Based on Undergraduate Curriculum Framework 2022

UNIVERSITY OF DELHI

UNDERGRADUATE PROGRAMMES OF STUDY

STRUCTURE, COURSES & SYLLABI OF

SEMESTER IV

Of

B.Tech. Information Technology and Mathematical Innovations

Cluster Innovation Centre

COURSES OFFERED BY CLUSTER INNOVATION CENTRE (CIC)

Category I

[UG Programme for B.Tech. (Information Technology and Mathematical Innovations) in four years]

B.Tech. (Information Technology and Mathematical Innovations)

SEMESTER-V

B. Tech. (Information Technology and Mathematical Innovations), Semester-V

Paper No.	Interactive Learning Modules (Paper Title)	Credits			
		L	T	P	Total
V.1 DSC 13	Linear Programming and Game Theory	3	0	1	4
V.2 DSC 14	Data Communication and Networking	3	1	0	4
V.3 DSC 15	Software Engineering	3	0	1	4
V.4 GE 5*	V. 4.1 Consumer behaviour and Marketing Research	3	0	1	4
	V.4.2 Digital electronics and logic design – Innovation Lab	0	0	4	
	V.4.3 Genes to Genomes	2	0	2	
V.5 DSE 1**	V.5.1. Health Data Analysis	0	0	4	4
	V.5.2. Citizen Science, Urban Ecology and Wildlife Biology: Participation to Analysis				
	V.5.3. Finding solutions through Nanotechnology				
	V.5.4. Computing and mathematical inference to analyse the problems of social/industrial impact.				
	V.5.5. Game Development Using UNITY				
	V.5.6. Innovation Skills: Learning from Innovators				
	V.5.7. Social Engineering				
	V.5.8. 3D Printing using Blender				
	V.5.9. Applications of Data Science: A case study approach				
	V.5.10. IoT, Security and Machine Learning				
	V.5.11. Urban Computing				
V.6 IAPC	Academic Internship	0	0	2	2
Grand Total					**22**

***Any one GE option with opted by students from GE 5 papers**
****Any one DSE option will be opted by students from DSE 1 papers**

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship

DISCIPLINE SPECIFIC CORE COURSE – 13 (DSC-13)
V.1. Linear Programming and Game Theory

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Linear Programming and Game Theory, **DSC 13, V.1**	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

To provide an understanding of the optimization of linear models in the many areas. This course starts with the definition of LPP, underlying assumptions and modeling of problems. Illustration of graphical methods will help to conceive the idea behind the solution of LPP. This will also help the reader to visualize the overall concept though explained for only two decision variables. Once the concept becomes clear, the theoretical as well as logical approach of the most popularly used simplex method will be explained. Students will also learn how to use and analyze the results of TORA software, MS Excel and LP Assistant for LPP.

Learning outcomes

After completing this course, student should be able to

- Formulate linear programming models for given real situations
- Learn simplex method and its computational efficiency
- Formulate dual problems and understand economical interpretation of primal dual relationship
- Analyze post optimality and its economical interpretation
- Solve Transportation problems and assignment problems
- Learn some basic concepts of game theory
- Learn linear programming solution of games with mixed strategies

Syllabus

Unit I: Formulation of Linear Programming Models - Theory of simplex method - optimality and unboundedness - the simplex algorithm - simplex method in tableau format - Computational efficiency of the technique **(10 hours)**

Unit II: Introduction to artificial variables – two-phase method, Big-M method and their comparison - Formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual **(10 Hours)**

Unit III: Introduction to Post optimality analysis - Dual Simplex Method and its application - Formulation of the Transportation problem - Algorithm for solving transportation problem - Northwest - corner method, least cost method and Vogel approximation method for determining the starting basic solution **(10 hours)**

Unit IV: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem - Formulation of two person zero sum games - Solving two person zero sum games - Games with mixed strategies - Graphical solution procedure -Linear programming solution of games **(15 hours)**

Practicals - **(30 Hours)**

Program with Solver and its application to simple models

- Formulation of the model in Solver
- Solution of LPP with Solver
- Sensitivity analysis with Solver
- Solution of Transportation and Assignment problem with Solver
- Innovation Project

Essential/recommended readings

1. Linear Programming and Network Flows, Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, (2nd edition), John Wiley and Sons, India, 2004.
2. Introduction to Operations Research, F. S. Hillier and G. J. Lieberman, (9th Edition), Tata McGrawHill, Singapore, 2009.
3. Operations Research, An Introduction, Hamdy A. Taha, (8th edition), Prentice-Hall India, 2006.

DISCIPLINE SPECIFIC CORE COURSE – 14 (DSC-14)
V.2. Data Communication and Netwroking

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Data Communication and Networking DSC 14, V.2	**4**	**3**	**1**	**0**	**12th Pass**	**NIL**

Learning Objectives

This course introduces to the students, fundamentals of data communication and computer networks, organization of network architecture, its components and functions. The course gives them a practical understanding of client-server programming and also introduces the basics of network security.

Learning outcomes

Following are the Learning Outcomes of the course:

- Will understand Data communication, Communication Channels, Topologies and Networking Applications.
- Will have knowledge of Layered Architecture & Models, Network Devices, Error Management, Network Protocols and Network Security.
- Will have exposure to Network Architectures of Enterprise Applications and Hands-on experience with Network Topologies on LAN/WAN – Wired & Wireless
- Will be able to understand the Routing Mechanism in Internet and Intranet, Setting up TCP/UDP applications on Network Devices, Socket Programming, Web/Server Based Applications.

Syllabus

Unit I: Introduction to Data Communication; Components and Basics-Communication Channels – Topologies **(15 Hours)**

Unit II: Networking Applications - Layered Architecture & Models – Network Devices **(15 Hours)**

Unit III: Introduction to Data Link - Error Management **(15 Hours)**

Unit IV: Network Protocols – Network Security – Network Architectures of Enterprise Applications **(15 Hours)**

Essential/recommended readings

1. Data Communication and Networking, Forouzan, B.A., Tata McGraw-Hill. 2013
2. Computer Networking: A Top-Down Approach Featuring the Internet, Kurose, .F. *a*nd Ross, K.W., 3rd Ed., Addison Wesley, 2004
3. Computer Networks, A S Tanenbaum, PHI, IV Ed, 2003
4. Computer Communication Networks, W. Stallings, PHI, 1999

DISCIPLINE SPECIFIC CORE COURSE – 15 (DSC-15)
V.3. Software Engineering

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Software Engineering, DSC-15, V.3	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

This course objective is to train students in developing software and large scale software products in a systematic manner through requirement analysis, design principles, quality assurance, software process models, and estimation of schedules, productivity and cost.

Learning outcomes

After completing this course, student should be able to:

- Will understand Software Engineering basics, Software Process Models, Software Requirement Process.
- Will understand System Design and Testing Approaches.
- Will understand Scheduling, Productivity and Cost Estimation.
- Will understand Risk Management.

Syllabus

Unit I: Introduction to software Engineering – Software Engineering Principles – Software metrics – Software development life-cycle. **(10 Hours)**

Unit II: Software Process Models – Software Requirement Process -– System Design – Testing. **(10 Hours)**

Unit III: Scheduling Estimation Models. **(10 Hours)**

Unit IV: Productivity Estimation – Cost Estimation – Schedule Estimation – Risk Management – Case Study **(15 Hours)**

Practicals - **(30 Hours)**

- Analysis of a desktop/enterprise Software Applications under lens of software design fundamentals
- Requirement gathering, verification and specification of a new Software Project
- Creating Prototypes and outlines of problems in the frame of Software engineering aligned with design methodologies
- Reverse engineering management aspects any Open Source Software Project and identify Software
- Software Projects sign off with Project Charter and management of project plans
- Hands on Experiment on Requirement Management, Deliverable attributes of Software projects
- Design a Software Application, Product, and Service and integrate with existing system
- Estimation of Costing of Software, Time sheet management in estimation of Effort, Resource Management
- Design of User Guides, Software Manuals, Update Documentation, Release Guides, Deployment Guides, FAQs
- Basic Understanding on use of Agile & Scrum
- Innovation Project

Essential/recommended readings

1. Requirements Risks Can Drown Software Projects, Leishman and Cook, Computer (November 2001).
2. Software Engineering: A Look Back and A Path to the Future. Leveson, Nancy, December 14, 1996.
3. Applied Software Project Management, Andrew Stallman & Jennifer Greene, O`Reilly, 2005.
4. R . S. Pressman, "Software Engineering – A practitioner's approach", 5th Ed., McGraw Hill Int. Ed., 2001.
5. K. K. Aggarwal &Yogesh Singh, "Software Engineering", 2nd Ed., New Age International, 2005.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES (GE-5)
V. 4.1. Consumer Behaviour and Marketing Research

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Consumer Behavior and Marketing Research, GE-5, V.4.1	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**	**Management Faculty of CIC**

Learning Objectives:

The success of business depends on a thorough understanding of how consumers behave and why they behave in a way they do to any business actions such as change in any of the 4 P's of marketing. This course provides the useful insights into consumer psychology with special focus on how consumers think, feel and react to marketing stimuli. Effective marketing research reduces the percentage of product or service failures. It is important for the participants to know the fundamental concepts in the field of marketing research.

Learning Outcomes

After completing the course, student should be able to:

- Factors important for consumer buying behaviour
- Various consumer behaviour models
- Basis of marketing decisions on consumer insights
- Understanding nature and scope of marketing research

- Fundamentals of MR
- Different methods of data collection, sampling techniques
- Learning various univariate and multivariate data analysis techniques
- Ethical issues in MR

SYLLABUS:

UNIT I: Consumer mind mapping and Consumer behaviour models (10 Hours)

Manager and Consumer perspectives, Mapping consumer mind, Deterministic and probabilistic approaches, Howard and Sheth model, Nicosia and Engle and Blackwell model.

Unit II: Consumer knowledge and perception (10 Hours)

Types of thresholds, consumer memory networks, Consumer engagement, Perceived risk, antecedents and consequences of consumer decision making, Learning and motivation theories

Unit III: Marketing Research & Types of Research Design (10 Hours)

Nature and Scope of Marketing Research, Marketing Research process, Exploratory, Descriptive and Conclusive Research

Unit IV: Data collection & Ethical Research (15 Hours)

Sample design and field work, Data coding, Data analysis, Use of statistical software for hypotheses testing, Ethical considerations.

Practicals - (30 Hours)

- Data collection and Coding
- Marketing Research Case studies

References

- Assael, H. (2009). *Consumer behaviour and marketing action*. New Delhi: Cengage Learning.
- Blackwell, R. D., Miniard, P. D., & Engle, J. F. (2009). *Consumer behaviour*. USA: Thomson-South Western.
- Evans, M., Jamal, A., &Foxall, G. (2009). *Consumer behaviour* (2nd ed.). New Jersey: John Wiley & Sons.
- Malhotra, N.,& Dash, S. (2015*). Marketing Research: An Applied Orientation* (6th ed.). New Delhi: Pearson.
- Burns, A. C., Veeck, A.F. &Bush, R. F. (2017). *Marketing Research* (8thed.). New Delhi: Pearson.
- Churchill, G., Iacobucci, D., & Israel, D. (2010). *Marketing Research: A South Asian Perspective*. Delhi: Cengage.

GENERIC ELECTIVES (GE-5)
V. 4.2. Digital Electronics and logic design – Innovation Lab

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Digital electronics and logic design – Innovation Lab, GE 5, V.4.2	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**	**Physics/ Electronics Faculty of CIC**

Learning Objectives

This is a hands-on learning practice-based module to design electronic circuits based on commonly used logic gates and flip-flops. This module will enable the students with simulation software and electronic design automation (EDA) skill for soft designing of circuits.

Learning Outcomes

• Providing students hands on experience of circuit designing through activities in Engineering Kitchen Laboratory
• Actual designing of following electronic circuits: Realization of logic gates through diodes and resistors, Design of half/full adder and sub tractor circuits, Design of shift registers using flipflops
• To learn process of verification of Boolean algebraic functions through digital IC gates
• To learn circuit design and simulation software and EDA
• Implementing students own ideas on circuit designing under guidance of mentor through Innovation Projects

Syllabus

Practicals – **(120 Hours)**

• Realization of logic gates through diodes and resistors
• Verification of Boolean algebraic functions through digital IC gates

• Design of half/full adder and sub tractor circuits
• Design of shift registers using flip-flops
• Circuit design and simulation software and EDA
• Innovation Project

GENERIC ELECTIVES (GE-5)
V. 4.3. Genes to Genomes

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Genes to Genomes, GE-5, V.4.3.	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**	**Chemistry/ Biology Faculty of CIC**

Learning Objectives

This module is designed to:

- Introduce students to the basics of genetics and genome biology
- Introduce students to genome sequencing analysis.
- Introduce students to population genetics.

Learning outcomes

After studying this course, the students will be able to:

- Comprehend the basis of the inheritance of characters from simple to complex
- Understand and analyze population-based inheritance patterns
- Generate and analyze Pedigree charts and family trees for inherited diseases

Syllabus

Unit I: Discovery of the gene concept and beyond **(10 Hours)**

Mendelian and non-Mendelian inheritance, Gene interaction, Epistasis, Linkage and recombination

Unit II: Population genetics **(8 Hours)**

Hardy Weinberg Principle and equilibrium, deviations and role of evolution in the equilibrium, metabolic and other diseases

Unit III: Eukaryotic genome complexity **(7 Hours)**

Junk DNA, Characteristics, Genome mapping techniques, Genome evolution, Transposable elements, Coding and noncoding RNA,

(10 Hours)

Practicals - **(60 Hours)**

- Punnett square, T-test
- Analysis of gene mapping
- Pedigree analysis
- Calculations to understand genome evolution
- Mathematical equations and models for prediction of inheritance

Essential/recommended readings

1. *Biology*, Raven et al., Tata McGraw-Hill, 2013.
2. *Biology: Global Approach*. Reece et al., Pearson Educations, Global edition, 2014.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V.5.1 Health Data Analysis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Health Data Analysis DSE-1, V.5.1	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This is a practical based module designed to:

- Introduce students to the complexity of data related to health and diseases.
- Introduce to the students the method of collection of data, their visualization and analysis

Learning outcomes

After studying this course, the students will be able to:

- Comprehend and handle complex data related to health and diseases, which are usually large.

- Do survey-based research for data collection, their visualization by different methods and their analysis including the statistical analysis

Syllabus

Practicals - **(120 Hours)**

- Art and Science of preparation of questionnaire for collection of health data: types and ethical consideration
- Types of data: Likert scale data and quantitative data related to health and diseases their collection methods
- Understanding how data is organized to facilitate analysis in the healthcare setting.
- Data visualization through histograms and tables
- Data visualization through heat maps

- Integration, understanding and selection of appropriate data visualization techniques to effectively communicate results
- Identifying ways in which data quality can be compromised and applying remedies
- Evaluation of data from varying sources to create meaningful presentations.
- A survey-based research on epidemiology and public health by collecting real data from the field area. It will include study designing, data collection, visualization and analyses of the data
- The results will be used for the preparation of a project report/manuscript.

Essential/recommended readings

1.Introduction to Data Science in Healthcare Reading:
https://www.r2library.com/Resource/detail/1584265329/ch0007s0170
2. Analytics and (Precision Medicine) Decision Support Reading:
https://www.r2library.com/Resource/detail/0128006811/ch0014s0163
3.Hype Cycle for Healthcare Providers, 2019 (Gartner) Reading: Pages 3-7
https://www.r2library.com/Resource/detail/0340950056/ch0004s0092
4. Principal components analysis
https://www.r2library.com/resource/detail/0803625642/ch0006s0141
ANOVAhttps://www.r2library.com/Resource/detail/0781781531/ch0015s0490Descriptive statistics.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.2. Citizen Science, Urban Ecology and Wildlife Biology: Participation to Analysis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Citizen Science, Urban Ecology and Wildlife Biology: Participation to Analysis, DSE-1, V.5.2	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This is a project based course through which students will understand the new area of Citizen Science. During the course students will participate in as well as create new Citizen Science projects on various

topics such as Urban Ecology, Wildlife Biology, Art and Historicity, Regional Problems to name a few. This course will develop a skill set of collecting and analysing data, creation of surveys, analysis of research results and collaboration with people from different fields of research.

Learning outcomes

After completing this course, student should be able to;

1. Contribute to a Citizen Science project, anywhere in the world
2. Create Survey, Develop new projects in collaboration with citizens across the spectrum.
3. Identify regional or local problems that need proper information and data analysis.
4. Understand the field of Urban Ecology, Sustainable Development and Wildlife Studies.

Syllabus

Practicals –

- What is Citizen Science and how CS projects are performed? Understanding different form of Citizen Science e.g. Crowd-Sourcing, Participatory Monitoring.
- Participate in any ongoing Citizen Science Project in the country or across the world.
- Identification of a regional or local issue related to Urban Ecology, Wildlife Biology or any Socially relevant issue and create a Citizen Science project based on that.
- Creating Survey Questionnaires, Visit to areas of interest for the study, developing collaboration with experts from the field.
- Learning Data Analysis tools and Visualization software.
- Learning problems in Urban Ecology and Wildlife Studies across India.
- Working on a long term basis on the developed CS project and building up on the local project to a bigger initiative across the regional or Country specific zone.

Essential/recommended readings/Websites

1. Citizen Science portals: https://scistarter.org/, https://www.zooniverse.org/, https://www.seasonwatch.in/, https://eu-citizen.science/
2. Bonney, Rick et al. (2009). Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. BioScience. 59. 977-984. 10.1525/bio.2009.59.11.9.
3. Lewenstein, B. V. (2016). 'Can we understand citizen science?'. JCOM 15 (01)
4. Guerrini et al. (2018) Citizen science, public policy, Science 361 (6398), 134-136.
5. Golumbic, Y.N. et al (2017) Between Vision and Reality: A Study of Scientists' Views on Citizen Science. Citizen Science: Theory and Practice, 2(1): 6, pp. 1–13, DOI: https://doi.org/10.5334/cstp.53
6. Guide To Citizen Science - UK Environmental Observation Framework (https://www.ceh.ac.uk/sites/default/files/citizenscienceguide.pdf)

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V.5.3. Finding Solutions through Nanotechnology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Finding Solutions through Nanotechnology, DSE-1, V.5.3.	**4**	**0**	**0**	**4**	**Class XII pass**	**NIL**

Learning Objectives

This course is designed to expose students regarding synthesis, characterization and applications of various types of nanomaterials. Students will be performing hands-on experiments in the laboratory and will get themselves acquainted with the fascinating world of nanotechnology. Students will be learning about various physicochemical techniques, their instrumentation, principles and procedures.

Learning outcomes

As this paper will be having all hands-on experiments, students will be learning:

- To synthesize nanomaterials using chemical or green synthesis
- To characterize nanomaterials using various physicochemical techniques
- To explore the interdisciplinary applications of nanotechnology related to a lot of different fields
- like health science, engineering, energy, environment etc.

Syllabus

Practicals - **(120 Hours)**

- Understanding and identifying a research problem based on nanotechnology
- Identifying the requirement of type of nanomaterials (nanoparticles, quantum dots, nanostructures etc.) depending upon their physical and chemical properties as per the identified research problem
- Chemical or green synthesis of nanomaterials based on the selective, identified protocols, which may later be modified for the novel method of synthesis
- Characterization of nanomaterials using various physicochemical techniques like UV-absorption spectroscopy, FT-IT spectroscopy, X-ray diffraction, Zetasizer, Dynamic

light scattering, Scanning electron microscope (SEM), HR-TEM, FESEM etc. for understanding their size, shape, charge, morphology etc.

- Exploring the role of nanomaterials synthesized and characterized for various applications like gene delivery, drug delivery, environmental remediation and energy etc.

Essential/recommended readings

- *Nanotechnology For Dummies; By Richard D. Brooker, Earl Boysen (2011), Wiley Publisher*
- *Nanotechnology: An Introduction; By Jeremy Ramsden (2011), Elsevier Science Publisher*
- *Research papers and reviews from journals of international repute like Nanotechnology Reviews (NTREV)* journal, NANO Reviews, Nature Nanotechnology

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V.5.4. Computing and mathematical inference to analyze the problems of social/industrial impact.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Computing and mathematical inference to analyze the problems of social/industrial impact, DSE 1, V. 5.4.	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objective

This a practical paper which aims to enable the students to utilize their mathematical skills learned in previous semesters to solve/analyze the problems of social/industrial impact. In this paper, the students will learn to utilize mathematical modelling with ordinary/partial differential equations in combination of probabilistic models & numerical techniques for the real world problems to give them an exposure of practical implications of mathematics.

Learning Outcome:

This paper will equip the students with hand on learning methods of solving & analyzing real social/industrial problems using mathematical tools.

Syllabus

Practical -

- Introduction & implementation of advanced numerical simulation techniques for solution of large-scale problems using MATLAB
- Implementation of Multivariate regression models with mathematical softwares.
- Simulation of non-linear ODE models of practical utility with validation from real data
- Simulation and analysis of inverse problems using integral transform such as wavelet transform, ridgelet transform, etc.
- Simulation of PDE models to solve many social and industrial problems

Essential Readings:

1.Mathematical Modelling, A case studies approach (2011) by Reinhard Illner, C Sean Bohun, Samantha McCollum, Thea van Roode, Orient Blackswan Private Limited - New Delhi.

2. Industrial Mathematics: A course in solving real world problems (1987) by Avner Friedman, Walter Littman, Society for Industrial and Applied Mathematics.

3.Mathematical Tools for Real-World Applications: A Gentle Introduction for Students and Practitioners (2022) by Alexandr Draganov, The MIT press.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.5. Game Development using UNITY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Game Development using UNITY, DSE 1, V. 5.5.	**4**	**0**	**0**	**4**	**Class XII pass with Mathematics**	**C^{++}**

Learning Objectives

The Learning Objectives of this course are

- to introduce the students to the game engine platform UNITY
- to give a basic on how to develop a game using this game engine.
- to design, develop and finalize a game on either an Android or an IOS platform

Learning outcomes

This course gives students an insight into developing a game either on a mobile or a desktop platform. Upon completion of the course the students would be able to-

- Possess basic ability to convert game idea into a working prototype
- Learn basic techniques for animation and simulation
- Extend the concept of game development on Web, console or VR platforms
- Develop a creative and aesthetic mindset by creating a good looking functional UI for the developed game

Practicals - **(120 Hours)**

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on UNITY before designing and developing a game. The following tasks will be performed in lab:

- Introduction to Unity's Interface and Unity's Basics
- Rigid Bodies And Colliders
- Audio Source And UI Elements
- Moving Character With Code
- Introduction To Variables; Operations With Variables; Functions; Conditional Statements; Loops; Coroutines; Classes
- Creating animations, simulations and background
- Designing, developing and finalizing a game

Essential/recommended readings

1. *Learning C# by Developing Games with Unity 5.x*, G. Lukosek, Packt publishing Ltd, 2016
2. *Developing 2D Games with Unity: Independent Game Programming with C#*, Jared Halpern, Apress, 1st Edition, 2018
3. *Unity in Action: Multiplatform Game Development in C# with Unity 5*, Joe Hocking, Manning publications, 3rd Edition, 2022
4. *Unity From Zero to Proficiency (Foundations)*, Patrick Felicia, LPF publishing, 4th Edition, 2015

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.6. Innovation Skills: Learning from Innovators

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Innovation Skills: Learning from Innovators, DSE 1, V.5.6	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives:

Innovation is an essential skill to convert ideas into action. This course aims to develop an insight and hands on learning experience into the process of innovation; inculcate among learners ways of using knowledge, experience, creativity and out of box ideas to transform existing products, processes and applications; and how to target realistic problems both at the local and global levels. One must understand that the role of technological advances and learning from innovators' experiences is essential for growth and development.

Course Learning Outcomes:

- Understanding the concept of innovation
- Identifying various types of innovations
- Use of innovative practices
- Impact of innovation on society
- Problem-solving through innovations

Practical - **(120 Hours)**

Activities based on concept of Innovation, its aspects and problem solving

- Understanding the term “Innovation” and four types of Innovations: Product, Process, Marketing and Organizational innovations: Examples from real world
- Essentials of innovation; “4Cs” of Innovation skills: Examples from real world
- Distinction between the terms: Innovation, Invention, Reforms and Changes: Examples from real world

- Innovation and its linkage to entrepreneurship: Examples from real world
- Use of Innovative Practices to enhance learning: Examples from real world
- Creating an environment for innovation. Factors responsible for Innovation. Fostering a culture of innovation in institutions: Examples from real world
- Role of innovation in our society and its outcomes: Examples from real world
- Innovation and Industry linkage and its positive impacts: Examples from real world
- Role of technology in Innovation: Examples from real world
- Implementing changes for promoting innovation and targeting realistic problems both at the local and global levels: Examples from real world
- Innovators as Role Models and Mentors: Examples from real world

Essential/recommended readings

1. Mark Dodgson & David Gann (2018). Innovation: A very short introduction. Oxford University Press, India. (ISBN: 9780192558619)
2. N. Radjou, J. Prabhu & S Ahuja (2012). Juggad Innovation - A frugal and flexible approach to innovation for the 21st century. Random House Publishers India Pvt. Limited. (ISBN: 9788184002058)
3. Tom Kelley and Jonathan Littman (2005). The ten faces of innovation. Doubleday, Random House Inc. (ISBN: 0385512074)
4. Sanjiv Narang (2016). Innovation: Why What and How. Vitasta Publishing (ISBN: 9789382711322)

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.7. Social Engineering

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the Course			Eligibility Criteria	Pre-requisite of the Course if any
		Lecture	Tutorial	Practical		
Social Engineering, DSE 1, V.5.7	**4**	**0**	**0**	**4**	**Class XII**	**NIL**

Learning objectives:

This practical based course helps students in providing knowledge, skills and aptitude to grow in social ventures that have a positive impact on society.

Learning outcomes:

- Origins, principles and practices of social entrepreneurship
- Identifying social issues
- Developing improved solutions to society
- Building social ventures
- Collaborating with stakeholders like government agencies and society at large
- Developing leadership skills

Practicals - **(120 Hours)**

Activities based on concept of Innovation, its impact on key stakeholders such as society.

- In depth understanding of what social innovation and social entrepreneurship is?
- Identifying the gaps between what is projected with what is actually achieved with social innovation.
- Impact assessment- Understanding the role of social enterprises,
- Identifying what new practices social entrepreneurs are adopting to improve their institution, city, state, country and world over.
- How social entrepreneurship is treated as a path to sustainable development
- Understanding, identifying and characterizing the social challenges
  Community driven research
  Social Innovation and design thinking
  Incremental and disruptive innovations in social context and real-life examples
  Regional comparisons of social innovations
- Building strategies for scaling and growth of social enterprises.
- Exploring the facilitators and impediments of collaborations of government, NGO's and other organisations for bringing innovation
- Understanding the impact of social innovation on building brand image
- Exploring the areas where policy and regulations are important, knowing impact of regulations on social enterprises.
- Increasing financial inclusion

Essential/recommended readings

1. Social entrepreneurship, Teresa Chahine, 2nd Edition, Routledge, 2022.
2. The social entrepreneur playbook: Pressure test, plan, launch and scale your social enterprise, Ian C Macmilan and James D Thompson, Wharton School Press, 2013.
3. Discoveringsocialentrepneurship
   https://www.youtube.com/watch?v=03XO0eHNpfk&list=PLyj-hvxCJtor5Z9AsRcZdhRtiw8kB55ZQ&index=2

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.8. 3D printing using Blender

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
3D printing using Blender, DSE 1, V. 5.8	**4**	**0**	**0**	**4**	**Class XII pass with Mathematics**	**NIL**

Learning Objectives

The Learning Objectives of this course are

- to introduce the students to Blender
- to understand the basic concepts of 3D modelling and printing using Blender
- to identify the pitfalls in 3D printing
- to apply the slicing techniques and generate G code

Learning outcomes

This course gives students an insight into using the free and open source ware Blender for 3D printing. Upon the successful completion of the course the students are expected to generate 3D models of some simple objects like flower vase, geometrical figures, tessellation tiles, bottle lids, etc.

Practicals - **(120 Hours)**

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small tasks initially on Blender before moving on to 3D printing. The following tasks will be performed in lab:

- Introduction to the User Interface and navigation in blender
- Creating simple geometrical objects like planes, cube, cylinder, cone, spheres, spirals, etc. on blender
- Movement, scaling and rotation transformations
- Simulation, animation and rendering
- Polygonal modelling for 3D printing
- 3D printing of simple geometrical objects
- Moving on to more complex 3D printing

Essential/recommended/ suggested readings

1. *Blender 3D printing tutorials for beginners,* https://all3dp.com/2/blender-3d-printing-tutorial/
2. *Blender for 3D printing design*

https://www.youtube.com/watch?v=5CyaeBBQIkc&list=PLvCZK2JKGQlNt8uEM5_J12Qj7eO5MqV03

3. *3D printing from zero to hero in Blender*
   https://www.udemy.com/course/learn-3d-printing/

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.9. Applications of Data Science: A Case Study Approach

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Application of Data Science: A Case Study Approach, DSE 1, V. 5.9.	**4**	**0**	**0**	**4**	**Class XII pass with Mathematics**	**Linear Algebra; Probability and Statistics; Basic programming**

Learning Objectives

- Introduce the students to Python based toolkits
- Understand the application of mathematics concepts to data science
- Formulate hypothesis for the case study under consideration
- Inculcate problem solving mind-set among students

Learning outcomes

The students will be enabled to identify a case study (for e.g. weather forecasting, stock market prediction, sentimental analysis, crime prediction, etc) and apply the fundamentals of mathematics and programming languages. The students will also understand the use of various Python tools such as NumPy, Matplotlib, etc.

Practicals - **(120 Hours)**

The course will be conducted completely on a hands- on mode. The basic concepts will be explained and each concept will be augmented by small exercises on lab either using Python/ MATLAB or R. A case study would be identified to implement all the concepts. Following tasks will be done in the computer lab

- Introduction to programming tools (Python/ MATLAB/ R)
- Visualising Data through Bar Charts, Line Charts, Box Plots, Histogram
- Scrapping web for data (Eg, Various social media sites)
- Cleaning the data
- Using models like K nearest neighbours; Naïve Bayes, Linear and Logistic Regression, Decision Trees, Neural Network, Clustering., Random forest to analyse the data
- Identifying a case study (for e.g. weather forecasting, stock market prediction, sentimental analysis, crime prediction, health data analytics etc) for a mini project

Essential/recommended/ suggested readings

1. *Data Science from Scratch: First principles with Python*, Joel Grus, 2nd Edition, O'Rielly Media Inc, 2019.
   https://all3dp.com/2/blender-3d-printing-tutorial/
2. *Python Data Science Handbook: Essential Tools for working with Data,* 2nd Edition, O'Rielly Media Inc, 2022
3. *Practical Statistics for Data Scientist,* Peter Bruce, Andrew Bruce and Peter Gedeck, 2nd Edition, O'Rielly Media Inc, 2020
4. *Python for Data Science,* L.M. John Paul Mueller, Wiley, 2019.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.10. IoT, Security and Machine Learning

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
IoT, Security and Machine Learning DSE 1, V.5.10	**4**	**0**	**0**	**4**	**12th pass**	**NIL**

Learning Objective:

This course introduces students to the field of machine learning, deep learning, security with python and its interaction with the Internet of Things (IoT) devices/ sensors. The course will cover topics such as security models, attacks, concept of privacy preservation, threats to machine learning models, and IoT devices. Students will be implementing various privacy preserving machine learning techniques with Python/ C or in Matlab. The students will also learn to use various IoT devices in real applications.

Learning Outcomes:

- Understand the fundamental concepts of machine learning, security and IoT.
- Identify deep learning and privacy preserving machine learning models, IoT platforms
- Implement various security techniques for IoT and machine learning applications
- Understand current research trends and developments in the field of machine learning, security and IoT
- Explore on Interacting with digital outputs with C/ Python.

Practicals -

- Implementing basic deep learning models
- Implementing Privacy Preserving Machine Learning (PPML) models on available data
- Implementing IoT devices for various sensing applications
- Training deep learning models on sensed data
- Using Python based application for IoT device control.

Essential/recommended/ suggested readings

1. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete
2. "Building IoT Projects with Raspberry Pi and Python" by Matthew Poole
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
4. "Machine Learning Yearning" by Andrew Ng
5. "Privacy in Context: Technology, Policy, and the Integrity of Social Life" by Helen Nissenbaum
6. Adrian McEwen, Hakim Cassimally, ―Designing the Internet of Things‖, John Wiley and Sons, 1st Edition, 2014
7. Matt Richardson, Shawn Wallace, ―Getting Started with Raspberry Pi‖, O'Reilly (SPD), 3rd Edition, 2014.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-1)
V. 5.11. Urban Computing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit-distribution of the course			Eligibility criteria	Prerequisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Urban Computing **DSE 4, V.5.11**	4	0	0	4	12th Pass	NIL

Learning Objectives:

This course introduces an interdisciplinary filed, is the science of using computing technology in solving urban challenges such as crowds, traffic, and pollution, governance issues etc. Urban computing research also focuses on acquiring an understanding of the nature of urban phenomena, predict the future of cities, and plan their development.

Learning Outcomes:

- Learn to formulate challenges urban problems.
- Ways of data acquisitions, integration, and modeling skills necessary for urban computing research.
- Learn to model cities, develop large-scale statistical models, and use visualization technologies to pose and answer questions.
- Solves issues related to public health, sustainable use of limited energy resources, emergency preparedness, and societal stability etc
- Work in blended project teams with people from a variety of disciplines.
- Ways to solve practical hands-on problems faced by urban spaces/cities. activities.

Practicals - **(120 Hours)**

The course will be conducted completely on a hands- on mode and project based learning. The basic concepts of Urban Computing will be explained and associated real world challenging problems will be identified.

- Problem solving on Urban context text analytics including Smart mobility and smart environments.
- Acquisition and processing of high resolution remotely sensed data for urban applications;
- Practical work on Location-based service in smart cities

- Experiments on Data acquisition, storage, management, analysis, sharing
- Agent-based simulation for urban dynamics
- Hands on working on Urban sensor network data and applications.
- Students will be exposed to the practical application of Urban Computing concepts and learn how to solve real world urban problems.

References:

- Zheng, Y. (2019). *Urban computing*. MIT Press.
- Yin, H. (2023). An overview of urban data variety and respective value to urban computing. *Handbook of Mobility Data Mining*, 1-13.
- Haldorai, A., Ramu, A., & Murugan, S. (2019). *Computing and Communication Systems in Urban Development: A Detailed Perspective*. Springer Nature.
- Zheng, Y., Capra, L., Wolfson, O., & Yang, H. (2014). Urban computing: concepts, methodologies, and applications. *ACM Transactions on Intelligent Systems and Technology (TIST)*, *5*(3), 1-55.