B. Tech. (IT & Mathematical Innovations)

Program Outcomes

PO1: To inculcate an innovation mindset as part of the curriculum and pedagogy. Building strong analytical skills through Mathematics and application skills of Information Technology (IT).

PO2: To offers three specialization streams – Management, Electronics & Embedded System and Systems Biology

PO3: To promote learning based on "hands-on" and "project-based" mode of learning.

PO4: To aim to produce adequately skilled graduates with a creative mindset who can provide new solutions to industry in particular and to society in general.

PO5: To encourage students under mentoring of teachers, for innovation and entrepreneurship. In addition to this, the course is specifically designed to boost undergraduate research.

Course Outcomes

SEMESTER – I

I.1 Seeing the world through calculus. First steps through symbolic mathematics.

CO1. Limits and continuity

CO2. Limits at infinity

CO3. Indeterminate forms

CO4. Special limits involving exponential and logarithmic functions

CO5. Asymptotes

CO6. Graphs of function and its derivatives

CO7. Optimization problems

CO8. Fluency in differentiation

CO9. Concavity and inflexion points

CO10. Integration

CO11. Parametric equations of curves, arc length and surface area

CO12 Vector valued functions, differentiation and integration of vector valued functions

CO13. Sequences, infinite series including Taylor approximations, Power series

CO14. Functions of several variables

CO15. Level curves and surfaces

CO16. Limits and continuity of functions of two and three real variables

CO17. Partial differentiation (two variables), partial derivative as a slope, partial derivative as a rate, Maxima and Minima

CO18. Multiple Integrals, line, surface and volume integrals

CO19. Applications of Green's, Stokes and Gauss's Theorem.

CO20. Introduction of basic functions

CO21. Plotting of graphs of functions and their derivatives

CO22. Manipulating the parameters in a graph

CO23. Fitting of a curve

CO24. Parametric plot of curves (Eg. Trochoid, Cycloid, Epicycloid)

CO25. Obtaining surfaces of revolution of curves

CO26. Plotting functions of two variables and their level curves

CO27. Graphical illustration of limits for functions of two variables

CO28 Innovation Project

I.2 Linearity in Nature: Engineering through Linear Algebra. First steps through numerical algorithms

CO1. Algebra of matrices

CO2. Determinants

CO3. Hermitian, Skew-Hermitian and Unitary matrices

CO4. Vectors and vector operations in 2 and 3 dimensions

CO5. Solution and application of linear matrix system AX = B

CO6. Eigenvalues and eigenvectors, minimal polynomial

CO7. Cayley-Hamilton theorem and diagonalisation

CO8. Sets, relations, functions - Groups, subgroups

CO9. Abstract vector spaces, subspaces

CO10. Finite dimensional vector spaces

CO11. Linear independence and dependence of vectors, bases, dimension of vector spaces

CO12. Finite dimensional inner product spaces

CO13. Orthogonal sets and projections, Gram Schmidt process, orthogonal diagonalisation

CO14. Basic arithmetic operations, hierarchy of arithmetic operations

CO15. Declaration and assignment of variables

CO16. Introduction to elementary mathematical functions

CO17. Dealing with matrices and arrays

CO18. Basic programming with loops (for, while, switch), if else statements

CO19. Programs for solving system of linear equations, Orthogonalization

CO20. Creating 2D, 3D plots

CO21. Innovation project

I.3 Optimizing Memory use through Data Structure and Design

CO1. Basic concepts

CO2. Dynamic optimization

CO3. Memory Hierarchy

CO4. Hashing

CO5. Networks and Graphs

CO6. Search

CO7. Heaps

I.4 The Science and Art of Logic and Programming: Algorithms

CO1. Algorithmic analysis and modeling

CO2. Algorithmic proofs

CO3. Computational complexity

CO4. Asymptotic notation and analysis

CO5. NP Completeness

I.5 Physics at work I: Deconstructing Machines

CO1. Newtonian Mechanics (Kinematics & Dynamics)

CO2. Classical Mechanics at work

CO3. Deconstructing mechanical systems

CO4. Universal Gravitation

CO5. Oscillations

CO6. Inertial & Non-inertial frames

CO7. Central force motion

CO8. Understanding rotational dynamics

CO9. Efficiency and mechanical advantage in simple and complex machines: Levers, Pulley, Wheel & Axles, Gear systems, Hydraulic systems

CO10. Forms of energy and conversion between different forms of energy.

CO11. Concepts of measurement, error, precision, accuracy. Concept of scale. Understanding Measuring Instruments

CO12. Understanding oscillation using simple and compound pendulums

CO13. Mechanics system with 850 Universal Interface – understanding Newtonian Dynamics

CO14. Measurement of Moment of inertia from rotational dynamics

CO15. Roller coaster dynamics – computer simulation and physical verification

CO15. Coupled pendulum motion – using webcam and image analysis

CO16. Ballistic Pendulum

CO17. Understanding physics of complex machines – one implementation of "Tod-Phod-Jod" concept.

CO18. Visualization in 3D and understand how things work – Building a CAD model in 3D to trace the flow of power, energy, information and material.

CO19. Innovation project – designing instruments, machines, prototypes, applets

I.6 Business, Entrepreneurship and Innovation Management.

CO1. Understanding Business

CO2 Types of Business Activities

CO3. Evaluating the Business

CO4. Business organization

CO5. Starting a Business

CO6. Entrepreneurship concept

CO7. Entrepreneurial attributes & characteristics

CO8. Leadership

CO9. Business Plan preparation

CO10. B2B and B2C models

CO11. Creativity & its components

CO12. Invention vs. Innovation

CO13. Types of innovation

CO14. Innovation and Technology

CO15. Innovation policy & IPR

CO16. Commercialization of Innovation.

I.7 Environmental Studies and Ecosystem Management

CO1. Relationship between environment and public health

CO2. Sustainable development: policy and practices

CO3. Biodiversity: Hotspots, Threats, Conservation

CO4. Ecosystem: Structure, Function, Energy flow, cycles

CO5. Environmental pollution & public health

CO6. Mitigation strategies

CO7. Policy

CO8. Collection and processing of environmental data

CO10. IT in ecosystem & environment management

CO11. Social and Cultural parameters

CO12. Environmental Risk & Impact Assessment.

SEMESTER – II

II.1 Modeling continuous change through ordinary differential equations and complex analysis

CO1. First order differential equations

CO2. Variable separable, homogeneous, linear, exact differential equation

CO3. Integrating factors

CO4. Existence and uniqueness of solution

CO5. General solutions of second order differential equation

CO6. Homogeneous and non-homogeneous differential equations with constant coefficients

CO7. Method of variation of parameters

CO8. Method of undetermined coefficients, higher order differential equations with constant coefficients

CO9. Planar autonomous linear systems with graphical representation

CO10. Determination of stability and classification of equilibrium of a planar nonlinear system by linearization

CO11. Power series solution about a regular point of an analytic ordinary differential equation

CO12. Power series solution of Legendre and Bessel's equation

CO13. Orthogonality of Legendre and Bessels function

CO14. Laplace transform methods applied to differential equations

CO15. Analytic functions of a complex variable: Power-series expansions

CO16. Laurent expansions and Liouville's theorem - Complex integration

CO17. Cauchy Integral Theorem.

CO18. Residue Theorem and applications to evaluate real integrals.

CO19. Plotting of slope fields and solution curves of first order and higher order differential equations

CO20. Graphical analysis of solution of Population model, Pollution Model, CO21. CO21. CO21. Acceleration – Velocity Models

CO22. Projectile motion, Mechanical Vibrations – Motion of Simple Pendulum, Free undamped and damped motion, Forced undamped and damped motion

CO23. Plotting of phase plane diagrams for predator – prey model, competing species, epidemic model and their analysis

CO24. Innovation project

II.2 Understanding real life situation through Discrete Mathematics

CO1. Combinatorics: Sets, counting of sets

CO2. Permutation

CO3. Combination

CO4. Inclusion

CO5. Exclusion

CO6. Generating functions

CO7. Recurrence relations

CO8. Graph Theory**:** Introduction

CO9. Basic terminologies

CO10. Graph representation

CO11. Euler relation

CO12. Isomorphism

CO13. Connectivity

CO14**.** Cut vertices and edges

CO15. Covering

CO16. Euler and Hamilton paths and circuits

CO17. Shortest Path Algorithms: Dijkstra's algorithm

CO18. Travelling salesman problem

CO19. Scheduling problems

CO20. Matching

CO21. Independent sets

CO22. Coloring

CO23. Planar graph: idea of region

CO24. Euler formula

CO25. Kuratowski theorem and application

CO26. Tree: basic terminology, traversal, Prefix code - Idea of data compression: Huffman code

CO27. Minimum spanning tree: Prim's and Kruskal method.

II.3 Decoding Computation Structure and Logic

CO1. Sets

CO2. Graphs

CO3. Digital abstraction

CO4. Automata

CO5. Combinatorial Logic

CO6. Randomness

CO7. Context free languages

II.4 Reflecting thought processes through Object Oriented Programming.

CO1. Background Programming Systems

CO2. Migration of Objects & Classes

CO3. Theory of OOPS paradigms & Concepts

CO4. OOPS Features in Real Systems

CO5. Applications and Framework

CO6. Programs implying the use of Arrays, Linked Lists, Strings, Loops

CO7. Programs on Object & Classes from Realistic Environment and Systems

CO8. Programs demonstrating Constructors, Destructors, Methods & other concepts

CO9. Programs Showcasing Inheritance, Polymorphism, Encapsulation & other OOPS features

CO10. Programs on Exception Handling, Packages and Threading

CO11. Reverse Engineering a Java Source/ project/Mobile Application and understanding the concepts

CO12. Mapping the programs with Real life Systems and showcasing the implementation

CO13. Innovation project

II.5 Physics at work II: Deconstructing Devices.

CO1. Basics of Electrostatics and Electrodynamics

CO2. Electric Circuit elements and function

CO3. Current, voltage, capacitance, resistance

CO4. Power and efficiency in electrical appliances

CO5. Joule heating

CO6. Electrical safety devices

CO7. Basics of Electromagnetism

CO8. Electromagnets and induction

CO9. Transformers. DC motors and generators

CO10. AC motors

CO11. Using electromagnetic spectrum

CO12. Information transfer and broadcasting

CO13. Use of Radiation energy and appliances

CO14. Photovoltaic cells and conversion of solar energy to electricity

CO15. Advantages, limitations and challenges of different solar cell technologies

CO16. Different forms of renewable energy and technology.

CO17. Electric circuit, power requirement, cost of electricity, energy efficiency of sample appliances

CO18. Potential divider, measurement of resistances of different scales

CO19. Build a buzzer

CO20. Conversion of solar power to electricity using photovoltaic cells: design, working principle, performance, application

CO21. Build an autonomous robot

CO22. Build a remote controlled robot

CO23. Understanding physics of devices – one implementation of "Tod-Phod-Jod" concept

CO24. Innovation project – designing instruments, devices, model & prototyping

II.6 Art of communication and Creative Writing.

CO1. Language and Communication

CO2. Context

CO3. Barriers to communication

CO4. Speech and writing

CO5. Writing skills

CO6. Linguistic unity, coherence, and cohesion

CO7. Scientific and technical writing

CO8. Oral interactional skills

CO9. Formal and informal speech

CO10. Public speaking

CO11. Negotiation

CO12. Group discussion

CO13. Comprehension

CO14. Intelligent listening

CO15. Creativity

CO16. Poetry

CO17. Narrative

CO18. Dramatic writing

CO19. Creative process

CO20. Cultural experience

CO21. Creative communication skills in daily life

CO22. Retention of traditional narratives - Storytelling

II.7.1 Business Process and strategic IT alignment

CO1. Introduction to different business Processes: Human Resources, Production, Operations, Marketing and Finance

CO2. Business process linkage with IT - IT enabled Businesses

CO3. IT governance & architecture

CO4. IT enabled change management

CO5. Business Analysis strategies & planning

CO6. Cost Benefit analysis

CO7. Enterprise Resource Planning

CO8. Digital Marketing and Media

CO9. Internet, Multimedia, and Mobile apps in business.

II.7.2 Electronics at Work & Circuit simulation

CO1. Analog World: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch

CO2. Potentiometer

CO3. Integrated Circuit

CO4. Transformer

CO5. Digital World: logic families, logic gates, boolean algebra

CO6. Combinational circuits: adders, encoders, decoders, multiplexer and demultiplexer

CO7. Sequential circuits: like flip flops, counters, shift registers, memories

CO8. Semiconductor Devices*:* PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. FET, MOSFET, FET, Operational Amplifier (Op Amp): inverting and non-inverting amplifier, integrator, differentiator, summing amplifier, active filters

CO9. ***Signal and System:*** Types, Generation, Audio and Video Signals and their applications, Operation on Signals, Classification of Signals and Systems, Discrete Convolution & Correlation

II.7.3 Exploring Biology: Systems approach.

CO1. Organism: origin of life and what organisms do

CO2. Biological sciences: from descriptive to reductionist to systems biology

CO3. Metabolism in living state

CO4. Living systems as energy machines

CO5. Cycles and life, Life cycles

CO6. Cell cycle & turnover

CO7. Origin and diversification of living systems

CO8. Hierarchy of organization of living systems (molecular, cellular, and population levels)

CO9. Evolution of living systems: probabilistic versus deterministic.

SEMESTER –III

III.1 Modeling change in the world around us: Partial Differential Equations

CO1. Familiarities with different type of first order linear and non-linear PDEs

CO2. Examples of PDEs arising in transport equation, conservation laws, spread of epidemic cholera

CO3. Cauchy problem for first order PDE method of characteristics

CO4. Monge's cone

CO5. Classical methods for simple PDE models

CO6. Second order PDE arising in wave equations, conduction of heat, gravitational potential, telegraph equation, dispersion of contaminants

CO7. Classification of second order PDE and their solution

CO8. Fourier Series and Fourier transforms

CO9. Boundary value problem: Dirichlet and Neumann

CO10. Lagrange Green's identity existence and uniqueness by energy considerations

III.2 Handling information through Data Modeling & Design.

CO1. Traditional Files & Databases

CO2. Database Management Systems

CO3. Relational Model

CO4. ER Modeling

CO5. Constraints, Query language & features

CO6. Normalization

CO7. Indexing

CO8. Transaction Processing & Concurrency Control

CO9. PL/SQL Basics

CO10. Graph Databases

CO11. Data Modeling Techniques & UML

CO12. Analysis of Data using Mining Techniques

CO13. Study of Real World Applications

CO14. ER Diagram of Existing systems and new systems

CO15. SQL Commands, Structures & execution of Commands on Test Database

CO16. Creation of Databases and identifying the Constraints

CO17. Execution of DDL, DML, TCL Queries on created database

CO18. XML Databases

CO19. Executing Aggregate Functions and Extraction of Data elements

CO20. Programs on Database Objects including Procedures, Functions, Exception

CO21. Modeling of Systems and Requirements using UML

CO22. Design of Application(s) using Mining Techniques

CO23. Reverse Engineering & Study of a Database System Architecture

III.3 Instructing computing devices: Operating System

CO1. Operating System Structures

CO2. Process, Memory & CPU management

CO3. Storage Devices & I/O systems

CO4. Operating Systems of Mobile Devices

CO5. Study & Analysis of Unix/Linux/Windows/Android

III.4 Language and Communication: Computational Linguistics

CO1. Introduction to Natural Language Processing (NLP)

CO2. Language structure and Analyzer

CO3. Morphological Analysis

CO4. Local Word Grouping

CO5. Parsing

CO6. Computational grammar and requirements

CO7. Machine Translation

CO8. Lexical semantics and algorithms

CO9. Spoken Language System

CO10. Tagging

CO11. Speech synthesis

CO12. Speech recognition

III.5.1 Understanding Economic Behavior: The micro level.

CO1. Exploring the subject matter of Economics - The Economic Problem:

CO2. Scarcity and Choice; the question of What to Produce, How to Produce and How to Distribute Output

CO3. Markets and Competition

CO4. Determinants of individual demand & supply

CO5. Demand-Supply schedule and curves

CO6. Market versus individual demand & supply

CO7. Shifts in the demand & supply curve

CO8. Market Interactions, How Price allocate resources

CO9. Elasticity and its application, Controls on Prices

CO10. Taxes and the Costs of Taxation

CO11. Households and Consumer Behavior

CO12. Budget Constraints, Firms and Producer Behavior

CO13. Perfect Market Structure, Imperfect Market Structures

CO14. Monopoly and antitrust policy, government policies towards competition

CO15. Imperfect information in the product market--The information problem

CO16. The market for lemons and adverse selection and Input Markets

III.5.2 Electronics circuit elements and instruments.

CO1. AC Fundamentals

CO2. Concept of voltage and current sources

CO3. KVL and KCL

CO4. Node voltage analysis and method of mesh currents

CO5. Network theorems.

CO6. PN Junction: variants and applications

CO7. Bipolar Junction Transistor (BJT) biasing and amplifier design

CO8. Field Effect Transistor (FET) variants

CO9. FET biasing and amplifier design

CO10. Structure and working of SCR

CO11. Structure and operation of LDR, Photo voltaic cell, Photo diode, Photo transistors and LED

CO12. Operational Amplifiers basics and practical circuits

CO13. Feedback and oscillator circuits

CO14. Voltmeters- Multimeters

CO15. Function generator

CO16. Cathode ray oscilloscope

CO17. Cathode Ray Tube.

III.5.3 Integrative Biology.

CO1. Demystifying living state

CO2. Nature of biological processes

CO3. Approaches to study Biology

CO4. Observational and Experimental, Physiology and Behavior

CO5. The regulated activities

CO6. Communication (external & internal) as the basis of regulation

CO7. Circuits and regulations in living systems

CO8. Interaction of biological components

CO9. Information flow in living systems: Proximate and Ultimate causes

CO10. Model organisms in study of Biology, Chaos and Order.

III.6.1 Principles of Management

CO1. Evolution of Management Thoughts

CO2. Contribution of selected management thinkers

CO3. Approaches to management

CO4. Contemporary Management practices in Global Environment

CO5. Management Functions: Planning Organizing

CO6. Staffing and controlling

CO7. Introduction to various streams of management

III.6.2 Electronics circuit elements and instruments – Innovation Lab

CO1. Characteristics of PN junction and Zener diode
CO2. Half wave rectifier.
CO3. Full wave rectifier with 2 diodes.
CO4. Full wave rectifier with 4 diodes (Bridge rectifier).
CO5. Input, Output and Transfer characteristics of CE and CC Amplifier.
CO6. Characteristics of LDR, Photo-diode and Photo transistor.
CO7. Transfer characteristics of JFET.
CO8. Transfer characteristics of MOSFET (with depletion and enhancement mode)
CO9. Characteristics of LED with three different wavelengths.
CO10. Series voltage Regulator.
CO11. Shunt voltage Regulator.
CO12. Characteristics of Thermistor.

III.6.3 Cell: Biochemical and Molecular perspective

CO1. Molecular interactions

CO2. Enzyme kinetics

CO3. Bioenergetics and Metabolism

CO4. Energy transduction in the living organisms (photosynthesis and respiration)

CO5. Cell organelles

CO6. Cell membrane and extracellular matrix

CO7. Cytoskeleton and membrane trafficking

CO8. Cell division and checkpoints

CO9. Cell signaling

CO10. Origin of eukaryotes: hypothesis

SEMESTER IV

IV.1 Does Nature play dice?: The amazing world of probability and statistics.

CO1. Probability space

CO2. Conditional probability

CO3. Bayes theorem

CO4. Independence

CO5. Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments)

CO6. Random variables

CO7. Joint distributions

CO8. Discrete distributions (Bernaulli, Binomial, Poisson) and their properties (Expectation, variance, conditional expectation, moments)

CO9. Continuous distributions (Uniform, Normal, Exponential) with their properties (Expectation, variance, conditional expectation, moments)

CO10. Joint, marginal and conditional distributions

CO11. Weak and strong law of large numbers

CO12. Central limit theorem

CO13. Sampling distributions

CO14. Hypothesis testing, interval estimation

CO15. Likelihood, analysis of categorical data

CO16. Curve fitting

CO17. linear regression, Correlation

CO18. Test statistic and their significance

CO19. Introduction to basic syntax of R for arithmetic operations, creating arrays and matrices

CO20. Getting data into R and basic data analysis in R

CO21. Statistical computations in R (evaluation of density functions and distribution functions, computation of descriptive measures for given data)

CO22. Data visualization in R

IV.2 Understanding Computing Systems Architecture

CO1. Computing Systems, Models & Logic

CO2. Organization & Architecture of Memory

CO3. CPU, I/O Devices

CO4. Distributed Computing

CO5. Parallel Architecture

CO6. Mobile Systems Architecture

CO7. Logic Gate Designs

CO8. Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)

CO9. Hands on experiments with Arduino/ARM Interface

CO10. Programming & interfacing with Sensors

CO11. Parallel Programming using OPENMP, OpenMPI & CUDA

CO12. Programming on HPC Interfaces

IV.3 Software Engineering

CO1. Introduction

CO2. Software Lifecycle

CO3. Software Design Patterns

CO4. Development

CO5. Costing

CO6. Planning & Monitoring

CO7. Quality

CO8. Maintenance

CO9. Migration of Software Engineering to Latest Technology Trends

CO10. Software Architecture - CASE

IV.4 Science, Philosophy, Truth: Impact of technology

CO1. Philosophy of Science

CO2. Methodology of Science

CO3. Science as a pursuit of truth:

CO4. Theory of falsification by Karl Popper and theory of paradigm shift by Thomas Kuhn

CO5. Evolution of science driven technology and technology driven science

CO6. Exploring scales

CO7. Science & Ethics - This course will also engage social ethics in response to its impact on the developing technologies of global societies. We will explore the idea that traditional concepts of ethics insist that people in social relationships be treated as ends, in and of themselves, and never as means to the ends of others. Since all technologies evolve from our social relationships, no technology is value-free. Because of the value-laden nature of technological developments, new technologies are characteristically defined as both socially-determinative and socially derived.

IV.5.1 Understanding Economic Behaviour: The macro level.

CO1. GDP Measurement Techniques

CO2. Classical and Keynesian Theories

CO3. Macroeconomic Equilibrium

CO4. Labor market, product market,

CO5. Full Employment

CO6. Aggregate Expenditure Model

CO7. Role of money and the Government

CO8. Monetary and Fiscal Policy

CO9. The multiplier effect, Inflation, Exploring the macroeconomics of an open Economy: international Economics;

CO10. Balance of Payments.

CO11. The current and capital account

CO12. Determining equilibrium output in an open economy

CO13. Open economy with flexible exchange rates

CO14. Markets for foreign exchange

CO15. Factors affecting exchange rates

CO16. Effects of exchange rates on the economy.

IV.5.2 Digital electronics and logic design.

CO1. Boolean algebra

CO2. Logic Gates

CO3. CMOS circuits

CO4. PLA

CO5. Digital IC families

CO6. Combinatorial circuits

CO7. Sequential circuits

CO8. MSI and PLD components

CO9. ADC

CO10. DAC

CO11. Semiconductor memories

CO12. Microprocessor

CO13. Assembly Language

CO14. I/O Interfacing

CO15. Data Transfer Techniques

CO16. Finite State Machine

CO17. Firmware design.

IV.5.3 Genes to Genomes.

CO1. Mendelian and non-Mendelian inheritance

CO2. Gene interaction

CO3. Epistasis

CO4. Linkage and recombination

CO5. Population genetics and diseases

CO6. Genomes (Characteristics, Genome mapping techniques, Genome evolution)

CO7. Epigenetics

CO8. Transposable elements

CO9. Coding and non-coding RNA.

CO10. Gene expression.

IV.6.1 Bringing Companies and clients together: Sales & Marketing management.

CO1. Concepts

CO2. Strategies

CO3. Marketing Mix

CO4. Buyer Behavior Models

CO5. Marketing Research and trends in Marketing

CO6. Advertising and Branding

CO7. E-Business Marketing

CO8. IT-Enabled capabilities that influence marketing strategies

IV.6.2 Digital electronics and logic design

CO1. Realization of logic gates through diodes and resistors

CO2. Verification of Boolean algebraic functions through digital IC gates

CO3. Design of half/full adder and sub tractor circuits

CO4. Design of shift registers using flip-flops

CO5. Circuit design and simulation software and EDA

IV.6.3 Flow of information in living systems

CO1. Nature of genetic material

CO2. Process of information transfer (Replication, Transcription and translation machinery)

CO3. Energetics and accuracy of information transfer

CO4. Problems of information transfer (DNA damage and repair)

CO5. Regulation of informational transfer (transcription factors, operon)

CO6. DNA packaging and chromatin structure.

CO7. Agarose Gel Electrophoresis

CO8. SDS-PAGE Electrophoresis

CO9. Polymerase Chain Reaction (PCR)

CO10. Primer design

CO11. Spectrometry

CO12. Analysis of growth curve, molar extinction coefficient, absorption maxima

CO13. Biochemical assays

CO14. Restriction digestion

CO15. Introductory Gene Cloning (Transformation to Ligation).

SEMESTER V

CO1. Solving Nonlinear Equations

CO2. Graphical method

CO3. Bracketing and Non-bracketing approach

CO4. Bisection, Method of false position, Iterative method, Newton-Raphson method and Secant method

CO5. Errors and rate of convergence

CO6. Matrix notation of a system of linear equations

CO7. Gaussian elimination and Gauss-seidel method

CO8. Pivoting

CO9. Row-echelon form - LU factorization

CO10. Cholesky's method

CO11. Ill-conditioning

CO12. Norms

CO13. Solution of a system of nonlinear equations

CO14. Polynomial interpolation

CO15. Forward, Backward and Divided differences

CO16. Piecewise linear and Cubic Spline interpolation

CO17. Errors in interpolation

CO18. Newton-Cotes Integration Formula

CO19. Trapezoidal and Simpson's rules

CO20. Gaussian quadrature

CO21. Error formulae

CO22. Euler, Modified Euler and Runge-Kutta methods for solution of differential equations

CO23. Power method, QR method, Gershgorin's theorem for Eigen Value problems

CO24. Writing C/C++ programs for finding root of the equations using Bisection, Newton-Raphson, Iterative and Secant methods

CO25. Writing C/C++ programs for solving system of linear equations

CO26. Writing C/C++ programs for interpolation, forward, backward and divided difference

CO27. Writing C/C++ programs for methods of numerical integration

CO28. Writing C/C++ programs for Euler and Runge-Kutta methods

V.2 Information exchange in computing devices: Data Communication & Networking

CO1. Communication Channels

CO2. Topologies

CO3. Networking Applications

CO4. Layered Architecture & Models

CO5. Network Devices

CO6. Error Management

CO7. Network Protocols

CO8. Network Security & Cryptography

CO9. Network Architectures of Enterprise Applications

CO10. Hands on experiment with Network Topologies on LAN/WAN – Wired & Wireless

CO11. Hands on Experiments with Routing Mechanism in Internet and Intranet

CO12. Setting up TCP/UDP applications on Network Devices

CO13. Socket Programming

CO14. Use of Wire shark for Packet Analysis

CO15. Study Security protocols & certificates

CO16. Study of Streaming Applications and Protocols

CO17. Design of Web/Server Based Applications

CO18. Reverse Engineering the Network Protocols

V.3 Computer and Brain: Knowledge Discovery and Artificial Intelligence

CO1. Data driven reasoning and learning models

CO2. Classification

CO3. Statistical inferences

CO4. Knowledge representation

CO5. Role of knowledge in language understanding and analysis

CO6. Context awareness

CO7. Neural networks

CO8. Genetic Algorithms

CO9. Expert systems

V.4 History, culture & civilization.

CO1. The module has to be taught through projects and case studies by adopting information analysis

CO2. Mathematical and technological insights associated with History, Culture and Civilization

CO3. Rebooting history and historical thoughts through technology, math and science perspective

CO4. Pre – Internet and Post - Internet analysis of civilization and culture demonstrated through case studies, Spatio-temporal aspects of culture and civilization.

V.5.1 Maximizing performance: Human Resource management and Organizational\ Behavior.

CO1. Evolution of the concept of HRM

CO2. HR policies, functions and roles

CO3. Leadership

CO4. Recruitment

CO5. Performance & potential appraisal

CO6. Statutory laws

CO7. Individual & Group Behavior

CO8. Leadership & power

CO9. Dynamics of Organizational Behavior

CO10. Human resource information system.

V.5.2 Embedded systems studio – I

CO1. Microcontroller and Microprocessor

CO2. Introduction to RTOS, VHDL, FPGA

CO3. Embedded system development (Memory, Interfaces, Peripheral devices, Sensors)

CO4. Networking for embedded systems

CO5. Introduction to robotics and control

CO6. Actuators and Drives

CO7. Kinematics and motion control

CO8. Sensors and Navigation

CO9. Internet of Things

CO10. Design and rapid prototyping of embedded system using FPGA

CO11. VHDL and RTOS implementation

CO12. Study and implementation of networking protocols

CO13. Networking using Internet of Things

CO14. Design and fabrication of robots

V.5.3 Biological Networks: from Micro to Macro niche.

CO1. Inter and intra-cellular networks

CO2. Signal transduction in prokaryotes

CO3. Metabolic network

CO4. Neurological networks

CO5. Regulatory pathway and components

CO6. Blood

CO7. Secretion systems in prokaryotes and eukaryotes

CO8. Ecosystem dynamics and sustainability

CO9. Tree of life and macroevolution.

V.6.1 Efficient manufacturing process: Production and Operations Management

CO1. Concept

CO2. Operations strategy

CO3. Management of Quality

CO4. Statistical Process Control,

CO5. Capability analysis and six sigma approach

CO6. Cconcept and framework of Total quality management system

CO7. Elements and objective of supply chain management

CO8. Inventory management: models and applications,

CO9. Evaluation and Selection of appropriate Production and Operations technology,

CO10. Computer Integrated Manufacturing Systems

CO11. Case study discussion on the company's productivity problem from the viewpoints of classical and modern organization theories and linking it with the real life problem

CO12. Case study discussion on the development of new production techniques which is being practiced in different sectors

CO13. Creating live models which could be tested and used in companies linking mathematical models with the production techniques and strategies.

V.6.2 Signals & Systems Engineering.

CO1. Discrete-time systems

CO2. Continuous-time systems

CO3. Laplace transforms

CO4. Z transforms

CO5. Convolution

CO6. Frequency response

CO7. Fourier series and transform

CO8. Feedback

CO9. Sampling

CO10. Modulation

CO11. Filters design techniques CO12. Study of Convolution types.

CO13. Computation of DFT & IDFT using DSP Processors

CO14. FIR & IIR Filter Implementation using the DSP Processors

CO15. MATLAB implementation of different signal types

CO16. Sampling theorem and reconstruction of signal from its samples using natural sampling

V.6.3 Applied Genomics and Proteomics: Methods and techniques.

CO1. Recombinant DNA technology

CO2. Artificial chromosome

CO3. PCR and its types

CO4. DNA and Protein sequencing

CO5. Microarray

CO6. MALDI – RAPD – RFLP – *in situ* hybridization

CO7. Site-directed mutagenesis

CO8. Gene transfer and gene therapy

CO9. Electrophoresis

CO10. Spectrometry

CO11. X-ray crystallography

CO12. NMR

CO13. Genomic and cDNA library

CO14. Two hybrid systems

CO15. Plant and Mammalian tissue culture

CO16. Agarose Gel Electrophoresis

CO17. SDS-PAGE Electrophoresis

CO18. Polymerase Chain Reaction (PCR)

CO19. Primer design

CO20. Spectrometry

CO21. Analysis of growth curve, molar extinction coefficient, absorption maxima

CO22. Biochemical assays

CO23. Restriction digestion

CO24. Introductory Gene Cloning (Transformation to Ligation).

SEMESTER –VI

VI.1 Linear Construction of Actions: Engineering through Linear Programming and Game Theory

CO1. Formulation of Linear Programming Models
CO2. Theory of simplex method

CO3. Optimality and unboundedness

CO4. The simplex algorithm

CO5. Simplex method in tableau format

CO6. Computational efficiency of the technique

CO7. Introduction to artificial variables

CO8. Two-phase method, Big-M method and their comparison

CO9. Formulation of the dual problem

CO10. Primal-dual relationships

CO11. Economic interpretation of the dual

CO12. Introduction to Post optimality analysis

CO13. Dual Simplex Method and its application

CO14. Formulation of the Transportation problem

CO15. Algorithm for solving transportation problem

CO16. Northwest - corner method, least cost method and Vogel approximation method for determining the starting basic solution

CO17. Assignment problem and its mathematical formulation

CO18. Hungarian method for solving assignment problem

CO19. Formulation of two person zero sum games

CO20. Solving two person zero sum games

CO21. Games with mixed strategies

CO22. Graphical solution procedure

CO23. Linear programming solution of games.

VI.2 Computer Graphics and Visualization Architecture

CO1. Display devices

CO2. Transformation algorithms

CO3. Ray Tracing and shading

CO4. Camera and image formation

CO5. Computer and machine vision

CO6. Object recognition and processing

CO7. Motion analysis

CO8. 2D and 3D transformation modeling

CO9. Concept of Animations and Motion Pictures

CO10. Smart Interfaces

CO11. Virtual Augmentation applications in security, medicine and manufacturing

CO12. Indexing and retrieval of video databases

VI.3 Advanced Algorithm Design.

CO1. Advanced data structure

CO2. Geometric algorithms

CO3. Graph algorithms

CO4. Linear Programming

CO5. Search heuristics

CO6. Approximation algorithms

CO7. Compression and streaming algorithms

VI.4 Art & Design.

CO1. Exercises in design to understand principles of design

CO2. Distribution of space

CO3. Language of proportion and the process of form synthesis

CO4. Introduction to orthographic projections in simple positions

CO5. Drawing of plan, elevation and section of simple objects to scale, full size, reduced or enlarged

CO6. User interface and user experience design elements

CO7. Affective Computing in Interface Designs

VI.5.1 Handling money: Finance management.

CO1. Basic Concepts of Finance

CO2. Investment decisions

CO3. Financing and dividend decision

CO4. Working capital management

CO5. Long term sources of finance

CO6. Strategic financing decisions

CO7. Online Financial Management

CO8. Global financial information using Information Technology.

VI.5.2 Embedded systems studio – II.

CO1. VHDL Language

CO2. Concurrent and Sequential Assignment

CO3. Hardware specification

CO4. FPGA Architecture

CO5. Design of advanced robotic systems and embedded devices for varied applications

CO6. Virtual Reality and Computer Vision

VI.5.3 Biodefense and Bioengineering

CO1. Emerging pathogens and host

CO2. Pathogen interactions

CO3. Autoimmune diseases

CO4. Receptor Biology

CO5. Cancer and Tuberculosis

CO6. Antigen processing

CO7. Antibody synthesis and secretion

CO8. Viruses and Bacteria

CO9. Microbial growth kinetics

CO10. Secondary metabolites in plants

CO11. Innate immunity in insects and plants

CO12. Toll Receptors.

CO13. Engineered single chain antibody

VI.6.1 Business: Organization and Strategy.

CO1. Foundation of e-business and e-commerce

CO2. Organizational models

CO3. Role of Information Systems in Business

CO4. Various approaches in ICT Systems

CO5. Emerging models in e-business

CO6. E-business and organizational changes

CO7. Productivity and industries transformations

CO8. Perspectives and requirements for starting online business

CO9. Processes associated with managing website development ICT in B2B: Business models

CO10. Revenues and sources

CO11. Performance trends

CO12. Business and organization management

CO13. Internet Marketing and e-Tailing.

CO14. Case study discussion on real life cases of the companies that exploited the competitive advantage of IT to leverage their growth and expansion.

CO15. Management quiz on the recent updates of the happenings in the e-business market scenario

CO16. Case study discussion on the development of new e-business which emerged out of market space and other concepts.

VI.6.2 Control Systems.

CO1. Basic concept

CO2. Classification and modeling of control systems

CO3. Time and Frequency domain analysis

CO4. Root locus and State variable techniques

CO5. Non - linear analysis

CO6. Feedback

CO7. Design of control systems

CO8. Designing the model of a DC motor

CO9. Design of controllers for speed and position control

CO10. Compensator design

CO11. State space model design

CO12. Design of temperature controller.

VI.6.3 I*n silico* Biology.

CO1. Sequence analysis and alignment

CO2. Promoter domains and motifs

CO3. Scoring matrices

CO4. Biological databases and data-mining

CO5. Phylogeny and cladistics

CO6. Structure analysis

CO7. Molecular modelling and simulations

CO8. Bio-statistics

CO9. Stochastic models

CO10. Algorithm and programming language.

CO11. Sequence analysis (BLAST, FASTA).

CO12. Database (NCBI, DDBJ, EMBL).

CO13. Motif and Promoter searches (e.g. CD-Search, SMART, SignalP).

CO14. Phylogenetic analysis (PHYLIP, MEGA).

CO15. Protein interaction (STRING, BioGRID).

CO16. Protein structure, Function (PROSITE programs, Chimera.

CO17. Gene expression, function (GEA, Gene card, OMIM).

SEMESTER –VII

VII.1 Fluidity in nature: computational interpretations

CO1. Polar, spherical, cylindrical, Moving and Rotating coordinate systems.

CO2. Generalised coordinates

CO3. Basic equations of fluid dynamics

CO4. Conservation of mass, momentum and energy

CO5. Mathematical nature of the flow equations and their boundary conditions

CO6. Numerical solution of Navier-Stokes equationsCO7.

CO8. Finite difference method - Its application over first order and second order differential equations - Shortcomings of finite difference method - Weak forms of the differential equations -Finite element method Its shape functions over one dimensional and two-dimensional geometries

CO9. Assembly of stiffness matrices over all the elements

CO10. Solution of assembled system of equations after applying boundary conditions

CO11. Shortcomings of Finite element method

VII.2. Computer Language Design & Engineering.

CO1. Function and structure of compilers

CO2. Lexical analyzer

CO3. Tokens

CO4. Parsing

CO5. Type system

CO6. Run time environment

CO7. Code generation and optimization

VII.3 Software Project Management.

CO1. Software Design

CO2. Project management

CO3. Software Management Process Framework

CO4. Quality (CMMI) & Risk Management

CO5. Evaluation & Forecasting

CO6. Present Frameworks and Strategies

CO7. Analysis of a desktop/enterprise Software Applications under lens of software design fundamentals

CO8. Requirement gathering, verification and specification of a new Software Project

CO9. Creating Prototypes and outlines of problems in the frame of Software engineering aligned with design methodologies

CO10. Reverse engineering any Open Source Software Project and identify Software management aspects

CO11. Software Projects sign off with Project Charter and management of project plans

CO12. Hands on Experiment on Requirement Management, Deliverable attributes of Software projects

CO13. Design a Software Application, Product, and Service and integrate with existing systems

CO14. Estimation of Costing of Software, Time sheet management in estimation of Effort, Resource Management

CO15. Design of User Guides, Software Manuals, Update Documentation, Release Guides, Deployment Guides, FAQs

CO16. Basic Understanding on use of Agile & Scrum.

VII.4 Visual arts & aesthetics.

CO1. Introduction to media art, computer art, digital art and interactive art

CO2. Aesthetic strategies in processual art

CO3. Art, technology and society

CO4. Interaction as aesthetic experience

CO5. Aesthetic of interaction in digital art

CO6. Aesthetic and new media

CO7. Interpreting visualizations : : Visualizing interpretations - Case studies

VII.5.1 Environment Management.

CO1. Identification and evaluation of the environmental impacts of ganization/product/service

CO2. Management of the environmental impacts of an organization, environmental auditing and environmental management systems

CO3. Environmental management tools and techniques of sustainable development

CO4. Eco system Modeling, Environmental Information System.

VII.5.2 Engineering at Molecular Scale: Devices and Nanotechnology.

CO1. Optical devices, electronic devices, liquid crystal and magnetic devices and their functionality

CO2. Spintronic devices (including spin valves and MRAM devices)

CO3. Nanoscale semiconductor electronic devices

CO4. CMOS at sub-15nm gate length, III-V and wide-bandgap devices

CO5. Spintronic devices (including spin valves and MRAM devices)

CO6. Devices for quantum computing -Nanoscale photonic devices

CO7. Basic properties of liquid crystals

CO8. Molecular properties of the organic materials and their use in current production and research level electronic devices

VII.5.3 Modeling and Simulating Brain Functions: Computational Neuroscience

CO1. Introduction to Neurobiology

CO2. Integrative Physiology (whole organism and population)

CO3. Cognitive and neural modelling

CO4. Single Neuron Model

CO5. Neural models (vision, memory function, rhythm)

CO6. Synapse and networks

CO7. Neural plasticity and computational learning

CO8. Neural coding

CO9. Artificial intelligence

CO10. Neural imaging.

VII.6.1 Business automation strategies. ERP. Case studies and project in industry.

CO1. Business Process modeling, Process Metrics.

CO2. Overview of Enterprise systems and Business Processes.

CO3. Identify and understand the functionalities in an ERP system, issues of ERP architecture, design development.

CO4. Performance & Capabilities Gaps.

CO5. Business Process mapping & redesign.

CO6. Advanced ERP modules.

CO7. Industry specific case study.

CO8. Project implementation.

VII.6.2 Circuit Analysis and Synthesis

CO1. Basic circuits analysis

CO2. Ohm's Law - Kirchoffs laws

CO3. DC and AC Circuits

CO4. Resistors in series and parallel circuits

CO5. Mesh current and node voltage method of analysis for D.C and A.C. circuits

CO6. Phasor Diagram

CO7. Power, Power Factor and Energy

CO8. Network reduction and network theorems for dc and ac circuits

CO9. Voltage and current division, source transformation

CO10. Star delta conversion

CO11. Thevenins and Nortons Theorem

CO12. Superposition Theorem

CO13. Maximum power transfer theorem

CO14. Reciprocity Theorem

CO15. Resonance and coupled circuits

CO16. Series, parallel resonance and their frequency response

CO17. Quality factor and Bandwidth

CO18. Self and mutual inductance

CO19. Coefficient of coupling

CO20. Tuned circuits.

CO21. Single tuned circuits

CO22. Transient response for DC circuits

CO23. Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input

CO24. Characterization of two port networks in terms of Z,Y and h parameters

CO25. Three phase circuits -Three phase balanced / unbalanced voltage sources - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - Phasor diagram of voltages and currents - power and power factor measurements in three phase circuits

CO26. Verification of nodal voltage and mesh current methods for solving circuits.

CO27. Verification of important network theorems.

CO28. Study of the response of the first order R-C and R-L circuits

CO29. Study of the response of a series and a parallel RLC circuits

VII.6.3 Systems Biology

CO1. Biological complexity

CO2. Biological circuits

CO3. Thermodynamics

CO4. Bio-physical properties of macromolecules

CO5. Bio-molecular interaction analysis

CO6. Developmental biology

CO7. Data integration and hypothesis generation

CO8. Reversible reactions and feedback loops

CO9. Transient networks

CO10. Behavioral network

CO11. Instinct and Learning

CO12. Gene Regulation/interaction networks models and software (KEGG, CYTOSCAPE). Intercellular signaling network and softwares

CO13. Biochemical & thermodynamics properties of Protein – Protein Modeling software.

CO14. Large scale data analysis (high-throughput).

CO15. Molecular markers.

CO16. Deriving mathematical equations from biological phenomenon