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-VI

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

Paper No.	Interactive Learning Modules (Paper Title)	Credits			
		L	T	P	Total
VI.1 DSC 16	Numerical Methods for Computational Mathematics	2	0	2	4
VI.2 DSC 17	Information Security	3	1	0	4
VI.3 DSC 18	Artificial Intelligence	3	1	0	4
VI.4 GE 6*	VI.4.1 e-Business: Organisation and Strategy	3	1	0	4
	VI.4.2. Genomics and Proteomics	2	0	2	
	VI.4.3 Control Systems	2	0	2	
	VI.4.4 Circuit Analysis and Synthesis	2	0	2	
VI.5 DSE 2**	VI.5.1. Computational analysis and visualization of Epigenetic Data	0	0	4	4
	VI. 5.2. Analysis and visualization of high throughput data of Genomics and Proteomics				
	VI.5.3. Technology based solutions of societal issues: An interdisciplinary approach				
	VI.5.4. Design & Analysis of CFD based modules to simulate flow/heat transfer problems with ANSYS/COMSOL				
	VI.5.5. Develop and Simulate Data Driven Approaches for Medical Imaging				
	VI.5.6. Mathematical modelling & simulation of dynamical systems				
	VI.5.7. Alternate Energy studies: Analysis, modeling and simulations of the systems				
	VI. 5.8. Social Media				
	VI.5.9 Virtual Reality				
	VI.5.10 Complex Systems				
	VI. 5.11 Research and Methodology				
VI.6 IAPC 4	VI.6.1. Simulation of real-world problems	0	0	2	2
Grand Total					22

***Any one GE option with opted by students from GE 6 papers**

****Any one DSE option will be opted by students from DSE 2 papers**

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

SEMESTER-VI

DISCIPLINE SPECIFIC CORE COURSE – 16 (DSC-16)
VI.1. Numerical Methods for Computational Mathematics

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		
Numerical Methods for Computational Mathematics DSC 16, VI.1	**4**	**2**	**0**	**2**	**12th Pass**	**Mathematics till XII**

Learning Objectives

In practical scenarios, the governing mathematical models are usually too complex to be solved analytically and numerical techniques become the only way out to approximate the solutions. This paper aim to teach the student solutions of nonlinear equations in one variable with error analysis, interpolation and approximation, numerical differentiation and integration, direct methods for solving linear systems, numerical solution of ordinary differential equations. By the end of this paper, students should have the ability to compare the computational methods for advantages and drawbacks and choose the suitable computational method among several existing methods for underlying physical problems. In this paper, students will write codes in MATLAB/C/C++ for implementation of numerical methods.

Learning outcomes

After completing this course, student should be able to;

- Understand the need of numerical techniques and their importance in real situations
- Learn different techniques of solving non-linear equations such as Bisection method, Newton Raphson method, Regula falsi method, Secant method & Iterative methods
- Analyze errors associated with these methods and their rate of convergence
- Learn Gauss elimination, Gauss seidel, LU decomposition methods for solving system of linear equations with pivoting concepts
- Learn polynomial interpolation, linear and cubic spline interpolations, analyze errors of interpolation

- Conceptualize numerical integration and errors associated with it.
- Learn Euler's method and Runge-Kutta method for numerical solution of differential equations
- Write programs of all these numerical methods in MATLAB/C/C++

SYLLABUS

Unit I: Solving Nonlinear Equations - Graphical method - Bracketing and Non-bracketing approach. - Bisection, Method of false position, Iterative method, Newton-Raphson method and Secant method - Errors and rate of convergence **(8 Hours)**

Unit II: Matrix notation of a system of linear equations - Gaussian elimination and Gauss-seidel method – Pivoting - Row-echelon form - LU factorization **(6 Hours)**

Unit III: Polynomial interpolation - Forward, Backward and Divided differences - Piecewise linear and Cubic Spline interpolation - Errors in interpolation **(6 Hours)**

Unit IV: Newton-Cotes Integration Formula - Trapezoidal and Simpson's rules - Gaussian quadrature, Euler, Modified Euler and Runge-Kutta methods for solution of differential equations - Power method, QR method for Eigen Value problems **(10 Hours)**

Practicals- **(60 Hours)**

- Writing MATLAB/C/C++programs for finding root of the equations using Bisection,Newton- Raphson, Iterative and Secant methods
- Writing MATLAB/C/C++programs for solving system of linear equations (Gaussian Eliminations, Gauss Jacobi & Gauss Seidel Method)
- Writing MATLAB/C/C++ programs for interpolation, forward, backward and divided difference
- Writing MATLAB/C/C++ programs for methods of numerical integration
- Writing MATLAB/C/C++ programs for Euler and Runge-Kutta methods.

Essential/recommended readings

1. Applied Numerical Analysis, C. F. Gerald and P. O. Wheatly, Pearson Education India, 2007.
2. Introduction to Applied Numerical Analysis, R. W. Hamming, Dover Publications, 2012.
3. Elementary Numerical Analysis- An Algorithmic Approach, S. D. Conte and Carl de Boor, McGraw-Hill, 1980.
4. Numerical Recipes:The Art of ScientificComputing,3rd Edition,William H.Press, Saul A.Teukolsky,William T. Vetterling, Brian P. Flannery, Cambridge University Press, 2007

DISCIPLINE SPECIFIC CORE COURSE – 17 (DSC-17)
VI.2. Information Security

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		
Information Security, **DSC-17, VI.2.**	**4**	**3**	**1**	**0**	**12th Pass**	**Mathematics till XII**

Learning Objectives

This course will discuss the fundamentals of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Understand vulnerability analysis of network security. Acquire background on hash functions; authentication; firewalls; intrusion detection techniques. Gain hands-on experience with programming and simulation techniques for security protocols. Understand the tradeoffs and criteria/concerns for security countermeasure development. Apply methods for authentication, access control, intrusion detection and prevention. Identify and mitigate software security vulnerabilities in existing systems.

Learning outcomes

After completing this course, student should be able to;

- Understand and explain the risks faced by computer systems and networks.
- Identify and analyze security problems in computer systems and networks.
- Explain how standard security mechanisms work.
- Develop security mechanisms to protect computer systems and networks.
- Write programs that are more secure.
- Use cryptography algorithms and protocols to achieve computer security.

SYLLABUS

Unit I: Introduction to Information Security: Attacks, Vulnerability, Security Goals, Security Services and mechanisms, CIA **(8 Hours)**

Unit II: Conventional Cryptographic Techniques : Substitution and transposition ciphers, One-time Pad, Block cipher and Stream Cipher, Steganography **(8 Hours)**

Unit III: Symmetric and Asymmetric Cryptographic Techniques: DES, AES, RSA algorithms **(8 Hours)**

Unit IV: Authentication and Digital Signatures: Use of Cryptography for authentication, Secure Hash function, Key management – Kerberos **(8 Hours)**

Unit V: Program Security: Nonmalicious Program errors – Buffer overflow, Incomplete mediation, Time-of-check to Time-of- use Errors, Viruses, Trapdoors, Salami attack, Man-in-the-middle attacks, Covert channels **(8 Hours)**

Unit VI: Security in Networks: Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP,S/MIME **(16 Hours)**

Essential/recommended readings

1. Security in Computing, Fourth Edition, by Charles P. Pfleeger, Pearson Education
2. Cryptography And Network Security Principles And Practice, Fourth or Fifth Edition, William Stallings, Pearson
3. Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall
4. Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall

DISCIPLINE SPECIFIC COURSE -18 (DSC 18)
VI. 3: Artificial Intelligence

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		
Artificial Intelligence DSC 18, VI.3	**4**	**3**	**1**	**0**	**12th Pass**	**NIL**

Learning Objectives

The objective is to introduce the basic principles and techniques of Artificial Intelligence. The course explains and provides a theoretical foundation for the variety of concepts in the field of artificial intelligence. The course does not provide mastery of specific software tools or programming environments. To enhance the practical understanding of AI concepts, the course expects problem-solving projects as a 'hands-on' approach and avenue for exploration and creativity.

Learning outcomes

Upon completion of this course the student will be able to:

- Learn the fundamentals of artificial intelligence.
- Learn to problematize the problems and solve them.
- Understand and implement search and adversarial (game) algorithms.
- Understand mathematical models such as belief networks and apply them to a range of AI problems.
- Have a glance at machine learning algorithms and extracting knowledge models from data.
- Learn different logic formalisms and decision taking in planning problems.
- Learn the Bayesian Networks, and Markov Decision Processes
- Will have an understanding of the fundamentals of Machine learning and Reinforcement learning.

SYLLABUS

Unit I: Philosophy of Artificial Intelligence, Intelligent Agents **(12 Hours)**

UNIT II: Problem-solving, Search techniques, Constraint satisfaction, Game playing, Automated Planning **(12 Hours)**

UNIT III: Knowledge Representation and Reasoning through Logic, Bayesian Networks, Markov Decision Processes **(16 Hours)**

UNIT IV: Machine Learning, and Reinforcement Learning **(20 Hours)**

Essential/recommended readings

1. Russell, S., & Norvig, P. (2021). Artificial intelligence: A modern approach, global edition 4th. *Foundations*, *19*, 23.
2. Poole, D. L., & Mackworth, A. K. (2010). *Artificial Intelligence: foundations of computational agents*. Cambridge University Press.
3. Kulkarni, P., & Joshi, P. (2015). *Artificial intelligence: Building intelligent systems*. PHI Learning Pvt. Ltd.
4. Artificial Intelligence, 3rd Edition. R. Elaine, K. Knight, S. Nair, Tata McGraw-Hill, 2009.
5. Bishop, C. M., & Nasrabadi, N. M. (2006). *Pattern recognition and machine learning* (Vol. 4, No. 4, p. 738). New York: Springer.
6. Winston, Patrick Henry, Artificial Intelligence. 3rd ed. Addison-Wesley, 1992.
7. Kevin P. Murphy and Robert R. Reitano, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES (GE-6)
VI. 4.1. e-Business Organization and Strategy

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			
e-Business: Organization and Strategy, GE-6, VI. 4.1.	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**	**Management Faculty of CIC**

Learning Objectives

This course unit studies how to employ Internet-based IT/IS to do business. It aims to provide participants with opportunities to learn the theory and practice of IT/IS in the business context. It examines the emerging IT and new business models. It will also discuss e-commerce and e-business issues

Learning outcomes

After completing this course, student should be able to:

- Understand the current changing business environment
- Understand the elements of Business models
- Comprehend in-depth review and analysis of organization and functioning of various categories of Business models based on transactions and Business entity
- Grasp the functions of e marketing and analysis of all e-marketing techniques
- Develop theoretical framework of e- marketing planning and Web analytics through KPI's
- Assimilate information systems being used at various managerial levels and across different sectors

- Understand important strategic elements of e- SCM ,e-CRM ,e-procurement ,e-security
- Envision financial requirements for a startup and website management
- Create awareness of change requirements and understand evaluation parameters for e-Business

SYLLABUS

Unit-I. Evolution of e-business-Internet penetration and E-commerce, Web 1.0, Web 2.0, Web 3.0, Online marketing Indian perspective, Business responsiveness **(9 Hours)**

Unit-II. E-business and consumer behavior, Consumer decision making in E-business, Trust and Security and role of Information Systems and various approaches in ICT Systems, Emerging models E-business and organizational changes **(12 Hours)**

Unit-III. Perspectives and requirements for starting online business: Revenue and resources, Processes associated with managing website development ICT in B2B **(12 Hours)**

Unit-IV. Digital Marketing- Customer acquisition, conversion and retention, SEO's, measuring success, On page and off page search engine optimisation, user experience, social media analytics **(12 Hours)**

PRACTICALS- **(30 Hours)**

- Case study discussion on real life cases of the companies that exploited the competitive advantage of IT to leverage their growth and expansion**.**
- Management quiz on the recent updates of the happenings in the e-business market scenario.
- Case study discussion on the development of new e-business which emerged out of market space and other concepts.

Essential/recommended readings

1. Internet Business Models and Strategies: Text and Cases, A. Afuah and C. L. Tucci, McGraw-Hill., 2003.
2. Information Technology and the Corporation of the 1990s: Research Studies, T. J. Allen and M. S. Morton, Oxford University Press, New York 1994.
3. Strategies for e-Business: Creating Value through Electronic and Mobile Commerce, T. Jelassi and A. Enders, Prentice Hall, 2005.
4. Competitive Advantage: Creating and Sustaining Superior, Performance, Michael E. Porter, The Free Press, New York, 1985.
5. E-Learning Tools and Technologies, Horton and Horton, Wiley Publishing, 2003

GENERIC ELECTIVES (GE-6)
VI. 4.2. Control Systems

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			
Control Systems GE-6, VI. 4.2	4	2	0	2	12th Pass	Mathematics till XII	Physics/ Electronics Faculty of CIC

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of functionality and control of a system or a device. It will emphasize on the conceptual know-how of the behavioral aspects and mechanism of different machines, equipment or a system, their manageability, efficiency and performance as per controlled parameters.

Learning outcomes

After completing this course, student should be able to;

- Understand the building blocks of basic and modern control systems.
- Understand the concept of stability analysis of control systems in both time and frequency domain.
- Understand the concept of MATLAB and SIMULINK toolbox to simulate the control systems.
- Perform comparative study of electrical systems using simulation software - Multisim, Eagle, LTSpice and experimental set-up.
- Understand the complex mathematical operations associated with building blocks of various control systems.

SYLLABUS

Unit I: Introduction to Control Systems - Analysis and design objectives - The design process - Classification and modeling of control systems **(6 Hours)**

Unit II: Modeling in the frequency domain - Modeling in the time domain - Time response - Reduction of multiple subsystems **(6 Hours)**

Unit III: Signal flow graphs - Mason's rule - Routh Hurwitz Criterion - Steady state errors - Root locus techniques - Frequency Response Techniques **(8 Hours)**

Unit IV: Root Locus and its Applications -– Design via state space -– Non-linear analysis – Controller and its applications -– Case Studies **(10 Hours)**

Practicals – (60 Hours)

The following explorations would be carried out on matrix based numerical mathematics software

- Designing the model of a DC motor
- Design of controllers for speed and position control
- Compensator design
- Circuit simulation
- State space model design
- Design of temperature controller
- Hands on experiments with PID controller
- Innovation Project

Essential/recommended readings

1. *Control Systems Engineering*, 6th Edition, Norman S Nise, Wiley, 2011.
2. *Linear Control Systems With MATLAB Applications*, 11th Edition, B. S. Manke, Khanna Publishers, 2013
3. *Discrete-Time Control Systems*, K. Ogata, Prentice Hall, 1995.
4. *Control Tutorials for MATLAB and Simulink*, W. Messner and D. Tilbury, Addison-Wesley, 1998.

GENERIC ELECTIVES (GE-6)
VI. 4.3. Circuit Analysis and Synthesis

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			
Circuit Analysis and Synthesis, GE 6, VI. 4.3	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**	**Physics/ Electronics Faculty of CIC**

Learning Objectives

This module is designed to enable the students with skills (i) for analysing an electronic circuit and (ii) to synthesis a circuit based on practical needs. All necessary theoretical inputs are explained in details to achieve the said objective. Module also explains the calculation methods to determine voltages, currents, power factors and other attributes of electrical circuits.

Learning Outcomes

- To understand difference between various types of electric circuits like DC and AC Circuits with Resistors in series and parallel and understanding related basic laws like Ohm's Law, Kirchhoff's laws
- To understand various circuit analysis methods like Mesh current and node voltage method of analysis for D.C and A.C. circuits, Network reduction and network theorems for dc and ac circuits, voltage and current division, source transformation, star delta conversion, Thevenins and Norton's Theorem, Superposition Theorem, Maximum power transfer theorem, Reciprocity Theorem
- To study resonance and coupled L, C, R circuits: Series, parallel resonance and their frequency response, Quality factor and Bandwidth, Tuned circuits , Single tuned circuits-Transient response for DC circuits , Transient response of RL, RC and RLC Circuits
- To learn about characterization of two port networks in terms of Z,Y and h parameters.

Syllabus

Unit I: Basic circuits analysis - Ohm's Law - Kirchoffs laws - DC and AC Circuits - Resistors in series and parallel circuits -Mesh current and node voltage method of analysis for D.C and A.C. circuits - Phasor Diagram - Power, Power Factor and Energy **(10 Hours)**

Unit II: Network reduction and network theorems for dc circuits - voltage and current division, source transformation - star delta conversion - Thevenins and Nortons Theorem – Superposition Theorem - Maximum power transfer theorem - Reciprocity Theorem - Resonance and coupled circuits – Series, parallel resonance and their frequency response - Quality factor and Bandwidth, Characterization of two port networks in terms of Z,Y and h parameters. **(10 Hours)**

Unit III: Tuned circuits - Single tuned circuits, Transient response for DC circuits - Transient response of RL, RC and RLC Circuits **(10 Hours)**

Practicals - **(90 Hours)**

- Verification of nodal voltage and mesh current methods for solving circuits.
- Verification of important network theorems.
- Study of the response of the first order R-C and R-L circuits.
- Study of the response of a series and a parallel RLC circuits.

GENERIC ELECTIVES (GE-6)
VI. 4.4, Genomics and Proteomics

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)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Genomics and Proteomics GE-6, VI.4.4	4	2	0	2	12th Pass	NIL	Chemistry/ Biology Faculty of CIC

Learning Objectives

This module is designed to:

- Introduce students to basic RDT techniques
- Introduce students to basic tools of genomics and proteomics
- Introduce students to building and analyzing networks involving complex biological data.

Learning outcomes

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

- Design primers for PCR
- Well-versed in gene cloning techniques
- Will develop skills in understanding the advancement of the genomic and proteomics branches of Sciences and their importance in manipulating genome and proteome.

SYLLABUS

Unit I: Basics of gene cloning (8 Hours)

Introduction to Recombinant DNA technology, Isolation of DNA, PCR amplification, Types of PCR, Restriction digestion, Cloning and expression vectors, Cloning, Expression, Purification of expressed proteins, DNA libraries and Screening

Unit II: Genome analysis (8 Hours)

Genome sequences and database, Discovery of new genes and function, Early DNA sequencing efforts: Maxam & Gilbert Method, Sanger Di-deoxy method, Fluorescence method, shot-gun approach, NGS: different methods and principles, Genome libraries, expressed sequenced tags (ESTs)

Unit III: Applied Genomics (8 Hours)

Genotyping tools: DNA Chips, Diagnostic assays, Diagnostic services. Functional genomic studies with model systems such as Drosophila, Yeast and C. elegans, Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown. Gene Editing - Crispr Cas9

Unit IV: Applied Proteomics (6 Hours)

Large-scale preparation of proteins and peptides, Synthesis of peptides, Use of peptides as probes Two-hybrid interaction screens, Mass-spec based analysis of protein expression. "Protein Chip" - interactions and detection techniques, Two-dimensional PAGE for proteome analysis, Detection of proteins on SDS gels, Protein cleavage, Edman protein micro-sequencing, Automation in proteomics, Applications of proteome analysis to drug development and toxicology, Phage antibodies as tools for proteomics.

Practicals- **(60 Hours)**

- Isolation and analysis of plasmids
- Expression of proteins as inclusion bodies
- Isolation and refolding of the inclusion bodies
- Agarose Gel Electrophoresis
- SDS PAGE analysis
- Primer design
- Polymerase Chain Reaction (PCR)
- Restriction Digestion
- Cloning Strategy (Introductory Gene Cloning)

Essential Readings

1. *Principles and Techniques of Biochemistry and Molecular Biology*, Wilson & Walker, Cambridge University Press, 2010
2. *Principles of Gene Manipulation and Genomics*, Primrose and Twyman, Wiley-Blackwell 2013

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.1. Computational analysis and visualization of Epigenetic data

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title &Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of thecourse (if any)
		Lecture	Tutorial	Practical/ Practice		
Computational analysis and visualization of Epigenetic data DSE-6, VI. 5.1.	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This is a practical based module designed to:

- Introduce students to the epigenetic basis of inheritance.
- Introduce chromatin structure, remodelling and histone modifications

Learning outcomes

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

- Understand the epigenetic basis of transgenerational inheritance.
- Comprehend the eukaryotic gene regulation and appreciate the role of histones and chromatin in modulating gene expression.
- Will be able to analyse and visualize epigenetic data.

SYLLABUS

(120 hours)

Practical components

1. Understanding the nucleosome structure through models: from 10 nm to higher-order chromatin

2. Statistical approaches for epigenetic Data analysis.
3. Data Analysis of ChIP-Seq experiments.
4. Data analytics of ChIP - microarray data and ChIP-Seq data.
5. Computational method for microRNA target Prediction.
6. Integrative mathematical analysis of epigenomics Data.
7. Differential DNA methylation and network analysis in diseases such as Schizophrenia, Alzimers, Diabetis, Cancer, Obecity etc.
8. Mathematical modelling of epigenetic players of different cancer types.

Essential/recommended readings

- Epigenetics (2014) by Lyle Armstrong; Published by Garland Science, Taylor & Francis Group (ISBN-13: 978-0815365112; ISBN-10: 081536511X)
- Epigenetics a reference Manual by Jeffrey M. Craig and Nicholas C. Wong (2011), Caister Academic Press DOI: https://doi.org/10.21775/9781910190494
- Banister CE. Review of *Epigenetics: A Reference Manual*: A book edited by Jeffrey M. Craig and Nicholas C. Wong. Epigenetics. 2012 Aug 1;7(8):963–4. doi: 10.4161/epi.21137. PMCID: PMC3427292

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.2. Analysis and Visualization of high throughput data of Genomics and Proteomics

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		
Analysis and Visualization of high throughput data of Genomics and Proteomics **DSE 2, VI. 5.2.**	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This module is designed to:

- Introduce students the basic tools and processes of genetic engineering
- Introduce students to basic tools of genomics and proteomics
- Introduce students to building and analysing networks involving complex biological data.

Learning outcomes

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

- Will develop skills in understanding the advancement of the genomic and proteomics branches of Sciences and their importance in manipulating genome and proteome.
- Will be able to handle genome and proteome data.
- Can do mathematical prediction of high throughput data

SYLLABUS **(120 hours)**

Practicals-

1. Large scale genome sequencing strategies and interpretation of results
2. Handling microarray data, SNPs and OMIMs
3. Transcriptome Analysis: Databases and basic tools: Gene Expression Omnibus (GEO)
4. Array Express, SAGE databases
5. RNA Sequencing
6. Active site prediction
7. Machine learning tools, such as Neural network, SVM etc.
8. Protein MS applications: identifying unknown proteins by peptide mass fingerprinting; de novo sequencing of peptides from fragment ion spectra obtained by tandem MS; Protein arrays: basic principles. Bioinformatics tools for proteomics: SEQUES, MASCOT etc.

Essential Readings

1. *Principles and Techniques of Biochemistry and Molecular Biology,* Wilson & Walker, Cambridge University Press, 2010
2. *Principles of Gene Manipulation and Genomics,* Primrose and Twyman, Wiley-Blackwell 2013
3. Gayon J, Malaterre C, Morange M, Raulin-Cerceau F, Tirard S (2010) Defining life:conference proceedings. Orig Life Evol Biosph 40(2):119–120
4. Pujol A, Mosca R, Farrés J, Aloy P (2010) Unveiling the role of network and systems biology in drug discovery. Trends Pharmacol Sci 31(3):115–123

5. del Sol A, Balling R, Hood L, Galas D (2010) Diseases as network perturbations. Curr Opin Biotechnol 21(4):566–571
6. Hood L, Flores M (2012) A personal view on systems medicine and the emergence of proactive P4 medicine: predictive, preventive, personalized and participatory. New Biotechnol 29:613

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.3. Technology based solutions of societal issues: An interdisciplinary 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		
Technology based solutions of societal issues: An interdisciplinary approach, DSE-2, VI.5.3.	**4**	**0**	**0**	**4**	**12th pass**	**NIL**

Learning Objectives

This course is designed for students to give them hands-on experience of working on interdisciplinary research problems, which may have direct impact or relevance for society. This will broaden their horizon regarding the identification of an issue and then step by step way of solving the same, either theoretically or experimentally by acquiring the required technology based skill-sets.

Learning outcomes

After completing this course, student should be able to;

1. Identify a research problem related to a societal issue, which needs attention

2. Acquire the required technical skill-sets, which will be needed for solving such problems
3. Get the hands-on training for working on a problem which is a real societal issue, so that students can become more sensitive and responsible for solving such issues

Syllabus

Practicals – (120 hours)

- Developing an understanding related to societal issues specifically in the sectors of water, food, electricity, textiles, housing, energy, defense and human health etc.

- Identification of a problem as per interest of the student, which may be solved using innovative and interdisciplinary approaches
- Working on problems based on artificial intelligence-based biosensors, Electrochemical biosensors, wearable biosensors etc. for various applications related to society
- Building machine learning models on various datasets specially related to health issues for the identification, diagnosis or prediction of the disease
- Computational modeling/ simulation of nanoparticles and their usage in drug delivery applications for various diseases. Examples can be like neuro-simulation of drug-loaded nanoparticles for understanding the pathway for diseases like mental depressive disorders.

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-2)
VI.5.4. Design & Analysis of CFD based modules to simulate flow/ heat transfer problems with ANSYS/COMSOL

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		

Design & Analysis of CFD based modules to simulate flow/heat transfer problems with ANSYS/COMSOL, DSE-2, VI.5.4	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This interactive practical paper aims to enable the students to visualize different types of problems of flow and heat transfer in various fields. Blood flow within arteries, biological tissues, heat transfer within biological tissues, flow within circular pipes, flow within an aquifer are some of the important application of CFD. In this paper, students will learn CFD models, mathematical analysis of these models, their numerical simulation using mathematical softwares and post processing of obtained numerical results.

Learning Outcome

After completing this paper, students will be able;

- Learn mathematical models of flow and heat transfer problems and their applications.
- Implementation of existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design of UDF based problem specific modules in ANSYS/COMSOL
- Validate their numerical results with experimental data (if available) for suggesting new designs.

Syllabus (Practical component):

- Complete understanding of Navier Stokes models under different flow conditions.
- Introduction to different types of fluids under realistic conditions such as Newtonian, Non-Newtonian, Nano-fluids, Visco-elastic fluids, bio-fluids etc.
- Implementation of existing CFD based modules in ANSYS/COMSOL for simulation purpose.
- Design and modification of existing modules using UDF (User defined functions) in ANSYS/COMSOL as per the problem requirement.
- Post-processing of numerically simulated results

Essential Readings:

1. Computational Fluid Dynamics: A practical Approach (2019) by Jiyuan Tu, Guan Yeoh, Chaoqun Liu, 2nd Edition, Publisher: Butterworth-Heinemann.

2. Computational Fluid and Particle Dynamics in the Human Respiratory system (2012) by Jiyuan Tu, Kiao Inthavong, Goodarz Ahmadi, Biological and Medical Physics, Bio-medical Engineering, Publisher: Springer.
3. Multiphysics Modelling using COMSOL: A First Principle Approach (2011), by Roger W. Pryor, Jones and Bartlett Publishers, London, Singapore.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.5. Develop and Simulate Data Driven Approached for Medical Imaging

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		
Develop and Simulate Data Driven Approaches for Medical Imaging, DSE-2, VI.5.5	**4**	**0**	**0**	**4**	**12th Pass**	**NIL**

Learning Objectives

This course covers data driven approaches for computer vision, with applications in medical image analysis. The course introduces fundamental concepts in machine learning, describes neural networks and the field of deep learning, and goes into detail about deep learning techniques. The course describes the different parts that are used when building deep learning architecture, such as filters, activation functions, loss functions; regularization techniques such as e.g. batch normalization and dropout; explains several of the different non-linear optimization algorithms that are used when training the networks, and describes popular network architectures.

Learning outcomes

- Formulate central concepts in machine learning, such as training and validation data, classification and regression, supervised and unsupervised learning, bias and variance, loss function, generalization error, accuracy, precision, to medical image dataset.

- Can describe deep learning parameters, such as e.g. depth, learning rate, hyper parameter, overtraining and regularization.
- Understand different deep learning architecture for classification and segmentation of diagnosis of various diseases.
- Can simulate deep learning architecture and models used in medical imaging.

Practical component

- Introduction to medical imaging modalities and image analysis softwares.
- Feature extraction, segmentation, systematic evaluation and validation on datasets.
- Machine learning based approaches for segmentation and classification.
- Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images.

Essential/recommended readings

1. The Handbook of Medical Image Perception and Techniques, by Ehsan Samei and Elizabeth A. Krupinski, second edition, Publisher Cambridge University Press.
2. Medical Imaging by DS Guru, K.C. Santosh, Nilanjan Dey, Sameer Antani, Publisher CRC Press.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.6. Mathematical modelling & Simulation of dynamical systems

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		
Mathematical modeling & simulation of dynamical systems DSE-2, VI.5.6	**4**	**0**	**0**	**4**	**12th pass**	**Mathematics till XII**

Learning Objectives

This interactive learning module intends to provide capabilities and basic understanding of system modeling and simulation performance. It will emphasis on analysis of dynamical behavior of

physical, electrical, mechanical, social, biological, chemical, and financial systems along with applications in engineering and other applied sciences. The simulation will be done with the MATLAB software platform.

Learning outcomes

After completing this course, student should be able to;

- understand the mathematical and computational tools for modeling and simulation of dynamical systems
- apply basic concepts of fractional calculus
- identify, model analyze, and simulate dynamical systems using simulation tools
- know how the simulation help to analyze system graphically
- describe the behavior of dynamical system

SYLLABUS

Practicals – (120 Hours)

The following explorations would be carried out on matrix based numerical mathematics software

- Modeling of integer and non-integer dynamical systems
- Introduction to basic simulation tools
- Simulation performance of integer and non-integer dynamical systems
- Chaotic behavior of integer and non-integer dynamical systems
- Parameter optimization to improve the performance of the system
- Model validation and performance analysis with data
- Innovation Project

Essential/recommended readings

1. *Theory of modeling and simulation*, Zeigler B.P., Praehofer. H., Kim I. G., 2nd Edition. Academic press, 2000.
2. *Theory of Fractional Dynamic Systems*, Lakshmikantham, V., Leela, S., Vasundhara Devi, J. Cambridge Academic Publishers, Cambridge, 2009.
3. *Fractional-order nonlinear systems: modeling, analysis and simulation*, Petras, I., Springer-Verlag Berlin Heidelberg, Germany, 2011.
4. *Chaos: An Introduction to Dynamical Systems*, K.T. Alligood, Sauer, Tim D., Yorke James A. Springer, 1996.
5. *Nonlinear Dynamics and Chaos*, Strogatz, S. Reading, MA: Addison-Wesley, 1994.
6. *Optimization and Dynamical Systems*, Helmke U., Moore J. B, SpringerVerlag, 1993.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.7. Alternate Energy studies: Analysis, modeling, and simulation of the systems

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		
Alternate Energy studies: Analysis, modeling and simulations of the systems, DSE-2, VI.5.7	**4**	**0**	**0**	**4**	**12th pass**	**Mathematics till XII**

Learning Objectives

This module involves basic practical knowledge of modeling simulation and analysis of systems involving alternative energy. It has experiments to gain knowledge of solar cells, PV architecture , solving dust mitigation, smart building design problems, design of simulators, physical PVT systems, Piezoelectric and Peltier systems , soil/air quality improvement techniques with nano-particles.
Study of the Social Aspects in regards to alternate energy acceptance.

Learning outcomes

After completing this course, students will achieve the practical knowledge of the following:

- Solar Cell fabrication and characterization.
- PV panel technology and smart building design.
- PVT systems including compound parabolic concentrators(CPC) including integrated double slope solar still and helically coiled exchangers incorporating single wall carbon nanotubes(SWCNT) and multi wall carbon nanotubes(MWCNT) and analysis of water-based nanofluids.
- Knowledge of piezoelectric and Peltier effect.
- Smart building design with alternate energy.
- Soil/Air quality improvement techniques using filters and nano-particles.

Practicals– **(120 Hours)**

- Study of solar cell thin film technology- fabrication, characterization, lifetime, measurements and application. Hybrid and organic solar cells in special consideration.
- PV panel architecture – Recognising dust mitigation problems in terrestrial and satellite usage. Study of traditional ways and use of electromagnetic waves for cleaning of PV panels.
- Design and fabrication of indoor PV standardizing measuring systems – Simulator and Standardization using pyranometer.
- PVT systems studies – PVT systems including compound parabolic concentrators (CPC) including integrated double slope solar still and helically coiled exchangers incorporating single wall carbon nanotubes (SWCNT) and multi wall carbon nanotubes(MWCNT) and analysis of water-based nanofluids.
- Study of piezoelectric material effect to replace mobile batteries and batteries of the pacemaker of heart in our body.
- Smart building design and complexes with solar energy usage with least energy wastage.
- Soil/Air – Improvement of quality control and replishment for example use of filters and nano-particles. Agricultural land quality control can be looked into and smart devices can be fabricated to control the soil and water pollution.
- Thermoelectric-effects:
    1. The Seeback effect
    2. The Peltier effect
    3. The Thomson effect

Peltier coolers will be studied for cooling in laser diodes, CCD cameras (Charged Coupled Device), blood analysers, micro-processors for improving the efficiency using many modules.

- Alternate energy usage, acceptance in society, survey and data collection.

Essential/recommended readings

1) Solar Power Plants: Fundamentals Technology Systems economics by C.J. Winter, Rudolf L. Sizmann, Lorin L. Vant Hull, Springer. Publications: Springer
2) Solar Photovoltaics: Fundamentals Technologies and applications 4.17, Publications: PHI Learning
3) Photovoltaic Systems Engineering third edition by Messenger Roger E.Et.Al, Taylor & Francis. Publisher Taylor & Francis.
4) Advanced Solar-Distillation Systems: Basic Principles, Thermal Modeling and it's applications by G.N. Tiwari, Lovedeep Sahota. Publication: Springer.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.8. Social Media Management

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 Media Management, DSE 2, VI. 5.8	**4**	**0**	**0**	**4**	**Class XII**	**NIL**

Learning Objective:

This course provides students with the knowledge and skills required to effectively manage social media handles like Linkedin, Twitter, Facebook, Instagram etc. for businesses and organizations.

Learning Outcomes:

- Developing social media strategy
- Brand voice
- Creating valuable content
- Managing social media accounts
- Developing Podcasts
- Monitoring user engagement
- Appropriate responsiveness

Practicals -

Business opportunities in Social-Media, Evolving from platform centric to goal centric approach, Collecting and segmenting social audience data, Prioritising and engaging social audiences, Adopting different social platforms, Developing strategy for social branding, Designing and distributing social content.

Suggested Resources:

1. Social Media Management: Persuasion in network culture, Ben Shields, Oxford University Press, 2015.

2. Jab, jab, jab, right hook: How to tell your story in a noisy social world, Gary Vaynerchuk, Harper business, 2013
3. Social Media Marketing, Jan Zimmerman and Deborah Ng, For Dummies, 2017.
4 Social Media Management, https://www.youtube.com/watch?v=HQ0jtPA-zLQ&list=PLUllurxaY2k4mZP7LPwwJhfK5kXqQfGqn

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.9. Virtual Reality

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		
Virtual Reality, DSC 2, VI. 5.9	**2**	**2**	**0**	**2**	**Class XII pass with Mathematics**	**C^{++}**

Learning Objectives

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications

Learning outcomes

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

- Understand geometric modelling and Virtual environment.
- Be able to do 2D and 3D geometrical modelling
- Develop Virtual Reality applications.

Practicals - **(120 Hours)**

The course will be conducted completely on a hands-on mode and project-based learning. The basic concepts will be explained and each concept will be augmented by small tasks in UNITY. Animations and physical simulations will be introduced to the students through an appropriate Virtual environment. Following tasks will be covered in the lab:

- Introduction to the Virtual environment
- Introducing frame of reference and modelling transformations
- Animation in virtual environment – projectile motion, flight/ car simulation, Ferris wheel, pendulums, etc.
- Visualising Human Anatomy/ geographical regions/ environment/ monuments in the VR

environment
- Modelling a store/ classroom/ office/ mall in VR

Essential/recommended/ suggested readings

1. *Virtual Reality Systems*, John Vince, Pearson Education India, 2002. https://all3dp.com/2/blender-3d-printing-tutorial/
2. *Understanding Virtual Reality: Interface, Application and Design*, William R Sherman and Alan B Craig, Morgan Kaufmann, 2018
3. *Virtual Reality*, Samuel Greengard, MIT Press, 2019.
4. *Virtual and Augmented Reality*, Paul Mealy, Wiley, 2018.

DISCIPLINE SPECIFIC ELECTIVE COURSE -1 (DSE-2)
VI.5.10. Research Methodology

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		
Research Methodology, DSC 2, VI. 5.10	**2**	**2**	**0**	**2**		

Learning Objectives:

The course is designed to make students understand about what, why and how to conduct research includes nature and purpose of research, identifying research problems, building research design, appropriate selection of research tools and methods for data analysis and also developing the base of future researches

Learning Outcomes

After completing the course, student should be able to

- Identify a research problem
- Formulate hypotheses
- In depth literature review
- Plan research design
- Use research tools and techniques, methods of analysis
- Ethics in research
- Communication skills

Practicals – **(120 Hours)**

- Art of reviewing research articles, identification of research gap and finding research problems, framing research objectives, Outline for research proposal.
- How to conduct an exploratory study, Experiments, Quantitative and qualitative study based on research questions and objectives, Data coding and entry to the software, Analysis of data through various tools, applications and research techniques such as regression and correlation, Hypothesis testing and inferences
- Familiarity with data collection software, E0resource library system with journals, books and publications, Usage of the data analysis and software.
- Directing students to follow report writing conventions, citations, acknowledgements, checking originality of the work vis plagiarism software and abiding research ethics, Presentation of work, how to get the research work published in a reputed journal.

Suggested Readings:

- Kitsakorn Locharoenrat, Research Methodologies for Beginners, Pan Stanford Publishing Pte. Ltd., Singapore, 2017.
- C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2004, ISBN 8122415229, 978812241522.
- Kumar R. Research Methodology: A step by step Guide for Beginners (2010) 3rd ed., Pearson Education. (ISBN-13: 978-1849203012)
- Relevant study material from ACM, IEEE, Elsevier, Springer
- Levin, R. I and D.S. Rubin, Statistics for Management, Prentice Hall of India.
- Aczel, Amir D., and Sounderpandian, J., Complete Business Statistics, Tata McGraw Hill Publishing