proximecs
Types of proximecs, Rapport building Reports and Data Transcoding Types of reports
Negotiation Skill
Effective negotiation strategies
Conflict Resolution
Types of conflicts

| **Module:3** | **Interpersonal Skill** | **8 hours** |
|---|---|---|

Social Interaction
Interpersonal Communication, Peer Communication, Bonding, Types of social interaction
Responsibility
Types of responsibilities, Moral and personal responsibilities
Networking
Competition, Collaboration, Content sharing
Personal Branding
Image Building, Grooming, Using social media for branding

| | | |
|---|---|---|
| Delegation and compliance<br>Assignment and responsibility, Grant of authority, Creation of accountability | | |
| **Module:4** | **Quantitative Ability** | **10 hours** |
| Number properties<br>Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position<br>Averages<br>Averages, Weighted Average<br>Progressions<br>Arithmetic Progression, Geometric Progression, Harmonic Progression<br>Percentages<br>Increase & Decrease or successive increase<br>Ratios<br>Types of ratios and proportions | | |
| **Module:5** | **Reasoning Ability** | **8 hours** |
| Analytical Reasoning<br>Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table | | |
| **Module:6** | **Verbal Ability** | **7 hours** |
| Vocabulary Building<br>Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi. |
| 2. | ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt.Ltd. |
| 3. | Mark G. Frank, David Matsumoto, Hyi Sung Hwang, Nonverbal Communication: Science and Applications, 2012, 1st Edition, Sage Publications, New York. |
| **Reference Books** | |
| 1. | Arun Sharma, Quantitative aptitude, 2016, 7th edition, Mcgraw Hill Education Pvt. Ltd. |
| 2. | Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler, Crucial Conversations: Tools for Talking When Stakes are High, 2001, 1st edition McGraw Hill Contemporary, Bangalore. |
| 3. | Dale Carnegie, How to Win Friends and Influence People, Latest Edition, 2016. Gallery Books, New York. |

| | | | |
|---|---|---|---|
| Mode of evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test) | | | |
| Recommended by Board of Studies | 09-06-2017 | | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| STS3022 | Introduction to Etiquette | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| **Pre-requisite** | **None** | **Syllabus version** | | | | |
| | | 2.0 | | | | |

**Course Objectives:**

1. To learn how to analyze social psychological phenomena in terms of impression management.
2. To apply the skills of working collaboratively with others.
3. To strengthen quantitative, reasoning and verbal ability.

**Expected Course Outcome:**

Creating in the students an understanding of decision making models and generating alternatives using appropriate expressions.

| **Module:1** | **Impression Management** | **8 hours** |
|---|---|---|

Types and techniques
Importance of impression management,Types of impression management, Techniques and case studies,Making a good first impression in an interview (TEDOS technique) , How to recover from a bad impressions/experience,Making a good first impression online
Non-verbal communication and body language
Dressing, Appearance and Grooming,Facial expression and Gestures, Body language (Kinesics), Keywords to be used, Voice elements (tone, pitch and pace)

| **Module:2** | **Group Discussion** | **4 hours** |
|---|---|---|

1.Awareness 2.Information gathering 3.Intuition about speaker 4.Structuring thoughts 5.Articulation

| **Module:3** | **Beyond Structure** | **4 hours** |
|---|---|---|

Art of questioning
How to frame questions, Blooms questioning pyramid, Purpose of questions
Etiquette
Business, Telephone etiquette, Cafeteria etiquette, Elevator etiquette, Email etiquette, Social media etiquette

| **Module:4** | **Quantitative Ability** | **9 hours** |
|---|---|---|

Profit and Loss
Cost Price & Selling Price, Margins & Markup
Interest Calculations
Simple Interest, Compound Interest, Recurring
Mixtures and solutions
Ratio & Averages, Proportions

| | | |
|---|---|---|
| Time and Work<br>Pipes & Cisterns, Man Day concept, Division Wages<br>Time Speed and Distance<br>Average speed, Relative speed, Boats and streams.<br>Proportions & Variations | | |
| **Module:5** | **Reasoning Ability** | **11 hours** |
| Logical Reasoning<br>Sequence and series, Coding and decoding, Directions Visual Reasoning Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial reasoning, Cubes Data Analysis And Interpretation DI-Tables/Charts/Text | | |
| **Module:6** | **Verbal Ability** | **9 hours** |
| Grammar<br>Spot the Errors,Sentence Correction, Gap Filling Exercise, Sentence Improvisations, Misc. Grammar Exercise | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Micheal Kallet,Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills, April 7, 2014, 1st Edition, Wiley, New Jersey. |
| 2. | MK Sehgal, Business Communication, 2008, 1st Edition, Excel Books,India. |
| 3. | FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi. |
| 4. | ETHNUS, Aptimithra, 2013, First edition, McGraw-Hill Education Pvt.Ltd, Banglore. |

**Reference Books**

| | |
|---|---|
| 1. | Andrew J. DuBrin,Impression Management in the Workplace: Research, Theory and Practice, 2010, 1st edition, Routledge. |
| 2. | Arun Sharma, Manorama Sharma, Quantitative aptitude, 2016, 7th edition, McGraw Hill Education Pvt. Ltd, Banglore. |
| 3. | M. Neil Browne, Stuart M. Keeley, Asking the right questions, 2014, 11th Edition, Pearson, London. |

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 09-06-2017 | | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| STS4021 | Preparedness for external opportunities | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 1 |
| **Pre-requisite** | **None** | **Syllabus version** | | | | |
| | | **2.0** | | | | |

**Course Objectives:**

1. To identify and improve the qualities of resume and interview skills.
2. To enhance the problem solving skills and basic mathematical skills.
3. To generate ideas from sources to develop content.

**Expected Course Outcome:**

- Enabling students acquire skills for preparing for interviews, presentations and higher education

| **Module:1** | **Interview Skills** | **3 hours** |
|---|---|---|

Types of interview
Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview
Techniques to face remote interviews
Video interview, Recorded feedback , Phone interview preparation
Mock Interview
Tips to customize preparation for personal interview, Practice rounds

| **Module:2** | **Resume Skills** | **4 hours** |
|---|---|---|

Resume Template
Structure of a standard resume, Content, color, font
Use of power verbs
Introduction to Power verbs and Write up
Types of resume
Quiz on types of resume
Customizing resume
Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

| **Module:3** | **Organizational Culture** | **3 hours** |
|---|---|---|

Organizational Culture:
1.Understanding the hierarchy of an organization 2.Adapting to the culture of the work place
3.Meeting industry’s expectation
Company Videos Mock Tests

| **Module:4** | **Quantative Ability** | **14 hours** |
|---|---|---|

Permutation-Combinations
Counting, Grouping, Linear Arrangement, Circular Arrangements
Probability
Conditional Probability, Independent and Dependent Events
Geometry and Mensuration
Properties of Polygon, 2D & 3D Figures, Area & Volumes
Trigonometry
Heights and distances, Simple trigonometric functions

| | | |
|---|---|---|
| Logarithms Introduction, Basic rules Functions<br>Introduction, Basic rules<br>Quadratic Equations<br>Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations<br>Set Theory<br>Basic concepts of Venn Diagram | | |
| **Module:5** | **Reasoning Ability** | **8 hours** |
| Logical reasoning<br>Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic<br>Data Analysis and Interpretation<br>Data Sufficiency<br>Data interpretation-Advanced Interpretation tables, pie charts & bar chats | | |
| **Module:6** | **Verbal Ability** | **8 hours** |
| Comprehension and Logic Reading comprehension Para Jumbles<br>Critical Reasoning :<br>Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument | | |
| **Module:7** | **Writing Skills** | **5 hours** |
| Note making<br>What is note making, Different ways of note making<br>Report writing<br>What is report writing, How to write a report, Writing a report & work sheet<br>Product description<br>Designing a product, Understanding it's features, Writing a product description<br>Research paper<br>Research and its importance, Writing sample research paper | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Michael Farra, Quick Resume & Cover letter Book, 2011, 1st Edition, JIST Editors, Saint Paul. |
| 2. | Daniel Flage, An Introduction to Critical Thinking, 2002, 1st Edition, Pearson, London. |

**Reference Books**

| | |
|---|---|
| 1. | FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi. |
| 2. | ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt. Ltd. |

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 09-06-2017 | | |
| Approved by Academic Council | No. 45 | Date | 15-06-2017 |

| Course Code | Comprehensive Examination | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MIY4098 | | 0 | 0 | 0 | 0 | 2 |
| Pre requisite | None | Syllabus version | | | | |
| | | 1.00 | | | | |
| | | | | | | |
| **Module 1:** | | | | | | |
| Descriptive Statistics – Probability – Inferential Statistics – Linear Algebra – Structured Thinking | | | | | | |
| | | | | | | |
| **Module 2:** | | | | | | |
| Tools (R/Python) - Exploration and Visualization (R/Python) – Feature Selection/ Engineering | | | | | | |
| | | | | | | |
| **Module 3:** | | | | | | |
| Linear Regression-Logistic Regression-Decision Trees-KNN (K- Nearest Neighbours)-K-Means-Naïve Bayes-dimensionality Reduction | | | | | | |
| | | | | | | |
| **Module 4:** | | | | | | |
| Random Forests-Dimensionality Reduction Techniques-Support Vector Machines-Gradient Boosting Machines-XGBOOST | | | | | | |
| | | | | | | |
| **Module 5:** | | | | | | |
| Interactive Visualization -Creating Visualizations | | | | | | |
| | | | | | | |
| **Module 6:** | | | | | | |
| Big Data: Using Smart Big Data, Analytics and Metrics to make better decisions and improve Performance | | | | | | |
| | | | | | | |
| **Module 7** | | | | | | |
| Implement several feature learning/deep learning algorithms- Reinforcement Learning | | | | | | |
| Recommended by Board of Studies | 11.03.2019 | | | | | |
| Approved by Academic Council | 55 | 13-06-2019 | | | | |

| Course Code | Master's Thesis | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MIY6099 | | | | | | |
| | | 0 | 0 | 0 | 0 | 14 |
| Pre-requisite | As per the academic regulations | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

**Expected Course Outcome:**

At the end of the course, the student will be able to

- Formulate specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.
- Perform a literature search and/or patent search in the area of interest.
- Design and Conduct experiments
- Perform error analysis /benchmarking/costing
- Synthesize the results and arrive at scientific conclusions
- Document the results in the form of technical report/presentation

**Contents**

1. It can be a theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, applied research, and any other related activities.
2. The project can be for one or two semesters based on the completion of the required number of credits as per the academic regulations.
3. It should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer-reviewed journals / International Conferences will be an added advantage

**Mode of Evaluation:** Periodic reviews, Presentation, Final oral viva, Poster submission

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 11.03.2019 | | |
| Approved by Academic Council | 55 | Date | 13-06-2019 |

# Programme Core

| Course code | Fundamentals of Statistics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1005 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | (10+2) level knowledge of Mathematics | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To acquaint the students with some basic concepts and knowledge of Statistics.
- To develop the foundations of some of the elementary statistical methods of analysis of data

**Expected Course Outcomes:**

- Students will be able to understand the data , data types, data scales and its measurement
- Students are able to acquire the fundamental knowledge of statistics in terms of definitions, theorems, results, numeric and graphical applications, solutions of basic problems and cases
- Students will be able to analyze: organize, tabulate, manipulate, and normalized the data and datasets.
- Students will be able to evaluate the properties and solutions of various statistical problems, methods, and meaningful applications.
- Students will be able to create, discuss, and share solutions of the problems. Students will be able to apply, the fundamental knowledge of statistics for further higher thinking and development of statistics

| Module:1 | Introduction to Statistical Data | 4 hours | CO: 1 |
|---|---|---|---|

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample Data: Quantitative and qualitative, attributes, variables, scales of measurements-nominal, ordinal, interval and ratio. Presentation of Data; Meaning and illustrations of Population and Samples. Finite & infinite population, homogenous population and heterogeneous population, concept of parameter and statistics, random and non - random sample.

| Module:2 | Table and graphical presentation of data | 4 hours | CO: 1 |
|---|---|---|---|

Table presentation of data and different classification of tables Graphical Representation of data Bar-charts, Pie- diagrams- classification of data, frequency histograms, polygon, Ogives

| Module:3 | Measures of Central Tendency | 8 hours | CO: 2 |
|---|---|---|---|

Mathematical Measures: Arithmetic Mean, Geometric Mean, Harmonic Mean, weighted Mean. Positional Measures: Median, Mode; Empirical relations between mean, median and mode; Partition Values: Quartiles, Deciles, Percentiles, IQR (Inter Quartile Range); Merits and demerits.

**Illustrations and Numerical problems.**

| Module:4 | Measures of Dispersion | 8 hours | CO: 2 |
|---|---|---|---|

Absolute Measure of Dispersion: Range, Quartile deviation, Mean deviation: Mean Square deviation, Variance and standard deviation: Definition, concept, computations, and meanings. Merits and demerits, combined variance, combined standard deviation, generalizations, computations of numerical problems; Relative measures of dispersion: Coefficient of range, coefficient of quartile deviations, coefficient of mean deviation, coefficient of variation (C.V.). Uses, applications and numerical problems.

| Module:5 | Skewness and Kurtosis | 6 hours | CO: 3 |
|---|---|---|---|

Skewness of frequency distribution, Types of Skewness, Measures of Skewness, Types of kurtosis, Measures of Kurtosis. Numerical problems.

| | | | |
|---|---|---|---|
| **Module:6** | **Moments** | **5 hours** | **CO: 4** |
| Central Moments and raw moments for grouped and ungrouped data; Effects of change of origin and scale; Relationship between central and raw moments; Sheppard's correction for moments; | | | |
| **Module:7** | **Correlation analysis** | **8 hours** | **CO: 5** |
| Definition, meaning and concept of correlation meanings and correlation-Scatter diagram and its uses for correlation analysis; Covariance between two variables: Definition, meaning, computations and effect of change of origin and scale; Karl Pearson's coefficient of Correlation (ρ or r): Computations for grouped and ungrouped data. Interpretation of results and Properties. | | | |
| **Module:8** | **Contemporary issues:** | **02 hours** | **CO:5** |
| Lecture by Industry Experts | | | |
| | **Total Lecture hours:** | **45 hours** | |

**Text Book(s)**

- Gupta.S.C. and Kapoor.V.K. (2014): Fundamentals of Mathematical Statistics ,Sultan Chand and sons.
- Agarwal.B.L (2007): Basic statistics , 3/e, New Age International (P) Ltd.
- Medhi.J. (1992): Statistical Methods an Introductory Text , Wiley Eastern Ltd.
- Douglas C. Montgomery, George C. Runger(2018),Applied Statistics and Probability for Engineers, Wiley

**Reference Books**

- Härdle, Wolfgang; Okhrin, Ostap; Okhrin, Yarema (2017),Basic Elements of computational Statistics, Springer
- Sheldon M.Ross (2006) : Introductory Statistics , 2/e, Elsevier Publications.
- Murray R. Spiegel and Larry J. Stephens (2005): Schaum's Outline of Theory and Problems of Statistics, 3/e, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT

**List of Experiments :**

| | | |
|---|---|---|
| 1 | Use of random numbers to draw SRSWOR,SRSWR stratified, systematic sampling | 5 hrs |
| 2 | Graphical and diagrammatic presentation of Statistical Problems | 5 hrs |
| 3 | Pivot tables ,Tabulation, Parato Diagram | 5 hrs |
| 4 | Computation of measures of central tendency (ungrouped and grouped data). Use of an appropriate measure and interpretation of results and computation of partition values. | 5 hrs |
| 5 | Computation measures of dispersion (ungrouped and grouped data). | 5 hrs |
| 6 | Scatter diagram, correlation coefficient (ungrouped data) | 5 hrs |
| | **Total Laboratory Hours** | **30 hrs** |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 11.03.2019 | | |
| Approved by Academic Council | No.55 | Date | 13-06-2019 |

| Course code | Probability and Random Variable | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1018 | | 3 | 2 | 0 | 0 | 4 |
| Pre-requisite | (10+2) level knowledge of Mathematics | Syllabus version | | | | |
| | | | | | | |

**Course Objectives:**

- To acquaint the students with some basic concepts and knowledge of Statistical methods of computations and analysis of data.
- To develop the foundations of some of the elementary statistical methods of analysis of data

**Expected Course Outcomes(CO's):**

- Students are able to **acquire** the fundamental knowledge of Probability and random variables statistics in terms of definitions, theorems, results, numeric and graphical applications, solutions of basic problems and cases.
- Students will be able to **understand** the basic computations of probability of a random variable.
- Students will be able to **analyze** problems that could be solved using various computational methods based on random variable, functions of random variables and various probabilities laws , theorems and inequalities.
- Students will be able to **evaluate** the properties and solutions of various statistical problems, methods, and meaningful applications using knowledge of random variables and probabilities theories.
- Students will be able to **apply**, the fundamental results and knowledge of probability and random variables for further higher thinking and development of statistics.

| Module:1 | Probability: Sample space and events | 6 hours | CO: 1 |
|---|---|---|---|

Definition, concepts and meanings of sample space, experiments, events, discrete sample space-finite and count ably infinite; Classical, axiomatic and empirical or limiting definition of probability. Some basic rules of probability. Addition and multiplication theorem of probability.

**Compliments, Cases, examples, illustrations and Numerical problems.**

| Module:2 | Conditional Probability | 6 hours | CO: 1 |
|---|---|---|---|

Conditional probability and independence. Bayes's Theorem (with proof) and applications; Compliments, cases, examples, illustrations, discussions, and applications

**Compliments, Cases, examples, illustrations and Numerical problems.**.

| Module:3 | Random Variable :One dimensional | 7 hours | CO: 2 |
|---|---|---|---|

Random variable ,Discrete Random variable, Continuous random variables Probability mass function, Probability density function ;distribution functions and Cumulative distribution function

**Compliments, Cases, examples, illustrations and Numerical problems.**

| Module:4 | Random Variable :Two dimensional | 7 hours | CO: 2 |
|---|---|---|---|

Concept of Joint Distribution, Joint Mass Function ;Bivariate distribution, Marginal and Conditional Distribution; Independence of Random Variables

**Compliments, Cases, examples, illustrations and Numerical problems.**

| Module:5 | Mathematical Expectation | 6 hours | CO: 3 |
|---|---|---|---|

Introduction, concept, definition and meaning of expectation; The expected value of discrete and continuous random variables; Properties of mathematical expectation; Computations of conditional expectation; Computations of variance and covariance using simple and conditional expectations.

**Compliments, Cases, examples, illustrations and Numerical problems.**

| **Module:6** | **Generating Functions** | **6 hours** | **CO: 4** |
|---|---|---|---|

5.1 Introduction: Concepts, Definition and meaning; Moments Generating Function, characteristic function, Probability generating functions and cumulative Generating functions

**Compliments, Cases, examples, illustrations and Numerical problems.**

| **Module:7** | **Law of Large Numbers** | **5 hours** | **CO: 5** |
|---|---|---|---|

Introduction,Chebyshev's Inequality, Chebyshev's Theorem,LLN(Weak Law of Large Numbers)

Cauchy-Schwarz inequality, Markov's Inequality : proof and application,Compliments, Cases, examples, illustrations, discussion and Numerical applications

| **Module:8** | **Contemporary issues** | **02 hours** | |
|---|---|---|---|
| Lecture by Industry Experts | | | |
| | **Total Lecture hours:** | **45 hours** | |
| **Tutorial** | • A minimum of 5 problems to be worked out by students in every tutorial class<br>• Another 5 problems per tutorial class to be given as a home work | **15 hours** | |

**Text Book(s)**

- Bansilal, Sanjay Arora and Sudha Arora (2006): Introducing Probability and Statistics, 2/e, Satya Prakashan Publications, New Delhi
- Parzen E ( 1962):Modern Probability Theory and its applications, John Wiley and Sons
- Douglas C. Montgomery, George C. Runger(2018),Applied Statistics and Probability for Engineers, Wiley
- Gupta,S.C. and Kapoor, V.K. (2000): Fundamentals of Mathematical Statistics, 10/e, Sultan Chand and sons.

**Reference Books**

- Hogg, R.V. , Mc Kean J W and Craig, A.T.(2005): Introduction to Mathematical Statistics, 6/e Pearson Edition
- Bhat, B.R., Srivenkataramana, T and Rao Madhava, K.S. (1997): Statistics: A Beginner's Text, Vol. II New Age International (P) Ltd.
- Goon, A.M., Gupta, M.K. and Das Gupta,B. (2001): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
- Mood, A.M., Graybill, F.A and Boes, D.C.(1974): Introduction to the Theory of Statistics, McGraw Hill
- Härdle, Wolfgang; Okhrin, Ostap; Okhrin, Yarema (2017),Basic Elements of computational Statistics, Springer

**Mode of evaluation:** CAT / Assignment / Quiz / FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 11.03.2019 | | |
| Approved by Academic Council | No.55 | Date | 13-06-2019 |

| Course code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1019 | Statistical Methods for data analytics | 3 | 2 | 0 | 0 | 4 |
| Pre-requisite | | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To acquaint the students with some basic concepts and knowledge of Statistical methods of computations and analysis of data.
- To develop the foundations of some of the important statistical methods of analysis of data

**Expected Course Outcomes(CO's):**

- Students are able to acquire the fundamental knowledge of Times Series in terms of definitions, theorems, results, numeric and graphical applications, solutions of basic problems and cases.
- Students will improve their Predictive Analytical knowledge.
- Understand the principles underlying sampling as a means of making inferences about a population
- Students are expected to understand preparation construction of life table.
- Students will be able to find out the association between the factors.
- Students will come to know about premium statistics institutes functioning in India.

| Module:1 | Basics in Times Series | 6 hours |
|---|---|---|

Concept of time series, components of a time series – Additive and Multiplicative models – Resolving the components of a time series – Evaluation of trend by least square method – Methods of moving averages.

| Module:2 | Measures in Times Series | 6 hours |
|---|---|---|

Seasonal indices – Simple average, Ratio to moving average – Ratio to trend – Concept of Cyclical fluctuations – Prediction in time series.

| Module:3 | Index numbers | 7 hours |
|---|---|---|

Definition and uses – Main steps in the construction of index numbers – Fixed and Chain base index numbers - Laspeyre's, Paasche's, Fisher's, Marshall – Edgeworth index numbers Construction and uses of cost of living and wholesale price index numbers

| Module:4 | Basic Sample theory | 6 hours |
|---|---|---|

Census and sample surveys – Advantages and disadvantages – principal steps in a sample survey – probability and non-probability sampling – sampling and non-sampling errors

| Module:5 | Vital and Population Statistics | 6 hours |
|---|---|---|

Introduction: Concept, definition and meaning of demography and vital statistics; Sources of demographic data; Computations of rate and ratios; Measurement of Fertility: CBR, GFR, ASFR, TFR etc; Measurement of Mortality: CDR, SDR etc; Measurement of Population Growth : Crude rate of natural growth, GRR and NRR

| Module:6 | Theory of Attributes and its measurement | 6 hours |
|---|---|---|

| | | |
|---|---|---|
| Attributes: Concept, definitions and meanings; Types of Attributes; Consistency of data. Concept of independence and association of two attributes. Yule's coefficient of association of two attributes. Computations of Yule's coefficients and interpretation. | | |
| **Module:7** | **Official Statistics** | **6 hours** |
| Present official statistical system in India – Methods of collection of official statistics – their reliability and limitations – Principal publications containing data on topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications, banking and finance – Various official agencies responsible for data collection and their main functions | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |
| **Tutorial** | • A minimum of 5 problems to be worked out by students in every tutorial class<br>• Another 5 problems per tutorial class to be given as a home work | **15 hours** |

**Text Book(s)**

- Gupta.S.C. and Kapoor.V.K. (2014): Fundamentals of Applied Statistics , Sultan Chand and sons.
- Agarwal.B.L (2007): Basic statistics , 3/e, New Age International (P) Ltd.
- Medhi.J. (1992): Statistical Methods an Introductory Text , Wiley Eastern Ltd.
- Douglas C. Montgomery, George C. Runger(2018),Applied Statistics and Probability for Engineers, Wiley

**Reference Books**

- Härdle, Wolfgang; Okhrin, Ostap; Okhrin, Yarema (2017),Basic Elements of computational Statistics, Springer
- Sheldon M.Ross (2006) : Introductory Statistics , 2/e, Elsevier Publications.
- Murray R. Spiegel and Larry J. Stephens (2005): Schaum's Outline of Theory and Problems of Statistics, 3/e, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.

| | | | |
|---|---|---|---|
| Mode of evaluation: CAT / Digital Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 11-03-2019 | | |
| Approved by Academic Council | No. 55 | Date | 13-06-2019 |

| Course code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1020 | Sampling Techniques | 3 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To amalgamate the intellectual facts of the sampling techniques to implement in projects and to motivate the students in carrying out the field projects in a scientific manner and statistical skills
- To convey some extended concepts in sampling to encourage the students in industrial and research aspects

**Expected Course Outcome:**

After completion of the course students will

- Accomplish research-oriented concepts in sampling
- use the sampling techniques in real time problems
- fetch the concepts of statistical quality control

| Module:1 | Sampling basics | 4 hours |
|---|---|---|

The concept of sampling - Need for sampling - population and sample - sampling unit and sample frame - Types of Population - Basic properties of the population - sample survey and census - Principal steps in a Sample survey - Notion of sampling error.

| Module:2 | Simple Random Sampling | 4 hours |
|---|---|---|

Simple Random Sampling with and without replacement - Estimation of Population mean and proportion and their variances- Determination of sample size

| Module:3 | Stratified sampling | 4 hours |
|---|---|---|

Stratified sampling - Principles of stratification - Estimation of population mean and its variance - Allocation techniques - Estimation of gain due to stratification

| Module:4 | Systematic sampling | 4 hours |
|---|---|---|

Systematic sampling - Estimation of population mean and its sampling variance - Circular systematic sampling - comparison of systematic, simple random and stratified random sampling - cluster sampling with equal sized clusters - estimation of population mean and variance.

| Module:5 | Unequal probability sampling | 4 hours |
|---|---|---|

PPSWR/WOR. Cumulative total and Lahiri's scheme; Methods and related estimators of finite population mean/total. Hurwitz – Thompson estimators – Des Raj ordered estimator and Murthy's unordered estimator.

| Module:6 | Cluster sampling | 4 hours |
|---|---|---|

Ratio and Regression methods of estimation- Two-stage sampling - Multi-stage sampling - Cluster sampling - Resampling methods and its applications.

| Module:7 | Two-stage sampling | 4 hours |
|---|---|---|

Double sampling for the difference ratio, regression and PPS estimators - Large scale sample surveys, Errors in surveys- A mathematical model for errors of measurement, Sampling and Nonsampling errors, Sources and types of non-sampling errors, Remedies for non-sampling errors.

| Module:8 | Contemporary issues | 2 hours |
|---|---|---|

Lecture by Industry Experts

| | Total Lecture hours: | 30 hours |
|---|---|---|

**Text Book(s)**

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

- Sampath S, Sampling Theory and Methods, Narosa Publishing house, 2017.
- Parimal Mukhopadhyay, Theory of Sample Surveys, Prentice Hall of India, 2009.

</td></tr>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td colspan="4">

- Raghunath Arnab, Survey Sampling theory and Applications, academic press, 2017.
- Cochran, W.G., Sampling Techniques, 3/e, Wiley, 2007.
- Hanif M., Qaiser Shahbaz M. and Munir Ahmad, Sampling Techniques: Methods and Applications, Nova Science Publishers, 2018.
- Sukhatme P.V., Sampling theory of surveys with applications, Iowa State University Press and IARS, 1984.
- Singh D and Choudhary F.S., Theory and Analysis of Sample Survey and Designs, New Age International, 1986.

</td></tr>
<tr><td colspan="4">Mode of Evaluation: CAT, Quiz, Digital Assignment and FAT.</td></tr>
<tr><td>Recommended by Board of Studies</td><td colspan="3">10.09.2019</td></tr>
<tr><td>Approved by Academic Council</td><td>No.56</td><td>Date</td><td>24-09-2019</td></tr>
</table>

| Course code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1025 | DATABASE MANAGEMENT SYSTEM | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. To understand the concept of DBMS and ER Modeling.
2. To explain the normalization, Query optimization and relational algebra.
3. To apply the concurrency control, recovery, security and indexing for the real time data.

**Expected Course Outcome:**

1. Explain the basic concept and role of DBMS in an organization.
2. Illustrate the design principles for database design, ER model and normalization.
3. Demonstrate the basics of query evaluation and heuristic query optimization techniques.
4. Apply Concurrency control and recovery mechanisms for the desirable database problem.
5. Compare the basic database storage structure and access techniques including B Tree, B+Trees and hashing.
6. Design and implement the database system with the fundamental concepts of DBMS.

| | | |
|---|---|---|
| **Module:1** | **DATABASE SYSTEMS CONCEPTS** | **5 hours** |
| History and motivation for Database Systems , Classification of Database Systems, Data Abstraction, Data Independence, Data Definition, Data Manipulation Languages | | |
| **Module:2** | **DATA MODELING** | **6 hours** |
| Entity Relationship Model, Types of Attributes, Relationship, Structural Constraints, Relational Model, Relational model Constraints, Mapping ER model to a relational schema, Integrity constraints , Data manipulation operations | | |
| **Module:3** | **RELATIONAL QUERY LANGUGAES** | **6 hours** |
| Guidelines for Relational Schema , Relational Algebra, Tuple and domain relational calculus, SQL, QBE | | |
| **Module:4** | **RELATIONAL DATABASE DESIGN** | **6 hours** |
| Functional dependency, Armstrong axioms, Normalization, Boyce Codd Normal Form, Multi-valued dependency and Fourth Normal form, Join dependency and Fifth Normal form , Dependency preservation, Lossless design | | |
| **Module:5** | **QUERY PROCESSING AND OPTIMIZATION** | **6 hours** |
| Translating SQL Queries into Relational Algebra, Heuristic query optimization, Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms | | |
| | | |
| **Module:6** | **TRANSACTION PROCESSING** | **7 hours** |
| Storage Strategies – Indices, B-trees, Hashing , Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions , Characterizing schedules based on recoverability, Characterizing schedules based on serializability | | |
| **Module:7** | **CONCURRENCY CONTROL AND RECOVERY TECHNIQUES** | **7 hours** |

| | | |
|---|---|---|
| Recovery and concurrency control, Two-Phase Locking Techniques for Concurrency Control, Concurrency Control based on timestamp, Recovery Concepts, Multiversion and Optimistic Concurrency Control Schemes, Recovery techniques based on deferred update, Recovery techniques based on immediate update, Shadow Paging. | | |
| **Module:8** | **CONTEMPORARY ISSUES** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Raghu Ramakrishnan, "Database Management Systems",Mcgraw-Hill, 4th edition, 2015. |
| 2. | A. Silberschatz, H. F. Korth, S. Sudershan, "Database System Concepts", McGraw Hill, 6th Edition 2010. |

**Reference Books**

| | |
|---|---|
| 1. | R. Elmasri S. B. Navathe, "Fundamentals of Database Systems", Addison Wesley, 7th Edition, 2015. |
| 2. | Thomas Connolly, Carolyn Begg, "Database Systems: A Practical Approach to Design, Implementation and Management",6th Edition, 2012. |
| 3. | Lipo Wang, Xiuju Fu, "Data Mining with Computational Intelligence", Springer, 2005 |
| 4. | Serge Abiteboul, Richard Humm and Victor Vianu, "Foundations of Databases", Addison Wesley, 1994 |

Mode of Evaluation: CAT / Assignment / Quiz / FAT

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Database Basics | 3 hours |
| 2. | Sorting Retrieved Data | 3 hours |
| 3. | Creating Calculated Fields , Aggregate Functions | 3 hours |
| 4. | Grouping and Filtering Data | 3 hours |
| 5. | Joins and Sub queries | 3 hours |
| 6. | Data Handling- Insertion, Updation | 3 hours |
| 7. | Iterations | 3 hours |
| 8. | Cursors | 3 hours |
| 9. | Functions and Procedures | 3 hours |
| 10. | Exception Handling and triggers | 3 hours |
| Total Laboratory Hours | | 30 hours |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course code | Discrete Mathematics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1026 | | 3 | 2 | 0 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- The objective of the discrete mathematics is the study of mathematical structures that are fundamentally discrete rather than continuous.
- To make the students to understand the essential fundamental concepts in mathematics, which are very much applied to computer science and its applications

**Expected Course Outcomes(CO's):**

- To emphasize the concept of logic, Statement and Predicate calculus, Counting Techniques, Algebraic structures.
- To provide the comprehensive idea about Lattices, Boolean algebra, Graphs, Trees and its applications.
- Students are able to determine the Boolean algebra concepts
- Students are able to know the Fundamentals of graphs
- Students are able to understand the concepts of Trees.

| Module:1 | Logic and Statement Calculus | 6 hours |
|---|---|---|

Introduction -Statements and Notation - Connectives – Tautologies – Equivalence - Implications – Normal forms - Theory of Inference for the Statement Calculus.

| Module:2 | Predicate Calculus | 4 hours |
|---|---|---|

Predicate Calculus - Inference Theory of the Predicate Calculus

| Module:3 | Techniques of Counting | 7 hours |
|---|---|---|

Basics of counting - Pigeonhole principle –Permutations and combinations- Inclusion – exclusion principle-Recurrence relations- Solving recurrence relations- Generating functions- Solution to recurrence relations

| Module:4 | Algebraic Structures | 7 hours |
|---|---|---|

Semigroups and Monoids - Groups – Subgroups – Cosets – Normal subgroups- Lagranges Theorem-Homomorphism –Properties - Group Codes

| Module:5 | Lattices | 5 hours |
|---|---|---|

Posets - Partially Ordered Relations -Lattices as Posets – Hasse Digram – Properties of Lattices

| Module:6 | Boolean Algebra | 5 hours |
|---|---|---|

Boolean algebra - Boolean Functions - Representation and Minimization of Boolean Functions – Karnaugh map

| Module:7 | Fundamentals of Graphs | 6 hours |
|---|---|---|

| | | |
|---|---|---|
| Basic Concepts of Graph – Connected graphs-Isomorphic graphs- Planar and Complete regular graph - Matrix Representation of Graphs – Connectivity – Cut sets -Euler and Hamilton Paths – Shortest Path algorithms | | |
| | | |
| **Module:8** | **Trees** | **5 hours** |
| Trees – properties of trees – distance and Centres in trees –Binary tree –Complete Binary tree- Spanning trees – Spanning tree algorithms | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| **Tutorial** | • A minimum of 5 problems to be worked out by students in every tutorial class<br>• Another 5 problems per tutorial class to be given as a home work | **15 hours** |

**Text Book(s)**

- Discrete Mathematical Structures with Applications to Computer Science by J .P. Trembley and R. Manohar, Tata McGraw Hill – 35th reprint, 2008.
- Narasing Deo, Graph theory with application to Engineering and Computer Science, Prentice Hall India 2010.

**Reference Books**

- Discrete Mathematics and its applications by Kenneth H. Rosen, 7th Edition, Tata McGraw Hill, 2012.
- Discrete Mathematics by Richard Johnson baugh, 7th Edition, Prentice Hall, 2009.
- Discrete Mathematics by S. Lipschutz and M. Lipson, McGraw Hill Education (India) 2013.
- Elements of Discrete Mathematics – A Computer Oriented Approach by C.L, Liu, Tata McGraw Hill, Special Indian Edition, 2008.
- Introduction to Graph Theory by West. D.B, 3rd Edition, Prentice-Hall , Englewood Cliffs, NJ, 2007.

- Mode of evaluation: CAT / Digital Assignment / Quiz / FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course Code | DESIGN AND ANALYSIS OF ALGORITHMS | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1027 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To understand the concepts of algorithms and their analysis in terms of space and time complexity.
- To enable the students for deciding appropriate data type and data structure for a given problem.
- To apply appropriate algorithms for a given problem by considering various characteristics of the given problem.

**Expected Course Outcome:**

- Explain the basic concepts and role of algorithms to solve problems.
- Appropriate analysis of algorithms in terms of space and time complexity.
- Develop proficiency in checking correctness of proofs.
- Demonstrate a familiarity with combinatorial optimization techniques.
- Learn various advanced algorithms and applications.
- Synthesize efficient algorithms in common engineering design situations

| Module:1 | INTRODUCTION OF ALGORITHMS | 3 hours |
|---|---|---|

History and motivation for algorithms, Role of algorithms in computing, Analysis of Algorithms, Asymptotic notation, Loop Invariant, Euclid's Algorithm

| Module:2 | PRINCIPLES OF ALGORITHM DESIGN | 5 hours |
|---|---|---|

Basic Methods of algorithm design, Sorting Algorithms and their Complexity analysis, Divide and Conquer Technique, Solving recurrences – substitution, iteration, Recursion Tree, Changing variable and Master's method

| Module:3 | COMBINATORIAL OPTIMIZATION | 5 hours |
|---|---|---|

Introduction, Methods for optimization, Techniques of backtracking, Dynamic Programming – matrix chain multiplication, 0/1 Knapsack; Greedy algorithm – Coin change problem, activity selection; Method of branch and bound

| Module:4 | GRAPH ALGORITHMS | 7 hours |
|---|---|---|

Introduction and concepts of graphs, Single source shortest Path algorithms – Dijkstra algorithm, Bellman Ford algorithm, Topological sorting , All pair shortest path algorithm – Floyd Warshall algorithm, Trees – Binary Tree, Binary Search Tree, Height Balanced Tree, Minimum Spanning Tree; Tree Traversals – BFS, DFS; Minimum Spanning Tree algorithms – Kruskal's algorithms, Prims algorithms; Network Flow problems

| Module:5 | ADVANCED ALGORITHMIC ANALYSIS | 5 hours |
|---|---|---|

Amortized analysis, Online and offline algorithms, Randomized algorithms, NP-completeness

| | | |
|---|---|---|
| **Module:6** | **LP-Based ALGORITHMS** | **9 hours** |
| Introduction to LP-Duality, Set cover via dual fitting, Rounding applied to set cover, Set-cover via the Primal-Dual Schema, Maximum Satisfiability – ¾ factor algorithm | | |
| **Module:7** | **PARALLEL AND DISTRIBUTED ALGORITHMS** | **9 hours** |
| Parallel algorithms – Introduction, PRAM Model, Exclusive Vs. Concurrent Reads and Writes, Pointer Jumping, Brent's Theorem and Work efficiency, Distributed algorithms – Introduction, Consensus and election, Termination detection, Fault tolerance, Stabilization | | |
| | | |
| **Module:8** | **CONTEMPORARY ISSUES** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Cormen, Leiserson, Rivest and Stein, "Introduction to Algorithms", 3rd edition, McGraw Hill, 2009.
- Anany Levitin, "Introduction to the Design and Analysis of Algorithms". 3rd edition., Addison Wesley , 2011.

**Reference Books**

- Kurt Mehlorn, Peter Sanders, "Algorithms and Data Structures", Springer, 2008.
- Ellis Horowitz, "Fundamentals of Computer Algorithms", 2nd Edition, Universities Press, 2008
- Vijay V. Vajirani, "Approximation Algorithms", Springer, 2001
- Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach" ,1st edition, Chapman & Hall/CRC Computer & Information Science Series, 2006

Mode of Evaluation: CAT / Assignment / Quiz / FAT

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Sorting Algorithms | 3 hours |
| 2. | Backtracking – Queen's problem and others | 3 hours |
| 3. | Dynamic Progamming – 0/1 Knapsack problem and others | 3 hours |
| 4. | Greedy Algorithm – Coin Change Problem and others | 3 hours |
| 5. | Shortest Path Algorithms | 3 hours |
| 6. | BFS, DFS | 3 hours |
| 7. | Tree Traversals | 3 hours |
| 8. | Subset Sum Problem | 3 hours |
| 9. | Traveling salesman problem | 3 hours |
| 10. | Satisfiability problems | 3 hours |
| Total Laboratory Hours | | **30 hours** |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| MAT1028 | Operations Research for Data Analysis | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | | **Syllabus version** | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To familiarize the students with some basic concepts of optimization techniques and approaches.
- To formulate a real-world problem as a mathematical programming model.
- To develop the model formulation and applications are used in solving decision problems.
- To solve specialized linear programming problems like the transportation and assignment problems

**Expected Course Outcomes(CO's):**

1 Students will be able to apply operations research techniques like linear programming problem in industrial optimization problems.
2 Students are able to solve allocation problems using various OR methods.
3 Students will be able to understand the characteristics of different types of decision-making environment and the appropriate decision making approaches and tools to be used in each type.
4 Students are able to recognize competitive forces in the marketplace and develop appropriate reactions based on existing constraints and resources.

| **Module:1** | **Introduction to Operation Research** | **6 hours** | |
|---|---|---|---|

Introduction-Mathematical models of Operation Research-Scope and applications of Operation Research-Phases of Operation Research study-Characteristics of Operation Research-Limitations of Operation Research.

| **Module:2** | **Linear Programming** | **6 hours** | |
|---|---|---|---|

Introduction –Properties of Linear Programming-Basic assumptions-Mathematical formulation of Linear Programming-Limitations or constraints-Methods for the solution of LP Problem-Graphical analysis of LP-Graphical LP Maximization problem-Graphical LP Minimization problem.

| **Module:3** | **Linear Programming Models** | **7 hours** | |
|---|---|---|---|

Simplex Method-Basics of Simplex Method-Formulating the Simplex Method-Simplex Method with two variables-Simplex Method with more than two variables-Big M Method.

| **Module:4** | **Dual Linear Programming** | **6 hours** | |
|---|---|---|---|

Introduction- Primal and Dual problem -Dual problem properties-Solution techniques of Dual problem-Dual Simplex method-Relations between direct and dual problem-Economic interpretation of Duality.

| **Module:5** | **Transportation and Assignment Models** | **6 hours** | |
|---|---|---|---|

Introduction: Transportation problem-Balanced-Unbalanced-Methods of basic feasible

| | | | |
|---|---|---|---|
| solution-Optimal solution-MODI method. Assignment problem-Hungarian Method. | | | |
| | | | |
| **Module:6** | **Network Analysis** | **6 hours** | |
| Basic concepts-Construction of Network-Rules and precautions-CPM and PERT Networks-Obtaining of critical path. Probability and cost consideration. Advantages of Network. | | | |
| | | | |
| **Module:7** | **Theory of Games** | **6 hours** | |
| Introduction-Terminology-Two Person Zero-Sum game-Solution of games with saddle points and without saddle points-2X2 games-dominance principle – mX2 and 2Xn games-Graphical method. | | | |
| | | | |
| **Module:8** | **Contemporary issues:** | **2 hours** | |
| Lecture by Industry Experts | | | |
| | | | |
| | **Total Lecture hours:** | **45 hours** | |
| **Tutorial** | • A minimum of 5 problems to be worked out by students in every tutorial class<br>• Another 5 problems per tutorial class to be given as a home work | **15 hours** | |

**Text Book(s)**

1. Hamdy. A Taha (2019), Operations research, 10th edition, Prentice Hall of India Private Ltd.
2. P. K. Gupta and D. S. Hira, (2007), Operations Research, S. Chand & co.,

**Reference Books**

1. S.D. Sharma (2000), Operations Research, Nath & Co., Meerut.
2. Maurice Solient, Arthur Yaspen, Lawrence Fridman, (2003), OR methods and Problems, New Age International Edition.
3. J K Sharma (2007), Operations Research Theory & Applications, 3e, Macmillan India Ltd.
4. P. Sankara Iyer, (2008), Operations Research, Tata McGraw-Hill.

| | | | |
|---|---|---|---|
| **Mode of evaluation:** CAT / Digital Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| MAT1029 | Statistical Quality Control | L | T | P | J | C |
|---|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | | Syllabus version | | | | |
| | | v. xx.xx | | | | |

**Course Objectives:**

- **To enable students with necessary knowledge towards constructing models.**
- **To impart knowledge of distribution theory in real life situations.**

**Expected Course Outcome:**

- demonstrate deep knowledge about statistical methods for quality technology and management, and in a systematic way select methods to solve advanced quality related problems within industry and service production
- discuss the occurrence and consequences of variation in industrial processes and from a systems perspective identify situations where statistical methods can contribute to improvement of products and processes
- plan and conduct industrial improvement projects based on advanced statistical methods for quality improvement
- analyse and identify improvement needs for measurement systems in industrial organisations
- explain and discuss how procedures for statistical quality control can be implemented and contribute to development in industrial organisations

| Module:1 | Quality fundamentals | 4 hours | |
|---|---|---|---|

Introduction to SQC - The Meaning of Quality and Quality, Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Quality costs and Quality loss.

| Module:2 | Process control and product control | 6 hours | |
|---|---|---|---|

Control limits, specification limits and Tolerance limits,3σ limits and Tools for SQC

| Module:3 | Control charts for variables | 6 hours | |
|---|---|---|---|

Control Charts for $\bar{X}$ and R (statistical basis, development and use, estimating process capability; interpretation, the effect of non- normality on the chart, the OC function, average run length); Control Charts for $\bar{X}$ and S; Control Chart for Individual Measurements; Applications of Variables Control Charts

| Module:4 | Control charts for attributes | 9 hours | |
|---|---|---|---|

P, np, C, control chart, Multi – variable chart, individual measurement charts – moving average and moving range charts, quality control in service sector

| Module:5 | Acceptance sampling inspection plans | 6 hours | |
|---|---|---|---|

Acceptable Quality level(AQL),Lot Tolerance Proportion or Percentage defective(LTPD),Process Average Fraction Defective, Consumer Risk, Producer Risk, Rectifying inspection plans, Average Out Quality Limit(AOQL),OC Curve

| Module:6 | Sampling inspection plans for attributes | 6 hours | |
|---|---|---|---|

Single sampling plan; Double sampling plan, single sampling vs double sampling plans,

| | | | |
|---|---|---|---|
| sequential sampling plan | | | |
| | | | |
| **Module:7** | **Six sigma** | **6 hours** | |
| Concept of six sigma, methods of six sigma, DMAIC methodology, DFSS methodology, six sigma control chart, case studies. | | | |
| | | | |
| **Module:8** | **Contemporary issues** | **2 hours** | |
| Lecture by Industry Experts | | | |
| | | | |
| | **Total Lecture hours:** | **45 hours** | |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Montgomery, D.C,Introduction to Statistical Quality Control, John Waley & Sons,2019 |
| 2. | Kapoor, V.K. and Gupta, S.P, Fundamentals of applied statistics, Sultan Chand & Sons,2017 |
| **Reference Books** | |
| 1. | Grant, E,L. and Laven Worth, R.S(2017): Statistical Quality Control, McGraw Hill |
| 2. | Steven M. Zimmerman, Marjorie Icenogle(2000); Statistical Quality Control Using Excel, ASQ Quality Press |
| | |

| | | |
|---|---|---|
| **List of Challenging Experiments (Indicative)** | | |
| 1. | Construction of Control charts for Mean and range | 2 |
| 2. | Construction of control chart for standard deviation | 1 |
| 3. | Construction of Control chart for Fraction defective | 2 |
| 4. | Construction of Control chart for Number of defectives | 2 |
| 5. | Construction of Control chart for number of defects per unit | 2 |
| 6 | Plot OC curve of Single Sapling plan | 2 |
| 7 | Plot OC curve of Double Sapling plan | 2 |
| 8. | Plot AOQ curve and determine AOQL. | 2 |
| | **Total Laboratory hours** | 15 hours |

| | | | |
|---|---|---|---|
| **Mode of evaluation:** CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course code | Statistical computing for data analysis | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1030 | | 0 | 0 | 4 | 0 | 2 |
| Pre-requisite | | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. Use of software packages for statistical theory towards computing environment.
2. To enhance the theoretical concepts and its application in the real time domain.

**Expected Course Outcome:**

Students will be able to

1. List motivation for learning a programming language
2. Access online resources for R and import new function packages into the R workspace
3. Import, review, manipulate and summarize data-sets in R
4. Explore data-sets to create testable hypotheses and identify appropriate statistical tests
5. Perform appropriate statistical tests using R Create and edit visualizations with

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1 | Introduction, How to run R, R Sessions and Functions, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes. | 4 hours |
| 2 | Creating List, Common list operations ,Recursive list, Creating a Data Frame ,Common data frame operations | 4 hours |
| 3 | R Programming Structures, Control Statements, Loops, - Looping Over Nonvector Sets,- If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R. | 2 hours |
| 4 | Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function – Customizing Graphs, Saving Graphs to Files | 4 hours |
| 5 | Maximum and Minimum, Frequency distribution ,Frequency distribution types, measure of central tendency and measure of dispersion, Correlation | 4 hours |
| 6 | Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution | 4 hours |
| 7 | Testing of the hypothesis ( □, □, □ and $□^2$- tests) | 4 hours |
| 8 | Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression | 4 hours |
| | **Total Laboratory hours:** | **30 hours** |

**Text Book(s)**

| | | | |
|---|---|---|---|
| 1. | Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters Beginner's Guide to R - Springer, 2009. | | |
| 2. | Allerhand M. Tiny Handbook of R - SpringerBriefs in Statistics, 2011 | | |
| **Reference Book(s)** | | | |
| 1. | Baayen R. Analyzing Linguistic Data - A Practical Introduction to Statistics using R , 2008. | | |
| 2. | Gardener M. Beginning R - The Statistical Programming Language , 2012. | | |
| 3. | Jim Albert, Maria Rizzo R by Example, 2012. | | |
| 4. | Matloff N. Art of R Programming - A Tour of Statistical Software Design , 2011. | | |
| **Mode of Evaluation**: Continuous Assessment and FAT. | | | |
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course code | Distribution Theory for data analytics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT2006 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | Fundamentals of statistics | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To discuss the concepts of various functions of random variables and distribution functions for data analytics.
- To impart knowledge of distribution functions in real life situations.

**Expected Course Outcome:**

Students will be able to

- understand the basics of distribution theory.
- apply the discrete distributions to analyze the data.
- apply normal distributions for large samples
- apply the concepts of continuous distributions to analyze the data.
- analyse Pareto distribution
- analyse the data and interpret by sampling distributions.

| Module:1 | Functions of Random variables | 7 hours |
|---|---|---|

Basic concepts in distribution theory-functions of random variables and their distributions-Probability distribution functions-cumulative probability distribution function-Expected value and variance of a random variable.

| Module:2 | Standard Discrete Distributions | 7 hours |
|---|---|---|

Definition-properties and simple problems of Bernoulli-Binomial-Poisson distribution and its applications.

| Module:3 | Applications of Discrete Distributions | 6 hours |
|---|---|---|

Definition-properties and simple problems of Geometric-Negative Binomial- Hyper Geometric and its applications.

| Module:4 | Normal Distribution | 6 hours |
|---|---|---|

Definition-properties-mean and standard deviation-empirical rule-determining intervals-standard normal distribution-finding z scores from areas-calculating values, probabilities and percentiles

| Module:5 | Continuous Distributions | 5 hours |
|---|---|---|

Definition-properties and simple problems in Exponential-Gamma-Weibull and its applications

| Module:6 | Pareto Distributions | 5 hours |
|---|---|---|

Definition-properties and simple problems in Beta-Cauchy- Pareto and its applications

| Module:7 | Sampling Distributions | 7 hours |
|---|---|---|

| | | |
|---|---|---|
| Chi Square, Small samples, F, logistic distributions and their interrelations and characteristics –<br>Applications in Tests of significance. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Probability and Mathematical Statistics by Prasanna Sahoo., 2015.
- Statistical Techniques in Business and Economics – Lind, Douglas., 2012

**Reference Books**

- Remadevi S, Bindu Krishnan, Probability Distribution, Random Processes and Numerical Methods, Wiley, 2016.
- **Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani.**
- An Introduction to Statistical Learning: With Applications in R (Springer Texts in Statistics) 1st ed. 2013, Corr. 5th printing 2015 Edition.

**Mode of Evaluation:** CAT, Quiz, Digital Assignment and FAT.

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1 | Introduction- Importing and Exporting data types | 5 hours |
| 2 | Data Visualization/data cleansing | 5 hours |
| 3 | Discrete Distributions | 5 hours |
| 4 | Normal Distribution | 5 hours |
| 5 | Continuous Distributions | 5 hours |
| 6 | Sampling Distributions | 5 hours |
| | Total Laboratory Hours | 30 hours |

**Mode of evaluation:** Continuous Assessment and FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 10-09-2019 | | |
| Approved by Academic Council | No. 56 | Date | 24-09-2019 |

| Course code | Linear Algebra and Numerical Methods | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT2007 | | 3 | 2 | 0 | 0 | 4 |
| Pre-requisite | MAT1001-Fundamentals of Mathematics | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

The aim of this course is to

- understand basic concepts of linear algebra to illustrate its power and utility through applications to computer science and Engineering.
- apply the concepts of vector spaces, linear transformations, matrices in engineering.
- cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences.

**Expected Course Outcome:**

At the end of the course the student should be able to

- Solve the system of linear equations using decomposition methods, the basic notion of vector spaces.
- Transform the vectors using linear transforms, which is the basic idea required in computer graphics.
- Observe the difference between exact solution and approximate solution.
- Use the numerical techniques (algorithms) to find the solution (approximate) of algebraic equations and system of equations.
- Fit the data using interpolation technique.

| Module:1 | System of Linear Equations | 7 hours |
|---|---|---|

Elementary row operations, echelon form of a matrix, row echelon form, reduced row echelon form, Gauss elimination, Gauss Jordan method.

| Module:2 | Vector Spaces | 8 hours |
|---|---|---|

Vector space, subspace, sum of subspaces, linear combination, linear dependence and independence, basis and dimension, finite dimensional spaces, ordered bases, interpolation.

| Module:3 | Linear Transformations | 7 hours |
|---|---|---|

Basic definitions, invertible linear transformations, rank-nullity theorem, matrix representation, algebra of linear transformations, change of basis

| Module:4 | Solution of System of Linear Equations | 8 hours |
|---|---|---|

Direct methods: Gauss elimination method, LU-decomposition method. Iterative methods: Jacobi and Gauss-Seidel methods. Dominant and smallest eigen values of a matrix by power method.

| Module:5 | Interpolation | 4 hours |
|---|---|---|

Finite difference operators, Newton's forward, Newton's backward, central differences, Bessel and Stirling's interpolation, Lagrange's interpolation.

| Module:6 | Numerical Differentiation | 4 hours |
|---|---|---|

First and second order derivatives by various interpolation formulae, maxima and minima for tabulated values.

| Module:7 | Numerical Integration | 5 hours |
|---|---|---|

Trapezoidal, Simpsons 1/3rd and 3/8th rules, Gauss Legendre 2-points and 3-points formulae

| Module:8 | Contemporary issues | 2 hours |
|---|---|---|

Lecture by Industry Experts

| | | |
|---|---|---|
| | **Total Lecture hours:** | **45 hours** |
| **Tutorial** | • A minimum of 10 problems to be worked out by students in every Tutorial Class.<br>• Another 5 problems per Tutorial Class to be given as home work. | **30 hours** |

**Text Book(s)**

- Linear Algebra with Applications, Leon, S.J., 9th Edition, Pearson, 2014.
- Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar and R. K. Jain, 6th Edition, New Age International Limited, 2012.

**Reference Books**

- Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Wellesley-Cambridge Press, 2016.
- Linear Algebra, Hoffman, K. and Kunze, R., 2nd Edition, Prentice Hall India Learning Private Limited, 2015.
- Numerical Analysis: Mathematics of Scientific Computing, David Kincaid and Ward Cheney, 3rd Edition, American Mathematical Society, 2009.
- Applied Numerical Analysis, Gerald, C. F. and Wheatly, P. O., 7th Edition, Pearson Education India, 2007.

**Mode of Evaluation:** Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 10-09-2019 | | |
| Approved by Academic Council | No. 56 | Date | 24-09-2019 |

| Course code | Statistical Inference | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5013 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Understand the types of questions that the statistical method addresses for decision making.
- Apply statistical methods to hypotheses testing and inference problems.
- Interpret the results in a way that addresses the question of interest.
- Use data to make evidence-based decisions that are technically sound.
- Communicate the purposes of the analyses, the findings from the analysis, and the implications of those findings.

**Expected Course Outcome:**

At the end of the course students will be able to:

- Understand the notion of a parametric model and point estimation of the parameters of those models and properties of a good estimator.
- Learn the approaches to point estimation of parameters.
- Understand the concept of interval estimation and confidence intervals.
- Basic concepts in tests of hypotheses.
- Understand and apply large-sample tests.
- Use small-sample tests of hypotheses.
- Discuss nonparametric tests of hypotheses.
- Translate and correlate the statistical analysis into Statistical inference

| Module:1 | Introduction | 9 hours |
|---|---|---|

Population, sample, parameter and statistic; characteristics of a good estimator; Consistency – Invariance property of Consistent estimator, Sufficient condition for consistency; Unbiasedness; Sufficiency – Factorization Theorem – Minimal sufficiency; Efficiency – Most efficient estimator, likelihood equivalence, Uniformly minimum variance unbiased estimator, Rao - Blackwell Theorem and applications.

| Module:2 | Point Estimation | 6 hours |
|---|---|---|

Point Estimation- Estimator, Estimate, Methods of point estimation – Maximum likelihood method (the asymptotic properties of ML estimators are not included), method of moments, method of least square, method of minimum chi-square and modified minimum chi-square- Asymptotic Maximum Likelihood Estimation.

| Module:3 | Interval Estimation | 4 hours |
|---|---|---|

Confidence level and confidence coefficient; Duality between acceptance region of a test and a confidence interval; Construction of confidence intervals for population proportion (small and large samples) and between two population proportions(large samples); Confidence intervals for mean and variance of a normal population; Difference between the mean and ratio of two normal populations.

| Module:4 | Testing of hypotheses | 6 hours |
|---|---|---|

Types of errors, power of a test, most powerful tests; Neyman-Pearson Fundamental Lemma and its applications; Notion of Uniformly most powerful tests; Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions.

| Module:5 | Large sample tests | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| Large sample properties; Tests of significance (under normality assumption)- Test for a population mean, proportion; Test for equality of two means, proportions; Test for correlation, Test for Regression. | | |
| **Module:6** | **Small sample tests** | **6 hours** |
| Student's t-test, test for a population mean, equality of two population means, paired t-test, F-test for equality of two population variances; Chi-square test for goodness of fit and test for independence of attributes. | | |
| **Module:7** | **Non-parametric tests** | **8 hours** |
| Sign test, Signed rank test, Median test, Mann-Whitney test, Run test and One sample Kolmogorov –Smirnov test (Description, properties and applications only). | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference – Testing of Hypotheses, Prentice Hall of India, 2014.
- Bansilal, Sanjay Arora and Sudha Arora, Introducing Probability and Statistics, 2/e, Satya Prakash Publications, 2006.

**Reference Book(s)**

- Marc S. Paolella, Fundamental statistical inference: A computational approach, Wiley, 2018.
- B. K. Kale and K. Muralidharan, Parametric Inference, Narosa Publishing House, 2016.
- Miller, I and Miller, M, John E. Freund's Mathematical statistics with Applications, Pearson Education, 2002.
- Rao, C.R., Linear Statistical Inference and its applications, 2nd Edition, Wiley Eastern, 1973.
- Gibbons, J.D., Non-Parametric Statistical Inference, 2/e,Marckel Decker, 1985.

**Mode of Evaluation**: CAT, Quiz, Assignment and FAT.

| **List of Experiments** | | |
|---|---|---|
| 1. | Calculating Confidence intervals, *p*- value | 3 hours |
| 2. | Large Sample Tests- Test for Population mean | 3 hours |
| 3. | Large Sample Tests- Test for Population proportions | 3 hours |
| 4. | Small Sample Tests – t – test for population mean | 3 hours |
| 5. | Paired t – test | 3 hours |
| 6. | F- test for population variances | 3 hours |
| 7. | Chi-square test for goodness of fit | 3 hours |
| 8. | Chi-square test for independence of Attributes | 3 hours |
| 9. | Test for correlation coefficient | 3 hours |
| 10. | Non-parametric Tests | 3 hours |
| | Total Laboratory hours | 30 hours |

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|---|---|---|---|
| Mode of evaluation: Digital Assignment, FAT. | | | |
| Recommended by Board of Studies | 11.03.2019 | | |
| Approved by Academic Council | No. 55 | Date | 13-06-2019 |

| Course Code | Time Series Analysis and Forecasting | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5016 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | NIL | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To equip various forecasting techniques and familiarize on modern statistical methods for analyzing time-series data.
- To amalgamate the intellectual facts of the time series data to implement in the field projects scientifically.
- To link time-dependent analytical tools and building the models by extracting real-time data.

**Expected Course Outcomes:**

- On completion of the course, students will be able to
- understand the fundamental advantages and apply essential of forecasting techniques
- apply an appropriate forecasting method in any given situation.
- apply non-stationary methods in real-time problems.
- forecast with better statistical models based on statistical data analysis
- learn and apply variance transformation techniques
- understand the application of frequency-domain time series analysis.

| Module:1 | Exploratory analysis of Time Series | 4 hours |
|---|---|---|

Graphical display, classical decomposition model, Components and various decompositions of Time Series Models-Numerical description of Time Series: Stationarity, Autocovariance and Autocorrelation functions - Data transformations - Methods of estimation –Trend, Seasonal and exponential.

| Module:2 | Smoothing Techniques | 6 hours |
|---|---|---|

Moving Averages: Simple, centered, double and weighted moving averages; single and double exponential smoothing – Holt's and winter's methods - Exponential smoothing techniques for series with trend and seasonality-Basic evaluation of exponential smoothing.

| Module:3 | Stationary models | 6 hours |
|---|---|---|

Time series data, Trend, seasonality, cycles and residuals, Stationary, White noise processes, Autoregressive (AR), Moving Average (MA), Autoregressive and Moving Average (ARMA) and Autoregressive Integrated Moving Average (ARIMA) processes, Choice of AR and MA periods.

| Module:4 | Non-stationary time series models | 9 hours |
|---|---|---|

Tests for Nonstationarity: Random walk –random walk with drift –Trend stationary –General Unit Root Tests: Dickey Fuller Test, Augmented Dickey Fuller Test.

ARIMA Models: Basic formulation of the ARIMA Model and their statistical properties - Autocorrelation function (ACF), Partial autocorrelation function (PACF) and their standard errors.

| Module:5 | Forecasting | 6 hours |
|---|---|---|

Nature of Forecasting – Forecasting methods- qualitative and quantitative methods – Steps involved in stochastic model building – Forecasting model evaluation.

Model selection techniques: AIC, BIC and AICC – Forecasting model monitoring.

| Module:6 | Transfer function and Intervention analysis | 6 hours |
|---|---|---|

Transfer function models- Transfer function – noise models; Cross correlation function; Model specification; Forecasting with Transfer function – noise models; Intervention analysis.

| Module:7 | Spectral analysis | 6 hours |
|---|---|---|

Spectral density function (s. d. f.) and its properties, s. d. f. of AR, MA and ARMA processes, Fourier transformation and periodogram.

| | | |
|---|---|---|
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, Introduction to Time Series Analysis and Forecasting, Second Ed., Wiley, 2016.
- George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, Fifth Ed., Wiley, 2016.

**Reference Books**

- Brockwell, P. J., & Davis, R. A., Introduction to time series and forecasting, Third Ed., Springer, 2016.
- Terence C. Mills, Applied Time Series Analysis: A Practical Guide to Modeling and Forecasting, Academic Press, 2019.

**Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT.

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1 | Visualization of Stationary and Non-stationary time series | 4 hours |
| 2 | Moving Average Time Series Model and Differencing | 4 hours |
| 3 | Exponential smoothing technique (Single, double and triple) | 4 hours |
| 4 | Auto-Regressive Model for Stationary Time Series | 4 hours |
| 5 | Autoregressive Integrated Moving Average for Non- Stationary Time Series | 4 hours |
| 6 | Forecasting With Univariate Models | 4 hours |
| 7 | Transfer Functions and Autoregressive Distributed Lag Modeling | 4 hours |
| 8 | Spectral density function | 2 hours |
| | **Total Laboratory hours** | 30 hours |

Mode of Evaluation: Continuous assessment and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 10.09.2019 | | |
| Approved by Academic Council | No. 56 | Date | 24-09-2019 |

| Course Code | Multivariate Data Analysis | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5017 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | Knowledge of Fundamental of Statistics, Matrices and Linear Algebra | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

The objective of the course is to make the student:

- Understand the fundamental concepts of Multivariate Data Analysis / Multivariate Statistical Analysis.
- Conversant with various methods and techniques used in summarization and analysis of multivariate data.
- Prepare for investigation of multivariate data and examine the possible diagnostics in multivariate methods.
- Formulate real time problem in a form of multivariate model.
- Develop feasible solution of real-life problems, using multivariate methods and techniques.
- Conduct research using multivariate data analysis techniques.

**Expected Course Outcome:**

At the end of the course students will be able to:

- Learn to develop an in-depth understanding of the Multivariate models, methods and techniques.
- Demonstrate the knowledge and skill of multivariate normal distributions, related probability distributions and their applications.
- Examine the relationships between dependent and independent variables of multivariate models, estimate the parameters and fit a model.
- Perform, handle and manipulate the analysis of discriminant function and logistic regression.
- Apply the method and analysis of principal components, factor analysis and dimension reduction of sample data.
- Investigate the events of clustering and multidimensional scaling presence in sample data.
- Conduct the application of Structural Equation Modeling (SEM) to real-time observations.
- Research on real-time problems from various disciplines using multivariate data analysis.

| Module:1 | Introduction to Multivariate Data Analysis | 5 hours |
|---|---|---|

Multivariate data and their diagrammatic representation. Exploratory multivariate data analysis, sample mean vector, sample dispersion matrix, sample correlation matrix, graphical representation, means, variances, co-variances, correlations of linear transforms, six step approach to multivariate model building. Introduction to multivariate linear regression, logistic regression, principal component analysis, factor analysis, cluster analysis, canonical analysis and canonical variables, structured equation modeling (SEM).

| Module:2 | Multivariate Normal Distribution(MND) | 8 hours |
|---|---|---|

Introduction to multivariate normal distribution, probability density function and moment generating function of multivariate normal distribution, singular and nonsingular normal distributions, distribution of linear and quadratic form of normal variables, marginal and conditional distributions. Random sampling from multivariate normal distributions. Goodness of fit of multivariate normal distribution. Wishart matrix-its distribution and properties.

| | | |
|---|---|---|
| **Module:3** | **Multivariate Linear Model and Analysis of Variance and Covariance** | **8 hours** |
| Maximum likelihood estimation of parameters, tests of linear hypothesis, distribution of partial and multiple correlation coefficients and regression coefficients. Multivariate linear regression, multivariate analysis of variance of one and two way classification data (only LR test). Multivariate analysis of covariance. Hoteling $\square^2$ and Mahalanobis $\square^2$ applications in testing and confidence set construction. | | |
| | | |
| **Module:4** | **Multiple Discriminant Analysis and Logistic Regression** | **7 hours** |
| **Discriminant model** and analysis: a two group discriminant analysis, a three group discriminant analysis, the decision process of discriminant analysis( objective, research design, assumptions, estimation of the model, assessing overall fit of a model, interpretation of the results, validation of the results). **Logistic Regression model** and analysis: regression with a binary dependent variable, representation of the binary dependent variable, estimating the logistic regression model, assessing the goodness of fit of the estimation model, testing for significance of the coefficients, interpreting the coefficients. | | |
| | | |
| **Module:5** | **Principal Components and common Factor Analysis** | **5 hours** |
| Population and sample principal components, their uses and applications, large sample inferences, graphical representation of principal components, Biplots, the orthogonal factor model, dimension reduction, estimation of factor loading and factor scores, interpretation of factor analysis. | | |
| | | |
| **Module:6** | **Cluster Analysis and Multidimensional Scaling** | **5 hours** |
| Concepts of cluster analysis and multidimensional scaling, similarity measures, hierarchical clustering methods, Ward's hierarchical clustering method's, nonhierarchical clustering methods, K-means methods. Clustering based on statistical models, multidimensional scaling and correspondence analysis, perceptual mapping. | | |
| | | |
| **Module:7** | **Structural Equation Modelling (SEM)** | **5 hours** |
| Concept of structural equation modeling, Confirmatory factor analysis, canonical correlation analysis, conjoint analysis. | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture Hours:** | **45 hours** |
| **Text Book(s)** | | |
| • | Hardly W.K. and Simor L., Applied Multivariate Statistical Analysis, 4th Edition, Springer- Verlag, **2015.** | |
| • | Richard A. Johnson and Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice hall India, 7th Edition, **2019.** | |
| **Reference Books** | | |
| • | Joseph F. Hair, Jr., William C. Black, Barry J. Babin, Rolph E. Anderson and Ronald L. | |

- Tatham, Multivariate Data Analysis, 7th Edition, Pearson Education India, **2014.**
- Rao, C. R. and Rao, M. M., Multivariate Statistics and Probability, Elsevier & Academic Press, **2014.**
- Kshirsagar, A. M., Multivariate Analysis, Marcel Dekkar, 2006.
- Anderson T.W., An Introduction to Multivariate Statistical Analysis, John Wiley & sons, 3rd Edition, **2009.**
- Bhuyan, K. C., Multivariate Analysis and its Applications, New Central book Agency Pvt. Ltd., **2005.**
- Weisberg S., Applied Linear Regression, 4th Edition, Wiley, 2013.

Kollo T., and Rosen D. Von, Advanced Multivariate Statistical Analysis with Matrices, Springer, New York, **2005.**


**Mode of Evaluation:** CAT / Assignment / Quiz / FAT / Project / Seminar.

| **List of Challenging Experiments (Indicative) using packages, software's and other scientific devices** | | |
|---|---|---|
| 1. | MLE of mean vector and variance-covariance matrix from the normal population. Generating random numbers from a multivariate normal distribution. | 4 hours |
| 2. | Hoteling $\square^2$ and Mahalanobis $\square^2$ | 4 hours |
| 3. | Computation of principal components and conducting factor analysis | 4 hours |
| 4. | Fitting a multivariate linear regression model and its interpretation. | 4 hours |
| 5. | Error analysis, outliers detection and related tests | 2 hours |
| 6. | Estimation, fitting and validating a logistic regression model. | 4 hours |
| 7. | Classification between two normal populations using discriminant analysis. | 2 hours |
| 8. | Cluster analysis | 2 hours |
| 9. | Computation of canonical variables and correlation | 2 hours |
| 10 | Structural Equation Modeling and related computations | 2 hours |
| Total Laboratory Hours | | **30 hours** |

**Mode of assessment**: Continuous Assessment and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course Code | Regression Analysis and Predictive Modelling | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6002 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | MAT5012 - Probability Theory and Distributions | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Develop an understanding of regression analysis and model building.
- Provide the ability to develop relationship between variables
- Investigate possible diagnostics in regression techniques
- Formulate feasible solution using regression model for real-life problems.

**Expected Course Outcome:**

At the end of the course students will be able to:

- develop in-depth understanding of the linear and nonlinear regression model.
- demonstrate the knowledge of regression modeling and model selection techniques.
- examine the relationships between dependent and independent variables.
- estimate the parameters and fit a model.
- investigate possible diagnostics in regression modeling and analysis.
- validate the model using hypothesis testing and confidence interval approach.
- understand the generalizations of the linear model to binary and count data.

| Module:1 | Simple Regression Analysis | 6 hours |
|---|---|---|

Introduction to a linear and nonlinear model. Ordinary Least Square methods. Simple linear regression model, using simple regression to describe a linear relationship. Fitting a linear trend to time series data, Validating simple regression model using t, F and p test. Developing confidence interval. Precautions in interpreting regression results.

| Module:2 | Multiple Regression Analysis | 6 hours |
|---|---|---|

Concept of Multiple regression model to describe a linear relationship, Assessing the fit of the regression line, inferences from multiple regression analysis, problem of overfitting of a model, comparing two regression model, prediction with multiple regression equation.

| Module:3 | Fitting Curves and Model Adequacy Checking | 6 hours |
|---|---|---|

Introduction, fitting curvilinear relationship, residual analysis, PRESS statistics, detection and treatment of outliers, lack of fit of the regression model, test of lack of fit, Problem of autocorrelation and heteroscedasticity. Estimation of pure errors from near neighbors.

| Module:4 | Transformation techniques | 5 hours |
|---|---|---|

Introduction, variance stabilizing transformations, transformations to linearize the model, Box-Cox methods, transformations on the repressors variables, Generalized and weighted least squares, Some practical applications.

| Module:5 | Multicollinearity | 7 hours |
|---|---|---|

Introduction, sources of multicollinearity, effects of multicollinearity. Multicollinearity diagnostics: examination of correlation matrix, variance Inflation factors (VIF), Eigen system analysis of $X^1X$. Methods of dealing with Multicollinearity: collecting additional data, model re-specification, and ridge regression.

| Module:6 | Generalized Linear Models | 7 hours |
|---|---|---|

Generalized linear model: link functions and linear predictors, parameter estimation and inference in the GLM, prediction and estimation with the GLM, Residual Analysis, and concept of over dispersion.

| Module:7 | Model building and Nonlinear Regression | 6 hours |
|---|---|---|

Variable selection, model building, model misspecification. Model validation techniques: Analysis

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|---|---|---|
| of model coefficients, and predicted values, data splitting method. Nonlinear regression model, nonlinear least squares, transformation to linear model, parameter estimation in nonlinear system, statistical inference in nonlinear regression. | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Third Ed., Wiley India Pvt. Ltd., 2016.
- Norman R. Draper, Harry Smith; Applied Regression Analysis, WILEY India Pvt. Ltd. New Delhi; Third Edition, 2015.

**Reference Books**

- Johnson, R A., Wichern, D. W., Applied Multivariate Statistical Analysis, Sixth Ed., PHI learning Pvt., Ltd., 2013.
- Iain Pardoe, Applied Regression Modeling, John Wiley and Sons, Inc, 2012.

Mode of Evaluation: CAT / Digital Assignment / Quiz / FAT

**List of Challenging Experiments**

| | | |
|---|---|---|
| 1. | Correlation Analysis using- scatter diagram, Karl Pearson's correlation coefficient and drawing inferences. | 2 hours |
| 2. | Simple linear regression: model fitting, estimation of parameters, computing $R^2$ and adjusted $R^2$ and model interpretation. | 4 hours |
| 3. | Residual analysis and forecast accuracy for a given data set. | 2 hours |
| 4. | Validating Simple linear regression using t, F and p- test. | 4 hours |
| 5. | Developing confidence interval and testing the model simple and multiple regression. | 4 hours |
| 6. | Multiple regression: estimation of parameters, fitting of the model, error analysis, model validation, variable selection and testing. | 4 hours |
| 7. | Problem of multicollinearity and, determination of VIF. | 2 hours |
| 8. | Diagnostic measures and outliers detection, Durbin Watson test, variable selection and model building | 4 hours |
| 9. | Autocorrelation, auto regressive model. | 2 hours |
| 10. | Fitting of nonlinear regression model. | 2 hours |
| **Total Laboratory Hours:** | | **30 hours** |

Mode of assessment: Continuous Assessment and FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 10-09-2019 | | |
| Approved by Academic Council | No. 56 | Date | 24-09-2019 |

| Course Code | Computational Statistics for Data Science | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6004 | | 0 | 0 | 4 | 0 | 2 |
| Pre-Requisite | MAT5013 - Statistical Inference | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Use of software packages for statistical theory towards computing environment.
- To enhance the theoretical concepts and its application in the real-time domain.

**Expected Course Outcomes:**

Students will be able to

- use software tools for projects in data management.
- apply technical skills in the statistical data analysis to transform a simple to multiple variables.
- understand the statistical decision-making theory and interpretation.
- analyze and solve real-time problems

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1 | Data Management – Handling Big data sets and variable selection | 6 hours |
| 2 | Descriptive statistics and their interpretation | 8 hours |
| 3 | Tabulation of Data and Cross Tabulation | 6 hours |
| 4 | Correlation analysis | 8 hours |
| 5 | Regression analysis | 8 hours |
| 6 | Testing of the hypothesis ( □, □, □ and $□^2$- tests) | 8 hours |
| 7 | Non-parametric tests | 8 hours |
| 8 | Design and analysis of experiments | 8 hours |
| | **Total Laboratory hours:** | **60 hours** |

**Text Book(s)**

- McCormick, Keith; Salcedo, Jesus, SPSS statistics for data analysis and visualization, Wiley, 2017.
- K. V. S. Sarma, Statistics Made Simple Do It Yourself, 2nd Ed, Prentice-Hall, 2010.

**Reference Book(s)**

- Murtaza Haider, Getting Started with Data Science: Making Sense of Data with Analytics, IBM Press, 2015.
- J.P. Verma, Data Analysis in Management with SPSS Software, Springer, 2013.

**Mode of Evaluation**: Continuous Assessment and FAT.

| | | | |
|---|---|---|---|
| **Recommended by Board of Studies** | 10.09.2019 | | |
| **Approved by Academic Council** | No. 56 | Date | 24-09-2019 |

| Course Code | Design and Analysis of Experiments | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6009 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | MAT5013 – Statistical Inference | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives**

- Describe how to design experiments, carry them out, and analyze the data they yield.
- Construct appropriate experimental designs for given problems: sample size determination, choice of levels of variables, designs with restrictions on randomization, utility functions for measuring design objectives, use of simulation to characterize properties of designs.

**Expected Course Outcome**

- Describe the purpose of robust construction and how it is applied in experimental design
- To formulate and validate the experimental designs in agricultural, medical, biomedical projects
- Avails them to fetch the background concepts of Model formulation and validation
- To accomplish research-oriented concepts given for statistical techniques required for experimental designs

| Module:1 | Basic Principles of Experimental design | 2 hours |
|---|---|---|

Strategy of Experimentation - Applications of Experimental Design – Basic Principles – Guidelines for designing experiments.

| Module:2 | Simple Comparative Experiments | 8 hours |
|---|---|---|

Principles of scientific experimentation – Basic Designs: Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD) – Analysis of RBD (with one observation per cell, more than one but equal number of observations per cell).

| Module:3 | Analysis of Co-variance | 6 hours |
|---|---|---|

Multiple Comparisons – Multiple Range Tests - Analysis of Covariance – Construction of Orthogonal Latin Square – Analysis of Graeco Latin Squares.

| Module:4 | Factorial experiments | 8 hours |
|---|---|---|

Factorial experiments - $2^2$, $2^3$ and $3^2$, $3^3$ experiments and their analysis - Fractional replication in Factorial Experiments.

| Module:5 | Confounding | 6 hours |
|---|---|---|

Necessity of confounding, Types of confounding, complete and partial confounding in $2^n$, $3^2$ and $3^3$- factorial designs, Analysis of confounded factorial designs; Fractional Replication.

| Module:6 | Balanced Incomplete Block design | 6 hours |
|---|---|---|

Balanced Incomplete Block Design (BIBD)– Types of BIBD – Simple construction methods – Concept of connectedness and balancing – Intra Block analysis of BIBD.

| Module:7 | Partially Balanced Incomplete Block design | 6 hours |
|---|---|---|

Partially Balanced Incomplete Block Design with two associate classes – intra block analysis - Split plot and strip plot design and their analysis.

| Module:8 | Contemporary issues | 2 hours |
|---|---|---|

Lecture by Industry Experts

| | | | | |
|---|---|---|---|---|
| | **Total Lecture hours** | | | **45 hours** |
| **Text Book(s)** | | | | |
| • | Douglas C. Montgomery, Design and Analysis of Experiments, 9h Edition, John Whiley and Sons, 2017. | | | |
| • | Angela Dean and Daniel Voss Danel Draguljić, Design and Analysis of Experiments, 2nd Edition, Springer International Publishing AG, 2017. | | | |
| **Reference Books** | | | | |
| • | Das M.N. and Giri N.C., Design and Analysis of Experiments, 3rd Edition, New Age International (P) Ltd 2017 | | | |
| • | John Lawson, Design and Analysis of Experiments with R, 1st Edition, CRC Press, 2015. | | | |
| **Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT | | | | |
| **List of Challenging Experiments (Indicative)** | | | | |
| 1 | One-way analysis of variance - CRD | | | 2 hours |
| 2 | RBD & LSD analysis of one and two observations | | | 4 hours |
| 3 | Analysis of Co-variance CRD & RBD | | | 4 hours |
| 4 | Analysis of Graeco Latin Squares | | | 4 hours |
| 5 | Factorial experiments | | | 4 hours |
| 6 | Confounding | | | 4 hours |
| 7 | BIBD and PBIBD | | | 4 hours |
| 8 | Split plot design | | | 4 hours |
| | **Total Laboratory hours** | | | **30 hours** |
| Mode of Evaluation: Continuous assessment and FAT | | | | |
| Recommended by Board of Studies | 24.06.2020 | | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 | |

| Course Code | Programming for Data Analysis | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6012 | | 2 | 0 | 4 | 0 | 4 |
| Pre-Requisite | None | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To introduce core programming basics required for data science using Python language
- To read and write simple Python programs
- To develop Python programs with conditionals and loops
- To use Python data structures – lists, tuples, dictionaries
- To introduce the important data science modules NumPy, SciPy and Matplotlib
- To introduce the input/output with files in Python and statistical processing of a data using Pandas

**Expected Course Outcome:**

At the end of the course students will be able to:

- Read, write, execute simple Python programs
- Decompose a Python program into functions
- Manipulate with 1-d,2-d and multidimensional data using Python
- Read and write data from/to files in Python programs
- Develop algorithmic solutions to data science related problems

| Module:1 | Algorithmic Problem Solving | 3 hours |
|---|---|---|

Algorithms, building blocks of algorithms (statements, state, control flow, functions); algorithmic problem solving; iteration, recursion. Illustrative problems: finding minimum in a list, guess an integer number in a range, factorial of a number

| Module:2 | Data, Expressions, Statements in Python | 4 hours |
|---|---|---|

Python Strengths and Weakness; Installing Python; IDLE - Spyder – Jupyter; Mutable and Immutable Data Types, Naming Conventions; String Values; String Operations; String Slices; String Operators; String functions – split, join, chr, ord; Numeric Data Types; Arithmetic Operators and Expressions; Comments in the Program; Understanding Error Messages

| Module:3 | Data Collection and Language Component of Python | 4 hours |
|---|---|---|

List; Tuples; Sets; Dictionaries; Sorting Dictionaries; Control Flow and Syntax; Indenting; The if statement; Relational Operators; Logical Operators; Bit-wise Operators; The while Loop – break and continue statements; The for Loop; List Comprehension

| Module:4 | Functions and Modules in Python | 4 hours |
|---|---|---|

Functions - Introduction; Defining your own functions; parameters; local and global scope; passing collections to a function; variable number of arguments; passing functions to a function; Lambda function; map; filter; Modules: Introduction; Standard Modules – sys, math, time

| Module:5 | Python Modules for Data Science – I | 5 hours |
|---|---|---|

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|---|---|---|
| NumPy arrays – 1-d, multidimensional arrays and matrices; Mathematical operations with arrays; Slicing and addressing arrays; Boolean masks; Difference between lists and arrays<br>SciPy – Scientific Computing library of Python – Introduction, Basic functions, Special functions, scipy.integrate, scipy.optimize, scipy.interpolate | | |
| **Module:6** | **Python Modules for Data Science – II** | **5 hours** |
| Python Plotting: PyPlot – Basic Plotting; Logarithmic Plots; Plots with multiple axes; Matplotlib – interactive functions 3d plotting; Pandas – Introduction, DataFrame, Reading and writing CSV, XLS files, Working with missing data, categorical data, data visualization with pandas | | |
| **Module:7** | **Error Handling in Python** | **3 hours** |
| Handling IO Exceptions, Metadata, Errors, Runtime Errors, Exception Model | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| **Total Lecture Hours** | | **30 hours** |
| | | |
| **Mode of Evaluation:** CAT, Quiz, Digital Assignment and FAT.<br>List of Challenging Experiments (Indicative) | | |
| 1. Python Program Environment, IDLE, Jupyter, Spyder environments<br>First Basic Experiment(s): (i) "Hello World!" Program in IDLE, Jupyter, Spyder Environments.<br>(ii) Program(s) to demonstrate the Python data types | | **4 hours** |
| 2. Python Operators, Expressions and Flow Controls<br>Simple Experiment(s): (i) Program to demonstrate the Python operators and their order of preference.<br>(ii) Program to add/multiply/divide two numbers<br>(iii) Program to verify whether a given number is even or odd<br>Perfection: Program to verify whether a given number is Armstrong number or not. A number is said to Armstrong number if sum of the cubes of individual digits of that number is equal to the number itself. Viz., 153 = 1^3 + 5^3 + 3^3 | | **4 hours** |
| 3. Python Lists, Tuples, Dictionaries & Sets<br>Simple Experiment: Write a Python program which demonstrate the use of Lists, Tuples Dictionaries and Sets. This program should accepts the elements into various types and perform the other operations such as append, copy, extend, pop, remove operations. | | **6 hours** |
| 4. Python Functions, Modules and Packages<br>Simple Experiment(s): Write a function file which accepts a set of numbers and displays the largest among them<br>Perfection: Write a function which accepts a number 'n' and list the first 'n' Fibonacci numbers<br>Challenging: Create a own module in Python which includes functions such as greeting() which greets a welcome message to user. This module should also contain some variables and functions which finds the maximum among the two given numbers. | | **4 hours** |

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|---|---|
| 5. Array and Matrix Manipulation in Python<br>Simple Experiment: Write a Python program demonstrating the NumPy matrix operations such as accepting two matrices finding the dimension, adding the two matrices<br>Perfection: Write a Python program which accepts a matrix A of order m x p another matrix B of order p x n and checks whether the matrix multiplication is possible or not. If possible then finds matrix multiplication and displays it to user. | **4 hours** |
| 6. Data Manipulation – SciPy Module<br>Simple Experiment: Write a Python program to find the det, inv, eigenvalues and eigenvectors of a matrix using corresponding SciPy module functions<br>Challenging: Create a data set consisting of time series observations of an experiment. Using the interpolation techniques of SciPy module form an interpolating polynomial and use it to estimate the experimental values for intermediate values. | **6 hours** |
| 7. Data Visualization in Python – PyPlot Module<br>*Compare:* Given the examination scores of students of three different classes for the same subject taught by different professors, display them visually to aid comparison of pass percentage, A grades etc. | **6 hours** |
| 8. Data Manipulation using Pandas – Exploring a Dataset and Analysing a Dataset<br>*Simple Experiments:* Create a data frame consists of five countries, their capitals, area of the country, population. The program should also print the description of the data frame and finally save this data frame to a csv file.<br>*Challenging:* Write a Python program demonstrating the Pandas indexing capabilities, identifying the null values in the dataset and filling them with or dropping them from the dataset. Also demonstrate the merging, joining and concatenating data frames using Pandas. | **6 hours** |
| 9. Descriptive Statistical Analysis – Evaluation, Plotting and Interpretation<br>*Linear Regression:* Read a data frame in csv/xls format containing the weather data such as pressure, min temp, max temp, humidity, rainfall. Using the Pandas, MatPlotlib and SciPy plot the scatter plots and develop a linear interpolation between rainfall with all other parameters and evaluate the statistical significance of the model. | **6 hours** |
| 10. Evaluation of Probability using various Distributions Functions<br>*Simple Experiments:* Write Python programs to generate a normal distribution, binomial distribution and Poisson distribution using Python and visualize them.<br>*Challenging:* Write Python program to check the normality of a dataset, which a foremost important test, required to determine whether to apply parametric tests or nonparametric tests on the given test. These tests include Histogram, Quantile-quantile plot, Shapiro-Wilk test, D'Agotino's K-squared test, Anderson-Darling test | **6 hours** |
| 11. Linear and Nonlinear Regression in Python<br>*Simple Linear Regression:* Write a Python program to implement the Simple Linear Regression model to predict the wine quality using the physicochemical and sensory variables by using Scikit-Learn module and estimate the statistical significance of the model.<br>*Nonlinear Linear Regression:* Write a Python program to predict the price of oil | **4 hours** |

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|---|---|
| (OIL) from indicators such as the West Texas Intermediate (WTI) price, Henry Hub gas price (HH), and the Mont Belvieu (MB) propane spot price. Data is available for OIL, WTI, HH, and MB from the years 2000 to 2016 at the link https://apmonitor.com/me575/uploads/Main/oil_data.txt. The OIL is related with WTI, HH and MB nonlinearly as follows: OIL = A ($WTI^B$) ($HH^C$) ($MB^D$) | |
| 12. Decision Trees and Time Series Analysis in Python<br>Programs to illustrate the use of decision trees in machine learning to develop the decisions and their possible consequences. In this experiment we will use the dataset related breast cancer to predict the breast cancer spread using decision trees. | **4 hours** |
| **Total Laboratory Hours** | **60 hours** |
| **Mode of Evaluation: CAT and FAT** | |

**Text Book(s)**

- David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2019.
  Jake vander Plas, Python Data Science Handbook – Essential Tools for Working with Data, O'Really Media, 2017

**Reference Book(s)**

- Robert Johansson, Numerical Python – Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib, Apress, 2019
- Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016
- Nelli, F., Python Data Analytics: with Pandas, NumPy and Matplotlib, Apress, 2018.

**Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT.

| | | | |
|---|---|---|---|
| **Recommended by Board of Studies** | 24-06-2020 | | |
| **Approved by Academic Council** | No. 59 | Date | 24-09-2020 |

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

# Programme Elective

| Course Code | Total Quality Management | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT3010 | | 3 | 0 | 0 | 4 | 4 |
| Pre-Requisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objective:**

The objective of the course is to make the student:

- To understand the basic concepts, contribution of gurus, barriers and benefits of TQM.
- To understand the basic principles of TQM.
- To understand the analysis and applications of tools and techniques in TQM.
- To understand the various concepts of TQM, quality concepts related to manufacturing and service processes.
- To understand the quality standards and systems in TQM.

**Course Outcome:**

At the end of the course, the students will be able to:

- Gain basic knowledge in total quality management relevant to both manufacturing and service industry including IT sector.
- Implement the basic principles of TQM in manufacturing and service based organization.
- Apply the tools and techniques-I of quality management to Manufacturing and services processes.
- Explore industrial applications of Quality function deployment, Taguchi quality concepts and TP and apply the tools and techniques-II of quality management to manufacturing and services processes.
- Gain the knowledge on various ISO standards and quality systems.

| Module: 1 | Introduction TQM | 6 Hours |
|---|---|---|

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of Product and Service Quality –Definition of TQM - Basic Concepts of TQM –- Gurus of TQM (Brief introduction) - TQM Framework- Barriers to TQM –Benefits of TQM.

| Module: 2 | TQM Principles | 7 Hours |
|---|---|---|

Leadership -The Deming Philosophy, Quality council, Quality statements and Strategic planning- - Customer Satisfaction – Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer Retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal - Continuous process improvement – Juran Trilogy, PDSA cycle, 5s and Kaizen - Supplier Partnership – Partnering, Supplier Selection, Supplier Rating and Relationship Development.

| Module: 3 | TQM Tools and Techniques I | 6 Hours |
|---|---|---|

The seven traditional tools of quality – New management tools – Six-sigma Process Capability– Bench marking – Reasons to bench mark, Bench marking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking .

| Module: 4 | TQM Tools and Techniques II | 6 Hours |
|---|---|---|

FMEA – Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.

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|---|---|---|
| **Module: 5** | **TQM Tools and Techniques III** | **6 Hours** |
| Quality Circles – Quality Function Deployment (QFD) – Taguchi Quality Loss Function – TPM – Concepts, Improvement Needs – Performance Measures-- Cost of Quality - BPR. | | |
| | | |
| **Module: 6** | **Quality Management System** | **6 Hours** |
| Introduction — Benefits of ISO Registration — ISO 9000 Series of Standards — Sector-Specific Standards — AS 9100, TS16949 and TL 9000 -- ISO 9001 Requirements — Implementation — Documentation — Internal Audits — Registration. | | |
| | | |
| **Module: 7** | **Environmental Management System** | **6 Hours** |
| Introduction - ISO 14000 Series Standards — Concepts of ISO 14001 — Requirements of ISO 14001 — Benefits of EMS. | | |
| | | |
| **Module: 8** | **Contemporary Issues** | **2 Hours** |
| Lecture by Industry Experts. | | |
| | **Total Lecture Hours:** | **45 Hours** |

**Text Book(s)**

- Dale H. Besterfiled, Carol B. Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

**Reference Book(s)**

- James R. Evans and William M. Lindsay, "The Management and Control of Quality", Sixth Edition, South-Western (Thomson Learning),2005.
- Oakland,J.S."TQM–Text with Cases", Butterworth–Heinemann Ltd., Oxford, Third Edition, 2003.
- Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall of India, 2006.
- Janakiraman,B and Gopal,R.K, "Total Quality Management–Text and Cases", Prentice Hall of India,2006.

**Mode of Evaluation:** Assignments, Quizzes, CATs and FAT.

| | | | |
|---|---|---|---|
| **Recommended by Board of Studies** | 30-06-2021 | | |
| **Approved by Academic Council** | No.: | Date: | |

| Course Code | Biostatistics | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1031 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | None | Syllabus Version | | | | |
| | | | | | | 1.0 |

**Course Objectives:**

The objective of the course is to make the student:

- To understand the role of biostatistics in medical studies, biology and others.
- To provide a foundation on statistical methods.
- To use appropriate statistical techniques to analyze real-world problems arising in medical science, public health and others.
- To interpret the statistical results accurately and effectively.

**Course Outcomes:**

At the end of the course, the students will be able to:

- Apply basic statistical concepts commonly used in Health and Medical Sciences.
- Calculate and interpret confidence intervals, p-value in hypothesis testing.
- Acquire knowledge in epidemiological study designs.
- Analyze categorical data and diagnostic tests.
- Familiar with the appropriate use of Non-parametric tests.
- Impart skills in measuring demographic and vital statistics.
- Understand survival analysis and construction of life table.

| Module: 1 | Introduction to Clinical Trials | 8 Hours |
|---|---|---|

Statistical Methods in Clinical Trials: Introduction to clinical trial and it's phases I, II, III and IV, statistical designs-fixed sample trials: simple randomized design, stratified randomized crossover design.

| Module: 2 | Randomization and Sequential Designs | 6 Hours |
|---|---|---|

Sequential design - open and close sequential design. Randomization-Dynamic randomization, Permuted block randomization; Blinding-Single, double and triple.

| Module: 3 | Bioassays | 6 Hours |
|---|---|---|

Biological Assays: Introduction, parallel-line assay, slope- ratio assays and quantile- response assay, Feller's theorem. Dose-response relationships-qualitative and quantitative response, dose response relation- estimation of median effective dose.

| Module: 4 | Epidemiology Study Designs and Measures | 5 Hours |
|---|---|---|

Measures of disease frequency – incidence – prevalence – relative risk – Epidemiological study designs – Cohort study design and its analysis – Case control study design and its analysis – concept of bias – information bias and selection bias.

| Module: 5 | ROC Curve Analysis | 6 Hours |
|---|---|---|

ROC Curve analysis - Estimation of Binomial Model and the Area under the Curve, its applications – Properties of ROC curve - Kullback –Leibler Divergence (KLD)– definition – functional relationship between Kullback –Leibler Divergence and the slope of the ROC curve – derivations of KLD expressions for Bi-normal ROC model.

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| **Module: 6** | **Repeated Measures Data** | **6 Hours** |
| Repeated Measures ANOVA – One Way and Two Classified Data and its analysis and interpretation – Profile Analysis. | | |
| | | |
| **Module: 7** | **Survival Analysis and Life Tables** | **6 Hours** |
| Describe survival data - compare survival of several groups - survival and hazard functions- Log-rank test - Cox regression - Exponential survival curves - Construction of a life table- Modified life table - Kaplan-Meier's Method - Censoring and different types of censoring. | | |
| | | |
| **Module: 8** | **Contemporary Issues** | **2 Hours** |
| Lecture by Industry Experts | | |
| **Total Lecture Hours:** | | **45 Hours** |
| **Text Book(s)** | | |
| • Elisa T.Lee & John Wenyu Wang (2003): Statistical methods for Survival Data analysis, 3rd Edition, John Wiley.<br>• Krzanowski, W and Hand, D.J.(2009): ROC Curves for Continuous Data, Chapman and Hall. | | |
| **Reference Book(s)** | | |
| • Jerrold H. Zar (2014): Bio-statistical Analysis, 5th edition, Pearson.<br>• Daniel, W. W. and Chad L. Cross (2018). Bio-Statistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons, 11th Edition.<br>• Klein J. P. and Moeschberger, M.L. (2013), Survival Analysis – Techniques for Censored and Truncated Data, Springer Inc, 2nd Edition.<br>• Rastogi, V.B. (2006): Fundamentals of Biostatistics, ANE Books, India.<br>• Gordis L; Epidemiology; 4th Edition, Philadelphia, 2014. | | |
| | | |
| **Mode of Evaluation:** Assignments, Quizzes, CATs and FAT. | | |
| | | |
| **List of Challenging Experiments (Indicative)** | | |
| 1. | Preparation of simple Randomization, Permuted Block Randomization | 3 Hours |
| 2. | Fitting Slope-Ratio Assay and its analysis cum interpretation | 3 Hours |
| 3. | Fitting Parallel Line assay and its analysis cum interpretation | 3 Hours |
| 4 | Construction of Bi-Normal ROC Curve and its measures | 3 Hours |
| 5 | Computation of Incidence, prevalence, risk ratio and odds ratio | 3 Hours |
| 6. | One Way Repeated Measures ANOVA | 3 Hours |
| 7. | Two Way Repeated Measures ANOVA | 3 Hours |
| 8. | Computation of Life tables | 3 Hours |
| 9. | Kaplan-Meier Analysis with log rank, breslow tests | 3 Hours |
| 10. | Cox Regression Analysis | 3 Hours |
| **Total Laboratory Hours:** | | **30 Hours** |
| Mode of Evaluation: Continuous Assessments, Oral Examination and FAT. | | |
| Recommended by Board of Studies | 30-06-2021 | |
| Approved by Academic Council | No. | Date |

| Course Code | Decision Modelling Techniques | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT1032 | | 2 | 0 | 2 | 0 | 3 |
| Pre-Requisite | Probability and Statistics | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

The objective of the course is to make the student:

- To understand the fundamental concepts of data analysis, data description, decision making, simulation, random number generation, regression modeling, decision modeling, and simulation modeling.
- To conversant with various methods and techniques used in summarization and analysis of data.
- To prepare for investigation of data and examine the possible diagnostics of regression model.
- To formulate real time problem in a form of model.
- To develop feasible solution of real-life problems, using spreadsheet, decision, simulation modeling techniques.
- To conduct research using data analysis and decision models.

**Course Outcomes:**

At the end of the course, the students will be able to:

- Learn to develop in-depth understanding of the data analysis and decision modeling.
- Demonstrate the knowledge and skill of data scaling, acquisition, handling, and manipulation.
- Examine the relationships between dependent and independent variables of simple and multiple regression models estimate the parameters and fit a model.
- Perform, handle and manipulate the analysis of various types of data and develop an appropriate decision model.
- Apply the methods of random number generators and use it to solve real life problems.

| Module: 1 | Introduction to Data Analysis and Visualization | 4 Hours |
|---|---|---|

Data and measurement, absolute and relative measures of data, data scale (nominal, ordinal, interval, and ratio), data types, methods of data acquisition, normalization of data, data transformation, concept of Z-score, Data visualization, Boxplot, stem-and-leaf plots, radar charts, Pie chart, stacked bar-charts, histograms, Time-series plots, concept of outliers, identification of outliers analytically (using Z-score) and graphically (using Boxplot).

| Module: 2 | Data Processing and Manipulation | 4 Hours |
|---|---|---|

Processing of data, methods of getting right data, sources of data, data sources on the Web, official statistics, data handling using Excel auto-filter, complex queries with advanced filter, importing external data from Access, creating pivot table from external data, exploring data with pivot table, data cleansing, handling the missing data, data manipulation, summary statistics and process of decision making.

| Module: 3 | Decision Making under Uncertainty | 4 Hours |
|---|---|---|

Introduction to elements of decision making, the precision tree, decision problems: single and multistage, Bayes rule, numerical problems and cases, and applications based on binomial, Poisson, normal and exponential distributions.

| Module: 4 | Random Number Generation | 4 Hours |
|---|---|---|

Concept and meaning of random number and its relevance, methods of random number generation, Generating Discrete Random Variates, Techniques for Generating Continuous Random Variates.

| Module: 5 | Modeling through Regression | 6 Hours |
|---|---|---|

Concept and definition of a model, steps of modeling, covariance and correlation, simple and multiple regression model, estimation of coefficients, fitting of a model, drawing inferences for regression

| | | |
|---|---|---|
| coefficients, concept of $R^2$ and adjusted $R^2$, Problem of overfitting of regression model, model validation, construction of confidence intervals for regression coefficients, developing prediction intervals. | | |
| **Module: 6** | **Modelling in Excel** | **3 Hours** |
| Introduction to Excel built-in (Analysis ToolPak, Solver Add-in) and external add-in modules, Add-in for multiple regression and correlation, partial least squares introduction to Excel macros. | | |
| **Module: 7** | **Simulation Modelling** | **3 Hours** |
| Introduction - Simulation modeling, Discrete Simulation model, Continuous Simulation model - Monte-Carlo simulation. Spreadsheet simulation modelling - selecting probability distributions for specific simulation, simulating correlated values. | | |
| **Module: 8** | **Contemporary Issues** | **2 Hours** |
| Lecture by Industry Experts | | |
| **Total Lecture Hours:** | | **30 Hours** |

**Text Book(s)**

- Albright, S. C., Winston, W. L. and Zappe, C. Data Analysis and Decision Making, 7th Edition, Cengage Learning Pvt. Ltd. 2020.

**Reference Book(s)**

- A.M. Law and W.D. Kelton. Simulation Modeling and Analysis, T.M.H. Edition (2016).
- S.M. Ross. Simulation, India Elsevier Publication (2016).
- Wendy L. Martinez, Angel R. Martinez., Computational Statistics handbook with MATLAB, Chapman & Hall / CRC (2002).

**Mode of Evaluation:** Assignments, Quizzes, CATs and FAT.

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1. | Introduction to Data Analysis | 3 Hours |
| 2. | Data analysis using statistics, missing value estimation, data transformations | 3 Hours |
| 3. | Graphical visualization techniques | 3 Hours |
| 4. | Generating continuous random variables | 3 Hours |
| 5. | Generating Discrete random variables | 3 Hours |
| 6. | Pivot Tables and Conditional Formatting | 3 Hours |
| 7. | Data Processing and Manipulation | 4 Hours |
| 8. | Decision Making under Uncertainties | 3 Hours |
| 9. | Modelling using clustering (k-means) | 2 Hours |
| 10. | Modelling Through Regression | 3 Hours |
| **Total Laboratory Hours:** | | **30 Hours** |

**Mode of Evaluation:** Continuous Assessments, Oral Examination and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 30-06-2021 | | |
| Approved by Academic Council | No.: | Date: | |

| Course code | Programming in C | L | T | P | J | C |
|---|---|---|---|---|---|---|
| CSE1008 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | None | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives**

a. To impart essential problem solving skills through general problem solving concepts.
b. To provide basic knowledge on programming essentials using C as implementation tool.
c. To introduce the Unix file system interface and introduce various programming methods using C.

**Course Outcomes**

After completion of this course, students will be able to:

1. Propose solutions for a given problem using algorithm and flowchart designs.
2. Infer the fundamental programming elements in C language and learn to apply basic control structures in C.
3. Visualize the capabilities of modular programming approach in C and demonstrate the same in the real world scenario.
4. Understand the basic principles of pointers and their association with various data structures during implementations.
5. Demonstrate the applications of structures and unions.
6. Apply various input, output and error handling functions in C while solving the given problem through unix system interface.
7. Showcase the attained knowledge by applying them to solve various real world problems.

| Module: 1 | Introduction to C-Programming | 3 hours |
|---|---|---|

How to solve basic problems using C-programming, Decisions and Loops, Introduction to imperative language, Syntax and constructs

| Module:2 | C-operators and expressions | 4 hours |
|---|---|---|

Types of variables, Data Type and Sizes, Identifiers and Keywords, Various operators – Arithmetic operators, Relational operators, Logical operators, Increment Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Type Conversion, Precedence and
Order of Evaluation, Hungarian Notation

| Module:3 | Structured and Unstructured programming | 7 hours |
|---|---|---|

Statements and Blocks, Introduction to If-Else-If, Switch, and Loops - while, do, for, break and continue, Goto Labels, Introduction to structured and un- structured programming

| Module:4 | Functions and Program Structure with Standard Library Functions | 6 hours |
|---|---|---|

Functions, recursion, macros, parameter passing and references, Scope Rules, Block structure, Initialization, Introduction to preprocessor, Standard Library Functions and return types

| Module:5 | Pointers and Arrays | 8 hours |
|---|---|---|

Introduction to Pointers, Types of pointers and arrays, Pointers and Strings, Arrays of Strings, Multi-dimensional arrays, Pointers to Arrays, Pointers and Dynamic allocation of memory, Pointers to Functions, Evaluation of complicated declarations.

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| **Module:6** | **Structures** | **9 hours** |
| Introduction to Structures, Pointers and Structures, Structures and Functions, Array of structures, Self-referral Structures, Table look up**,** Input and Output methods, Variable length argument list, File access including FILE structure, Error Handling, Line I/O, miscellaneous functions | | |
| **Module:7** | **Files and Directories** | **6 hours** |
| File Descriptor, Low level I/O, Random access, Introduction to Directories, Storage allocator, Different programming method, Debugging, User Defined Header, User Defined Library Function | | |
| **Module:8** | **ntemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |
| **Text Book(s)** | | |
| 1. | B. W. Kernighan and D. M. Ritchi, "The C Programming Language", Second Edition, Pearson, June 2015. | |
| 2. | Gary J Bronson, "ANSI C Programming", Fourth Edition, Cengage Learning India Private Limited; Fourth edition, 2016. | |
| 3. | B. Gottfried, "Programming in C", Second Edition, Schaum Outline Series, Tata Mc-Graw Hill Publishers, 1996. | |
| **Reference Books** | | |
| 1. | Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2000. | |
| 2. | Yashavant Kanetkar, "Let Us C", BPB Publications, 2017. | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | |
| **List of Challenging Experiments (Indicative)** | | |
| 1. | Algorithm and flowcharts of small problems like GCD | 2 hours |
| 2. | Small but tricky codes (use of operators and expressions) | 3 hours |
| 3. | Solving sequences (applications of control structures) | 4 hours |
| 4. | Proper parameter passing (User defined functions) | 3 hours |
| 5. | Command line Arguments (Understanding main( )) | 2 hours |
| 6. | Variable parameter (Pointers and Arrays) | 3 hours |
| 7. | Pointer to functions (Pointer and functions) | 3 hours |
| 8. | User defined header (Creation of headers) | 3 hours |
| 9. | Make file utility (unix make file) | 2 hours |

| | | |
|---|---|---|
| 10. | Multi file program and user defined libraries (Use of pre-processor directives) | 3 hours |
| 11. | Interesting substring matching / searching programs (String matching and searching) | 2 hours |
| | Total Laboratory Hours | **30 hours** |

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|---|---|---|---|
| Mode of assessment: | | | |
| Recommended by Board of Studies | 03-06-2019 | | |
| Approved by Academic Council | No. 55 | Date | 13.06.2019 |

| Course Code | Modelling and Simulation | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5022 | | 2 | 0 | 2 | 0 | 3 |
| Pre-Requisite | Calculus and Basic Probability and Statistic Concepts | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To understand the functioning of industries and business strategies.
- To provide students hands-on experience in using industry-standard simulation modelling software in order to structure and solve complex and large-scale managerial decision problems.

**Expected Course Outcome:**

- Have a comprehensive understanding of the theoretical foundations of stochastic simulation, including
- Random number generation, sampling from discrete and continuous distributions, and statistical analysis of transient/steady-state outputs.
- Build realistic discrete-event simulation models using industry-standard software.
- Apply simulation model building and analysis skills to systematically frame and solve complex business planning problems.
- Explain Verification and Validation of simulation model.
- Interpret the model and apply the results to resolve critical issues in a real world environment.
- Demonstrate various statistical software for simulation technique.

| Module:1 | Introduction to Modelling and Simulation | 4 hours |
|---|---|---|

Introduction to Simulation modeling, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples.

| Module:2 | General Principles | 2 hours |
|---|---|---|

Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling.

| Module:3 | Random Number and Random Variate Generation | 6 hours |
|---|---|---|

Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique

| Module:4 | Optimization via Simulation | 3 hours |
|---|---|---|

Meaning, difficulty, Robust Heuristics, Random Search.

| Module:5 | Analysis of Simulation Data | 4 hours |
|---|---|---|

Input Modelling: Data collection, Identification and distribution with data, parameter

| | | | |
|---|---|---|---|
| estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models. | | | |
| | | | |
| **Module:6** | **Output Analysis** | **5 hours** | |
| Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations. | | | |
| | | | |
| **Module:7** | **Simulation Software** | **4 hours** | |
| Selection of Simulation Software, Simulation packages, Trend in Simulation Software. | | | |
| | | | |
| **Module:8** | **Contemporary issues:** | **2 hours** | |
| Lecture by Industry Experts | | | |
| | **Total Lecture hours:** | **30 hours** | |

**Text Book(s)**

- Robinson, S. (2014) Simulation: The Practice of Model Development and Use (2nd Edition). Palgrave Macmillan.
- Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.

**Reference Books**

- Geoffrey Gordon, (1978) System Simulation, Prentice Hall publication, 2nd Edition, ISBN: 81-203-0140-4.
- Pidd, M., (2004) Computer Simulation in Management Science. John Wiley & Sons.
- Narsingh Deo (2004), Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, ISBN : 0-87692-028-8.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Features of Pro model Package and Input Modelling | 6 hours |
| 2. | Simulation of Manufacturing System | 6 hours |
| 3. | Simulation of Service Operations | 6 hours |
| 4. | Modelling a Live Problem | 6 hours |
| 5. | Modelling and simulation problems | 6 hours |
| Total Laboratory Hours | | 30 hours |

Mode of assessment: Weekly Assessment / FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course Code | Decision Support Systems | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT5024 | | 2 | 0 | 0 | 4 | 3 |
| Pre-Requisite | None | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To review and clarify the fundamental terms, concepts and theories associated with Decision Support Systems, computerized decision aids, expert systems, group support systems and executive information systems.
- To discuss and develop skills in the analysis, design and implementation of computerized Decision Support Systems.
- To discuss organizational and social implications of Decision Support Systems.

**Expected Course Outcomes:**

- Explain the nature of modelling and how real-world systems may be represented in mathematical form and realised on a computer.
- Determine when a realistic problem is in non-standard form and represent it quantitatively using a computer.
- To examine examples and case studies documenting computer support for organizational decision making, and various planning, analysis and control tasks.
- Distinguish among data processing systems, management information systems, and decision support/expert systems.
- Analyze how information is used to solve problems.

| Module:1 | Introduction to Systems Principles | 4 hours |
|---|---|---|

The Characteristics and elements of systems, General systems model, Explore communication systems, Differentiate between data processing systems, management information systems, and decision support systems.

| Module:2 | Methods of Decision Making and Problem Solving | 2 hours |
|---|---|---|

Elements of problem solving process - Problems versus systems - Structured, unstructured, and semi-structured problems - The systems approach and its relationship to the scientific approach.

| Module:3 | Decision Support Systems (DSS) | 5 hours |
|---|---|---|

Development of DSS - Relationship to data processing and database systems - DSS development and implementation - DSS features and capabilities - DSS in the information center.

| Module:4 | Expert Systems Overview | 5 hours |
|---|---|---|

Expert behaviour in decision-making situations - Knowledge capture - Expert systems development process - Build a minimal expert system - Apply and modify the system - Multiple levels of knowledge representation - Multiple levels of control and search procedures.

| Module:5 | Spreadsheet Facilities | 4 hours |
|---|---|---|

| | | |
|---|---|---|
| Modelling with a spread sheet - Hands-on use of a spreadsheet for business decision-making - Spreadsheet in the information center. | | |
| | | |
| **Module:6** | **Manipulation of Models as a decision making procedure** | **5 hours** |
| Effects of data manipulation to support decisions in pricing, production, cash flow, and new product evaluation models - Proficiency in utilizing expert system, spreadsheet, database, graphic and statistical software for "what if" analyses. | | |
| | | |
| **Module:7** | **Building Management Models** | **3 hours** |
| Picking a model type - Validation of models - Management models and expert systems in the information center. | | |
| | | |
| **Module:8** | **Contemporary issue** | **2 hours** |
| Lecture by Industry Experts | | |
| | | |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

- Bennett, John L. Building Decision Support Systems. Reading, MA: Addison Wesley, 1983.
- S. Christian Albright. VBA for Modelers: Developing Decision Support Systems with Microsoft Office Excel (5th Edition) Cengage Learning. 2016.

**Reference Books**

- Leigh, William E. & Michael E. Doherty. Decision Support and Expert Systems. Cincinnati: South Western Publishing, 1986.
- Sprague, Ralph H., Jr., & Hugh J. Watson, eds. Decision Support Systems. Englewood Cliffs, NJ: Prentice-Hall, 1986.
- Turban, Efraim. Decision Support and Expert System: Managerial Perspectives. New York: Macmillan, 1988.
- Young, Lawrence F. Decision Support and Idea Processing Systems, Dubuque, IA: Wm. C. Brown Publishers, 1989.

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 24-06-2020 | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 |

| Course code | Machine Learning for Data Science | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6005 | | 3 | 0 | 2 | 0 | 4 |
| Pre-requisite | MAT 5010- Foundations of Data Science | Syllabus version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
- Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- Distinguish overtraining and techniques to avoid it such as cross-validation.

**Expected Course Outcome:**

At the end of the course students will be able to:

- understand the most popular machine learning algorithms
- analyze and perform an evaluation of learning algorithms and model selection.
- compare the strengths and weaknesses of many popular machine learning approaches
- appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
- design and implement various machine learning algorithms in a range of real-world applications.

| Module:1 | Introduction to Machine Learning | 2 hours |
|---|---|---|

The origins of machine learning-How machines learn - Machine learning in practice-Exploring and understanding state-of-the-art methods.

| Module:2 | Classification | 6 hours |
|---|---|---|

Learning Associations-Classification-Regression- Decision Trees - Reinforcement Learning-Probably Approximately Correct Learning (PAC)- Noise-Learning -Multiple classes-Model Selection and Generalization- Support Vector Machines.

| Module:2 | Parametric Methods | 5 hours |
|---|---|---|

Introduction to Parametric methods-Maximum Likelihood Estimation: Bernoulli, binomial, Poisson distributions - Gaussian Density. Evaluating an Estimator: Bias and Variance-The Bayes Estimator-Parametric Classification.

| Module:3 | Nonparametric Methods | 8 hours |
|---|---|---|

Introduction-Nonparametric Density Estimation: Histogram Estimator-Kernel Estimator-K-Nearest Neighbour Estimator-Generalization to Multivariate Data-Nonparametric classification-Distance Based Classification-Outlier Detection.

| Module:4 | Multivariate Methods | 8 hours |
|---|---|---|

Multivariate Data-Parameter Estimation-Estimation of Missing Values- Expectation-Maximization algorithm -Multivariate Normal Distribution- Multivariate Classification-Tuning Complexity-Discrete Features.

| Module:5 | Dimensionality Reduction | 8 hours |
|---|---|---|

Introduction- Subset Selection-Principal Component Analysis, Feature Embedding-Factor Analysis-Singular Value Decomposition-Multidimensional Scaling- Canonical Correlation Analysis.

| Module:7 | Supervised Learning and Unsupervised Learning | 6 hours |
|---|---|---|

Linear Discrimination: Introduction- Generalizing the Linear Model-Geometry of the Linear Discriminant - Linear Discriminant Analysis- Pairwise Separation-Gradient Descent-Logistic

| | | | | |
|---|---|---|---|---|
| Discrimination. Clustering: Introduction, K-Means Clustering- Mixtures of Latent Variable Models- Spectral Clustering-Hierarchical Clustering-Clustering, Choosing the number of Clusters. | | | | |
| **Module:8** | **Contemporary issues** | | | **2 hours** |
| Lecture by Industry Experts | | | | |
| | **Total Lecture hours:** | | | **45 hours** |
| **Text Book(s)** | | | | |
| • E. Alpaydin, Introduction to Machine Learning, 3rd Edition, MIT Press, 2015.<br>• Pratap Dangeti, Statistics for Machine Learning, Packt Publishing, 2017. | | | | |
| **Reference Book(s)** | | | | |
| • C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2016<br>• K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012 | | | | |
| **Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT | | | | |
| **List of Challenging Experiments (Indicative)** | | | | |
| 1 | Exploring and Understanding data and formats | | | 5 hours |
| 2 | Classification techniques using Decision Trees | | | 5 hours |
| 3 | Support Vector Machines and Clustering Algorithms | | | 5 hours |
| 4 | Computation of missing values and multivariate classification | | | 5 hours |
| 5 | Dimensionality reduction: A factor analysis. | | | 5 hours |
| 6 | Discriminant analysis and Canonical Correlation analysis | | | 5 hours |
| | **Total Laboratory hours:** | | | **30 hours** |
| **Mode of evaluation:** Continuous Assessment and FAT. | | | | |
| **Recommended by Board of Studies** | 10.09.2019 | | | |
| **Approved by Academic Council** | No. 56 | Date | 24-09-2019 | |

| Course Code | Computational Statistics for Data Science | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6004 | | 0 | 0 | 4 | 0 | 2 |
| Pre-Requisite | MAT5013 - Statistical Inference | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Use of software packages for statistical theory towards computing environment.
- To enhance the theoretical concepts and its application in the real-time domain.

**Expected Course Outcomes:**

Students will be able to

- use software tools for projects in data management.
- apply technical skills in the statistical data analysis to transform a simple to multiple variables.
- understand the statistical decision-making theory and interpretation.
- analyze and solve real-time problems

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1 | Data Management – Handling Big data sets and variable selection | 6 hours |
| 2 | Descriptive statistics and their interpretation | 8 hours |
| 3 | Tabulation of Data and Cross Tabulation | 6 hours |
| 4 | Correlation analysis | 8 hours |
| 5 | Regression analysis | 8 hours |
| 6 | Testing of the hypothesis ( □, □, □ and $□^2$- tests) | 8 hours |
| 7 | Non-parametric tests | 8 hours |
| 8 | Design and analysis of experiments | 8 hours |
| | **Total Laboratory hours:** | **60 hours** |

**Text Book(s)**

- McCormick, Keith; Salcedo, Jesus, SPSS statistics for data analysis and visualization, Wiley, 2017.
- K. V. S. Sarma, Statistics Made Simple Do It Yourself, 2nd Ed, Prentice-Hall, 2010.

**Reference Book(s)**

- Murtaza Haider, Getting Started with Data Science: Making Sense of Data with Analytics, IBM Press, 2015.
- J.P. Verma, Data Analysis in Management with SPSS Software, Springer, 2013.

**Mode of Evaluation**: Continuous Assessment and FAT.

| | | | |
|---|---|---|---|
| **Recommended by Board of Studies** | 10.09.2019 | | |
| **Approved by Academic Council** | No. 56 | Date | 24-09-2019 |

| Course Code | Machine Learning for Data Science | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6005 | | 3 | 0 | 2 | 0 | 4 |
| Pre-Requisite | MAT5010 – Foundations of Data Science | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
- Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- Distinguish overtraining and techniques to avoid it such as cross-validation.

**Expected Course Outcome:**

At the end of the course students will be able to:

- understand the most popular machine learning algorithms
- analyze and perform an evaluation of learning algorithms and model selection.
- compare the strengths and weaknesses of many popular machine learning approaches
- appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
- design and implement various machine learning algorithms in a range of real-world applications.

| Module:1 | Introduction to Machine Learning | 2 hours |
|---|---|---|

The origins of machine learning-How machines learn - Machine learning in practice- Exploring and understanding state-of-the-art methods.

| Module:2 | Classification | 6 hours |
|---|---|---|

Learning Associations-Classification-Regression- Decision Trees - Reinforcement Learning-Probably Approximately Correct Learning (PAC)- Noise-Learning -Multiple classes-Model Selection and Generalization- Support Vector Machines.

| Module:3 | Parametric Methods | 5 hours |
|---|---|---|

Introduction to Parametric methods-Maximum Likelihood Estimation: Bernoulli, binomial, Poisson distributions - Gaussian Density. Evaluating an Estimator: Bias and Variance-The Bayes Estimator-Parametric Classification.

| Module:4 | Nonparametric Methods | 8 hours |
|---|---|---|

Introduction-Nonparametric Density Estimation: Histogram Estimator-Kernel Estimator-K-Nearest Neighbour Estimator-Generalization to Multivariate Data-Nonparametric classification-Distance Based Classification-Outlier Detection.

| Module:5 | Multivariate Methods | 8 hours |
|---|---|---|

Multivariate Data-Parameter Estimation-Estimation of Missing Values- Expectation-Maximization algorithm -Multivariate Normal Distribution- Multivariate Classification-Tuning Complexity-Discrete Features.

| Module:6 | Dimensionality Reduction | 8 hours |
|---|---|---|

Introduction- Subset Selection-Principal Component Analysis, Feature Embedding-Factor Analysis-Singular Value Decomposition-Multidimensional Scaling- Canonical Correlation Analysis.

| Module:7 | Supervised Learning and Unsupervised Learning | 6 hours |
|---|---|---|

Linear Discrimination: Introduction- Generalizing the Linear Model-Geometry of the Linear Discriminant- Linear Discriminant Analysis- Pairwise Separation-Gradient Descent-Logistic Discrimination. Clustering: Introduction, K-Means Clustering- Mixtures of Latent Variable Models-Spectral Clustering-Hierarchical Clustering-Clustering, Choosing the number of Clusters.

| | | |
|---|---|---|
| **Module:8** | **Contemporary issues** | **2 hours** |
| Lecture by Industry Experts | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

- E. Alpaydin, Introduction to Machine Learning, 3rd Edition, MIT Press, 2015.
- Pratap Dangeti, Statistics for Machine Learning, Packt Publishing, 2017.

**Reference Book(s)**

- C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2016
- K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

**Mode of Evaluation**: CAT, Quiz, Digital Assignment and FAT

**List of Challenging Experiments (Indicative)**

| | | |
|---|---|---|
| 1 | Exploring and Understanding data and formats | 2 hours |
| 2 | Classification techniques using Decision Trees | 4 hours |
| 3 | Support Vector Machines | 4 hours |
| 4 | Clustering Algorithms | 4 hours |
| 5 | Computation of missing values and multivariate classification | 4 hours |
| 6 | Dimensionality reduction: A factor analysis. | 4 hours |
| 7 | Discriminant analysis | 4 hours |
| 8 | Canonical Correlation analysis | 4 hours |
| | **Total Laboratory hours:** | **30 hours** |

**Mode of evaluation:** Continuous Assessment and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 10.09.2019 | | |
| Approved by Academic Council | No. 56 | Date | 24-09-2019 |

| Course Code | Deep Learning | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6007 | | 2 | 0 | 2 | 0 | 3 |
| Pre-Requisite | None | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To introduce the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long/short term memory cells and convolutional neural networks.
- To introduce complex learning models and deep learning models
- To explore various learning models using different software packages

**Expected Course Outcome:**

On completion of the course, students will be able to

- understand the fundamentals of deep learning and build deep learning models
- Apply the most appropriate deep learning method in any given situation.
- Develop neural network models in data-intensive real-time problems.
- Develop efficient generative models
- Learn and apply convolutional and recurrent neural network techniques.

| Module:1 | Introduction | 4 hours |
|---|---|---|

What is neural network, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Convergence theorem for Perceptron Learning Algorithm, Linear separability, feed-forward networks, input, hidden and output layers, organization and architecture of neural networks, linear and nonlinear networks

| Module:2 | Training algorithms for Feedforward networks | 5 hours |
|---|---|---|

Learning the weights, Cost functions, Back-propagation algorithms, gradient descent algorithm, unit saturation, heuristics to avoid local optima, accelerated algorithms, Multilayer Perceptron, Empirical Risk Minimization, regularization, autoencoders

| Module:3 | Deep Neural Networks | 4 hours |
|---|---|---|

Architectures, Properties of CNN representations: invertibility, stability, invariance, convolution, pooling of layers, CNN and Tensorflow, Difficulty of training deep neural networks, Greedy layer-wise training.

| Module:4 | Better Training of Neural Networks | 4 hours |
|---|---|---|

Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

| Module:5 | Recurrent neural networks | 4 hours |
|---|---|---|

LSTM, GRU, Encoder-decoder architectures, Auto-encoders (standard, de-noising, contractive, etc), Variational Autoencoders, kohonen SOM, **:** Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

| Module:6 | Deep Generative learning | 4 hours |
|---|---|---|

Dynamic memory models. Reinforcement learning, Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machine., deep belief networks, convolutional networks, LeNet, AlexNet

| Module:7 | Recent trends | 3 hours |
|---|---|---|

Variational Auto-encoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning

| | | | | |
|---|---|---|---|---|
| **Module:8** | **Contemporary issues** | | | **2 hours** |
| Lecture by Industry Experts | | | | |
| | **Total Lecture hours:** | | | **30 hours** |
| **Text Book(s)** | | | | |
| • | Bengio, Yoshua, Ian Goodfellow, Aaron Courville, Deep learning, MIT press, 2016. | | | |
| **Reference Book(s)** | | | | |
| • | Raúl Rojas, Neural Networks: A Systematic Introduction, 1996, 2nd edition<br>Bishop C., neural networks for pattern recognition, 2015, Oxford university press | | | |
| Mode of Evaluation: CAT / Digital Assignment / Quiz / FAT | | | | |
| **List of Challenging Experiments (Indicative)** | | | | |
| 1. | Setting up a neural network in memory | | | 6 hours |
| 2. | Backpropagation training experiment | | | 6 hours |
| 3. | Recurrent NN | | | 6 hours |
| 4. | Experiment: Object recognition | | | 6 hours |
| 5. | Experiment: Highway sign recognition | | | 6 hours |
| Total Laboratory Hours | | | | **30 hours** |
| **Mode of assessment:** Continuous assessment and FAT | | | | |
| Recommended by Board of Studies | 24.06.2020 | | | |
| Approved by Academic Council | No. 59 | Date | 24-09-2020 | |

| Course Code | Big Data Analytics and Visualization | L | T | P | J | C |
|---|---|---|---|---|---|---|
| MAT6015 | | 2 | 0 | 2 | 0 | 3 |
| Pre-Requisite | None | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

- To understand the functioning of industries and business strategies.
- To introduce the power of big data analytics and data visualisation techniques in contributing to business value creation.
- To solve a variety of complex data centred business problems using computer software tools.

**Expected Course Outcome:**

- Display conceptual understanding of big data analytics and visualization techniques.
- Demonstrate a systematic understanding of database management concepts and their connections with big data analytics.
- Develop a systematic understanding in order to build and apply skills in big data network analytics, text mining, and social media data mining.
- Demonstrate critical awareness of how managers and executives utilise big data analytics for business value creation by improving their operational, social, and financial performance and create opportunities for new business development.
- Critically evaluate and apply big data techniques using statistical software.

| Module:1 | Introduction to Big Data Analytics | 3 hours |
|---|---|---|

Big Data Overview - State of the Practice in Analytics - The Data Scientist - Big Data Analytics in Industry Verticals - Data Analytics Lifecycle.

| Module:2 | Advanced Analytics | 4 hours |
|---|---|---|

K-means clustering - Association rules- Linear Regression- Logistic Regression- Naïve Bayes Decision Trees- Time Series Analysis- Text Analysis.

| Module:3 | Big Data Analysis Models and Algorithms | 5 hours |
|---|---|---|

Analytics for Unstructured Data (Map Reduce and Hadoop)- The Hadoop Ecosystem- In-database Analytics – SQL Essentials- Advanced SQL and MADlib for in-database Analytics.

| Module:4 | Research Trends and Applications | 2 hours |
|---|---|---|

Operationalizing an Analytics Project -Creating the Final Deliverables- Data Visualization Techniques- Final Lab: Application of Data Analytics Lifecycle to a Big Data Analytics Challenge.

| Module:5 | Data Analytics Methods Using Statistical Packages | 4 hours |
|---|---|---|

Analyzing and Exploring the Data - Importing and Exporting of files – Recoding and Computing new variables – Visual Binning – Selection of cases – splitting and merging of files – multiple responses – Graphical plots : Box Plot, Scatter plot, Histogram, Bar and Pie charts - Fitting of Curves: Parabola, cubic and exponential – correlation and regression: simple, multiple – Rank correlation – Variable Selection in Multiple Regression - Residual Analysis: model adequacy, detection of outliers and influence observations.

| | | | |
|---|---|---|---|
| **Module:6** | | **6 hours** | |
| Testing of Hypotheses – two sample and paired samples t – test; F-test for two sample variances; Chi-square test for independence of attributes – One way and Two Way Analysis of Variance – Multiple Comparison tests : Tukey's test, Duncan's Multiple range test and Dunnett's test. Non-Parametric tests: One sample and Two sample Kolmogorov – Smirnov test, Kruskal – Wallis test, Friedman test, Median Test – One Way MANOVA – Hotelling's $T^2$ two sample test – Test for two Covariance matrices – One way Repeated Measures ANOVA. | | | |
| | | | |
| **Module:7** | **Factor Analysis** | **4 hours** | |
| Identification of Principle Component, Varimax rotation – Discriminant Analysis – Enter and Stepwise procedures, discriminant scores – Logistic regression – variable selection procedures (Backward and Forward with conditional and wald methods), Odds ratio, Classification matrix – $2^2$ , $2^3$ , $3^2$ and $3^3$ factorial designs – Split Plot designs. | | | |
| | | | |
| **Module:8** | **Contemporary issues** | **2 hours** | |
| Lecture by Industry Experts | | | |
| | | | |
| | **Total Lecture hours:** | **30 hours** | |
| **Text Book(s)** | | | |
| • Lemahieu, W., vanden Broucke, S., Baesens, B. (2018). Principles of Database Management: The Practical Guide to Storing, Managing and Analyzing Big and Small Data. Cambridge University Press.<br>• Sanders, R.N. (2014). Big Data Driven Supply Chain Management: A Framework for Implementing Analytics and Turning Information into Intelligence. Pearson FT Press. | | | |
| **Reference Books** | | | |
| • Luke, D.A. (2015). A User's Guide to Network Analysis in R. Springer.<br>• Kolaczyk, E.D., Csardi, G. (2014) Statistical Analysis of Network Data with R. Springer.<br>• Frank J. Ohlhorst (2013): Big data Analytics, Turning Big data into big money, John Wiley and Sons.<br>• Michael Minelli, Michele Chambers, Ambiga Dhiraj (2013): Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends . John Wiley and Sons.<br>• Arvind Sathi (2012): Big Data Analytics: Disruptive Technologies for Changing the Game., MC PressLLC. | | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar | | | |
| **List of Challenging Experiments (Indicative)** | | | |
| 1. | Import and Export of data files, Recoding into different variables, visual binning. Summary statistics using Descriptive option and Means option. | | 2 hours |
| 2. | Fitting of curves and Simple Correlation | | 3 hours |
| 3. | Multiple regression with variable selection | | 3 hours |
| 4. | Parametric and Non-parametric Tests | | 3 hours |

| | | |
|---|---|---|
| 5. | One Way ANOVA, Two Way ANOVA, One way MANOVA post hoc tests – Tukey, Bonferonni | 4 hours |
| 6. | Pictorial Representations of Multivariate data: 2D-bar, pie, histogram; 3D- pie, bar, histogram and bivariate Box plot, scatter matrix plot. | 3 hours |
| 7. | Logistic regression – odds ratio, Wald's statistic – Variable Selection | 3 hours |
| 8. | Discriminant Analysis – Stepwise Method – classification matrix and cross validation | 3 hours |
| 9. | Principal Component Analysis – Scree plot – eigen values – Interpretation and its uses – Factor analysis – Initial extraction of factors through Principal Components – varimax rotation - Assigning factor scores and its Applications | 3 hours |
| 10. | Concept of Change point analysis – ecp package for detecting single and multiple change points in univariate and multivariate data structures. | 3 hours |
| **Total Laboratory Hours** | | **30 hours** |
| **Mode of assessment:** Weekly Assessment / FAT | | |
| Recommended by Board of Studies | 24-06-2020 | |
| Approved by Academic Council | No. 59 | Date 24-09-2020 |