GURU KASHI UNIVERSITY

B. Voc.in – Robotics & Artificial Intelligence

Session: 2024-25

Department of Computer Science & Engineering

Programme Structure

Semester: I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR101	Programming for Problem Solving	Skill Based	4	0	0	4
BVR102	Programming for Problem Solving Lab	Compulsory Foundation	0	0	4	2
BVR103	Mathematics-I	Compulsory Foundation	4	0	0	4
BVR104	Communication Skills	Skill Based	4	0	0	4
BVR105	Communication Skills Lab	Compulsory Foundation	0	0	2	1
BVR106	Basics of Robotics & Artificial Intelligence and Machine Learning	Skill Based	4	0	0	4
BVR107	Fundamental of Computer and Information Technology Lab	Skill Based	0	0	2	1
Total			**16**	**0**	**08**	**20**

Semester: II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR201	Mathematics-II	Compulsory Foundation	4	0	0	4
BVR202	Object Oriented Programming Using C++	Skill based	3	0	0	3
BVR203	Web Technology	Skill based	3	0	0	3
BVR204	Data Structure & Algorithms	Compulsory Foundation	4	0	0	4
BVR205	Digital Electronics	Skill based	4	0	0	4
BVR206	Web Technology Lab	Skill based	0	0	2	1
BVR207	Object Oriented Programming Using C++ Lab	Skill based	0	0	2	1
Value Added Course						
BVR208	Environmental Science	VAC	2	0	0	2
Total			**20**	**0**	**4**	**22**

Semester: III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR301	Discrete Mathematics	Core	4	0	0	4
BVR302	Operating System	Core	4	0	0	4
BVR303	Design & Analysis of Algorithms	Core	4	0	0	4
BVR304	Computer Organization & Architecture	Core	4	0	0	4
BVR305	Operating System Lab	Skill based	0	0	4	2
BVR306	Design & Analysis of Algorithms Lab	Skill based	0	0	4	2
Elective-I(Any one of the following)						
BVR307	Data ware housing & Data Mining	Discipline Elective-I	**3**	**0**	**0**	**3**
BVR308	Big Data					
Open Elective – I(Open Elective Courses for other Departments)						
BVR309	Introduction to Artificial Intelligence & Machine Learning	Open Elective Course	2	0	0	2
Total			**21**	**0**	**8**	**25**

Semester: IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR401	Introduction to Machine Learning with Python	Core	4	0	0	4
BVR402	Java Programming	Core	4	0	0	4
BVR403	Relational Database Management System	Core	4	0	0	4
BVR404	Introduction to Robotics	Core	4	0	0	4
BVR405	Relational Database Management System Lab	Skill based	0	0	2	1
BVR406	Introduction to Machine Learning with Python Lab	Skill based	0	0	4	2
BVR407	Java Programming Lab	Skill based	0	0	2	1
BVR499	xxx	MOOC	-	-	-	3
Discipline Elective-II(Any one of the following)						
BVR408	Mobile Robots	Discipline Elective-II	3	0	0	3
BVR409	IoT and Automation					
Total			**19**	**0**	**8**	**23**

Semester: V						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR501	Formal Language & Automata Theory	Core	4	0	0	4
BVR502	Computer Networks	Core	4	0	0	4
BVR503	Deep learning	Core	4	0	0	4
BVR504	Deep Learning Lab	Skill based	0	0	4	2
BVR505	Project-1	Skill based	0	0	4	2
BVR506	Optimization Techniques in AI& ML	Core	4	0	0	4
BVR599	xxx	MOOC	0	0	0	3
Elective-III(Any one of the following)						
BVR507	Cognitive Robotics	Discipline Elective-II	3	0	0	3
BVR508	Cyber Ethics in AI					
Total			**19**	**0**	**8**	**26**

Semester: VI						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credits**
BVR601	Speech and Language Processing	Core	4	0	0	4
BVR602	Autonomous Drones	Core	4	0	0	4
BVR603	Data and Visual analytics in AI	Core	4	0	0	4
BVR604	Game Programming using AI	Skill based	4	0	0	4
BVR605	Project-II	Skill based	0	0	4	2
BVR606	Advanced Machine Learning Lab	Skill based	0	0	4	2
BVR699	xxx	MOOC	_	_	_	3
Elective-IV(Any one of the following)						
BVR607	Graph Theory Algorithms for Robotics	Discipline Elective-IV	3	0	0	3
BVR608	Robot Operating System					
Value Added Courses						
BVR609	Personality Development programme	VAC	2	0	0	2
Total			**21**	**0**	**8**	**28**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]
   CA1-Surprise Test (Two best out of Three) - (10 Marks)
   CA2-Assignment(s) (10 Marks)
   CA3-Term Paper/Quiz/Presentations (05 Marks)
B. Attendance: [05 marks]
C. Mid Semester Test: [30 Marks]
D. End-Term Exam: [40 Marks]

Evaluation Criteria for Practical Courses: Performance of each practical-(10 Marks), Report- (5 Marks)

Practical Viva – (5 Marks)
Total - (20 Marks) (Each Practical)

SEMESTER-I

Course Title: PROGRAMMING FOR PROBLEM SOLVING

Course Code: BVR101

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design the algorithms to write programs.
2. Illustrate arrays, pointers and structures to formulate algorithms and programs
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
4. Implement conditional branching, iteration and recursion.

Course Content

UNIT I **15 Hours**

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory Locations, Syntax and Logical Errors in compilation, object and executable code-

UNIT II **15 Hours**

Arithmetic expressions and precedence: Conditional Branching and Loops Writing and evaluation of conditionals and consequent branching

Iteration and loops

Arrays: Arrays (1-D, 2-D), Character arrays and Strings

Basic Algorithms: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of Equations, notion of order of complexity through example programs (no formal definition requirement.

UNIT III **15 Hours**

Function: Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference.

Recursion: Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT IV **15 Hours**

Structure: Structures, Defining structures and Array of Structures

Pointers: Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

File handling (only if time is available, otherwise should be done as part of the lab.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Byron Gottfried, Schaum's (1995), Outline of Programming with C, McGraw-Hill.*
- *E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill.*

Course Title: PROGRAMMING FOR PROBLEM SOLVING LAB

Course Code: BVR102

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Create read and write to and from simple text files.
2. Identify and correct logical errors encountered at run time
3. Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.
4. Represent data in arrays, strings and structures and manipulate them through a program

Course Content

1. Problem solving using computers
2. Familiarization with programming Environment
3. Variable types and type conversions
4. Simple computational problems using arithmetic expressions
5. Branching and logical expressions
6. Problems involving if-then-else structures
7. Loops, while and for loops
8. Iterative problems e.g., sum of series
9. 1D Arrays: searching, sorting
10. 1DArray manipulation
11. 2D arrays and Strings, memory structure
12. Matrix problems, String operations
13. Functions, call by value
14. Simple functions
15. Numerical methods (Root finding, numerical differentiation, numerical integration)
16. Numerical methods problems
17. Recursion, structure of recursive calls
18. Recursive functions
19. Pointers, structures and dynamic memory allocation
20. Pointers and structures
21. File handling
22. File operations

Course Title: MATHEMATICS-I
Course Code: BVR103

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. Classify of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. Illustrate the Tool of power series and Fourier series for learning advanced Engineering Mathematics.
4. Use of functions of several variables that is essential in most branches of engineering and tools of matrices and linear algebra in a comprehensive manner.

Course Content

UNIT I **15 Hours**

Calculus: Evaluates and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Rolle 's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and Hospital's rule; Maxima and minima.

Advanced Calculus: Differentiation: Limit continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Integration: Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

UNIT II **15 Hours**

Trigonometry: Hyperbolic and circular functions, logarithms of complex number resolving real and imaginary parts of a complex quantity, De Moivre's Theorem.

Theory of equations: Relation between roots and coefficients, reciprocal Equations, transformation of equations and diminishing the roots.

UNIT III **15 Hours**

Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

UNIT IV **15 Hours**

Algebra: Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank- nullity theorem, composition of linear maps, Matrix associated with a linear map.

Eigen values, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Thomas, G. B. (1992). Calculus and analytic geometry. Massachusetts Institute of Technology, Massachusetts, USA, Addison-Wesley Publishing Company, ISBN: 0-201-60700-X.*
- *UNIT, I. 16MA101 ENGINEERING MATHEMATICS-I LTPC. SNS COLLEGE OF TECHNOLOGY, 7, 19.*
- *Bali, N. P., & Goyal, M. (2010). A Textbook of Engineering Mathematics (PTU, Jalandhar) Sem-III/IV. Laxmi publications.*
- *PO, P. Edition, New Delhi, 2012. 6. Ramana BV, "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010. DEPARTMENT OF INSTRUMENTATION ENGINEERING ANNA UNIVERSITY, CHENNAI, 24.*

Course Title: COMMUNICATION SKILLS

Course Code: BVR104

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Develop vocabulary and improve the accuracy in Grammar.
2. Apply the concepts of accurate English while writing and become equally ease at using good vocabulary and language skills.
3. Develop and Expand writing skills through Controlled and guided activities.
4. Compose articles and compositions in English.

Course Content

UNIT I **15 Hours**

Vocabulary Building: The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

UNIT II **15 Hours**

Basic Writing Skills: Sentence Structures, use of phrases and clauses in sentences, Importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents, Techniques for writing precisely.

UNIT III **15 Hours**

Identifying Common Errors in Writing: Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Cliché

UNIT IV **15 Hours**

Nature and Style of Sensible Writing: Describing, Defining, Classifying, providing examples or evidence, writing introduction and conclusion

Writing Practices: Comprehension, Précis Writing, Essay Writing.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Swan, Michael. (1995). Practical English. OUP.*
- *Wood, F.T. (2007). Remedial English Grammar. Macmillan.*
- *Zinsser, W. (2001). On Writing Well. Harper Resource Book.*
- *Lyons, L. H. &Heasly, B. (2006). Study Writing. Cambridge University Press.*
- *Kumar, S &Lata, P. (2011). Communication Skills. Oxford University Press.*

Course Title: COMMUNICATION SKILLS LAB

Course Code: BVR105

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Illustrate the importance of pronunciation and apply the same day to day conversation.
2. Apply verbal and non-verbal communication techniques in the Professional Environment.
3. Develop coherence, cohesion and competence in Oral discourse.
4. Evaluate the interview process confidently.

Course Content

Oral Communication

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Course Title: BASICS OF ROBOTICS & ARTIFICIAL INTELLIGENCE and MACHINE LEARNING

Course Code: BVR106

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the concept of expert system using Machine Learning and Implement various machine learning models in robotics.
2. Design expert system by using AI tools and develop Intelligent system with the help of Neural Networks.
3. Create an expert system using Fuzzy Logic and game playing concepts involving robotics and AI.
4. Apply robotics to create robot driven systems and co-relate robotics with AI and use in real-world applications

Course Content

UNIT I , 15 Hours

Introduction to Machine Learning: Machine Learning Vs Statistical Modelling, Supervised vs Unsupervised Learning, Supervised Learning Classification, Unsupervised Learning, Reinforcement Learning, Applications, Python libraries suitable for Machine Learning: Pandas, Numpy, Scikit-learn, visualization libraries: matplotlib etc.

Regression: Simple Linear Regression, Multiple Linear Regression, Non-linear Regression, Model Evaluation in Regression Models, Evaluation Metrics in Regression Models

UNIT II 10 Hours

Classification: Introduction to Classification, Multiclass Classification, Binary Class Classification.

Unsupervised Learning: Intro to Clustering, K-Means Clustering, Hierarchical Clustering, Density-Based Clustering, Content-based recommender systems, Collaborative Filtering.

UNIT III 18 Hours

Introduction: What is AI, Importance of AI, Early work in AI, Applications of AI, Knowledge and its definition. Knowledge Representation: Prepositional logic, FOPL,

Properties of Well-formed formulas, Conversion to Clausal form, Inference rules, Resolution principle.

Structured Knowledge: Introduction, Associate frame structures, Conceptual dependencies and scripts.

Intelligent System: Definition, Rule based architecture, dealing with uncertainty, uncertainty Principles, Knowledge acquisition and validation, knowledge system building tools.

Knowledge Acquisition: Types of learning, General Learning models, Performance measures. Learning nearest neighbor, naive Bayes, and decision tree classifiers, K-Nearest Neighbor, Decision Trees, Logistic Regression, Random Forest, Lasso Regression Support Vector Machines, Logistic regression vs Linear regression, Evaluation Metrics in Classification.

UNIT IV **17 Hours**

Introduction: Introduction to Robotics Fundamentals of Robotics, Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

Need of AI in Robotics: History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents.

Robotics fundamentals: Robot Classification, Robot Specification, notation, kinematic representations and transformations, dynamics techniques; trajectory planning and control.

Robotics and Its applications: DDD concept, Intelligent robots, Robot Anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple Problems-Specifications of Robot-Speed of Robot, Robot joints and Links-Robot Classifications-Architecture of robotic Systems-Robot Drive Systems-Hydraulic, Pneumatic and Electric system

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Patterson, D. (1990). Introduction to artificial intelligence and expert systems. Prentice-Hall, Inc.*
- *Jackson, P. C. (2019). Introduction to artificial intelligence. Courier Dover Publications.*
- *Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.*

- *Hastie, T., Tibshirani, R., & Wainwright, M. (2015). Statistical learning with sparsity. Monographs on statistics and applied probability, 143(143), 8.*
- *McKinnon, P. (2015). Robotics: everything you Need to know about robotics from beginner to expert. Peter McKinnon.*
- *Murphy, R. R. (2019). Introduction to AI robotics. MIT press.*
- *Govers, F. X. (2018). Artificial intelligence for robotics: Build intelligent robots that perform human tasks using AI techniques. Packt Publishing Ltd.*

Course Title: FUNDAMENTALS OF COMPUTER & INFORMATION Technology

Course Code: BVR107

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understanding the concept of input and output devices of Computers.
2. Study to use the Internet safely, legally, and responsibly.
3. Understand an operating system and its working, and solve common problems related to operating systems.
4. Learn basic word processing, Spreadsheet and Presentation Graphics Software skills.

Course Content

1. Various Components of a Computer.
2. Introduction to Microsoft Word & Presentation.
3. Make a simple presentation on your college.
4. Use of 3D effects, on prescribed presentation.
5. Applications of MS-Office MS-Word.
6. MS-Excel.
7. MS-PowerPoint.
8. Create web pages for your college using different tags.
9. Web Browser and E- Mail.
10. Conversion of a word documents into PDF/ Image conversion using image file format.

Course Title: MATHEMATICS –II

Course Code: BVR201

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Demonstrate the methods of forming and solving Ordinary differential equations and solve linear differential equations with constant and variable coefficients
2. Explain the concept of differential equation and classifies the differential equations with respect to their order and linearity.
3. Solve first-order ordinary and exact differential equations and converts separable and homogeneous equations to exact differential equations by integrating factors.
4. Apply the method of undetermined coefficients to solve the non-homogeneous linear differential equations with constant coefficients.

Course Content

UNIT I **14 Hours**

First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

UNIT II **15 Hours**

Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT III **15 Hours**

Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

UNIT IV **16 Hours**

Transform Calculus: Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions.

Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of Integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method, Fourier transforms.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings:

- *Thomes, G.B.and Finney, R.L. (2010) Calculus and Analytic Geometry; Ninth Edition; Pearson Education*
- *Kreyszig, E. (1998) Advanced Engineering Mathematics; Eighth Edition, John Wiley and sons.*
- *Grewal, B.S. (1965) Higher Engineering Mathematics; Khanna Publishers, New Delhi.*
- *Babu Ram (2009) Advance Engineering Mathematics; First Edition; Pearson Education.*
- *Richard Courant and Fritz John (2012) Introduction to Calculus and Analysis, Volume II, V Springer Publica*

Course Title: OBJECT ORIENTED PROGRAMMING USING C++

Course Code: BVR202

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Describe the procedural and object-oriented paradigm with concepts of streams, classes, functions, data and objects.
2. Illustrate dynamic memory management techniques using pointers, constructors, destructors, etc.
3. Construct the concept of function overloading, operator overloading, virtual functions and polymorphism
4. Classify inheritance with the understanding of early and late binding, usage of exception handling and generic programming.

Course Content

UNIT I **10 Hours**

Object-Oriented Programming Concepts: Introduction, comparison between procedural programming paradigm and object-oriented programming paradigm, basic concepts of object-oriented programming — concepts of an object and a class, interface and implementation of a class, operations on objects, relationship among objects, abstraction, encapsulation, data hiding, inheritance, overloading, polymorphism, messaging.

UNIT II **15 Hours**

Standard Input/output: Concept of streams, hierarchy of console stream classes, input/output using overloaded operators >> and << and member functions of i/o stream classes, formatting output, formatting using ions class functions and flags, formatting using manipulators.

Classes and Objects: Specifying a class, creating class objects, accessing class members, access specifies, and static members, use of const keyword, friends of a class, empty classes, nested classes, local classes, abstract classes, container classes, bit fields and classes.

UNIT III **11 Hours**

Pointers and Dynamic Memory Management: Declaring and initializing pointers, accessing data through pointers, pointer arithmetic, memory allocation (static and dynamic), dynamic memory management using new and delete operators, pointer to an object, this pointer, pointer related problems - dangling/wild pointers, null pointer assignment, memory leak and allocation failures. Constructors/Destructors and

Operator Overloading and Type Conversion: Need for constructors and destructors, copy constructor, dynamic constructors, explicit constructors, destructors, constructors and destructors with static members, initialize lists. Overloading operators, rules for overloading operators, overloading of various operators, type conversion - basic type to class type, class type to basic type, class type to another class type

UNIT IV **9 Hours**

Inheritance and Virtual functions & Polymorphism: Introduction, defining derived classes, forms of inheritance, ambiguity in multiple and multipath inheritance, virtual base class, object slicing, overriding member functions, object composition and delegation, order of execution of constructors and destructors. Concept of binding - early binding and late binding, virtual functions, pure virtual functions, abstract classes, virtual destructors

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Lafore R. (1992). Object Oriented Programming in C++. WaiteGroup.*
- *BjarneStroustrup. (1985). The C++ Programming Language. AddisonWesley.*
- *Herbert Schildt. (1994). The Complete Reference to C++ Language. McGrawHill-Osborne.*
- *Lippman F. B. (1997). C++ Primer. AddisonWesle*

Course Title: WEB TECHNOLOGY

Course Code: BVR203

L	T	P	Credits
3	0	0	3

Learning Outcomes: After completion of this course, the learner will be able to:

1. History and development of the World Wide Web and associated technologies.
2. The client-server architecture of the World Wide Web and its communication protocol HTTP/HTTPS.
3. Formats and languages used in modern web-pages: HTML, XHTML, CSS, XSLT, JavaScript, DOM
4. Programming web pages with JavaScript/DOM (client) and Good design, universal design, multi-platform web applications

Course Content

UNIT I **9 Hours**

Introduction to Web Technologies: Web Fundamentals: Overview of the World Wide Web, client-server architecture, and HTTP/HTTPS protocols. Web Development Languages: Introduction to HTML, CSS, and JavaScript. Web Browsers and Servers: Functions and components of web browsers and web servers.

Web Standards and Accessibility: Importance of web standards (W3C) and practices for web accessibility.

UNIT II **10 Hours**

HTML and CSS: HTML Basics: Structure of HTML documents, common HTML tags, and attributes, HTML Forms: Creating forms, form elements, and validation,

CSS Basics: Introduction to CSS, selectors, properties, and values, Layout Techniques: Using CSS for layout design, including box model, flexbox, and grid layout.

UNIT III **15 Hours**

JavaScript and DOM Manipulation: JavaScript Basics: Variables, data types, operators, and control structures, Functions and Events: Defining functions, event handling, and DOM events, DOM Manipulation: Accessing and modifying the Document Object Model (DOM) using JavaScript, AJAX and Fetch API: Making asynchronous requests and handling responses using AJAX and the Fetch API.

UNIT IV **11 Hours**

Web Development Frameworks: Introduction to Web Frameworks: Overview of client-side and server-side frameworks, Client-Side Frameworks: Introduction to frameworks like React, Angular, or Vue.js., Server-Side Technologies: Basics of server-side frameworks such as Node.js, Express, or Django.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Jackson, J. C. (2006)*. Web Technologies. Pearson India.
- *Gopalan, N. P., & ADIKESAVAN, T. (2014*). Web Technology: A Developer's Perspective. PHI Learning Pvt. Ltd.
- *Allsopp, J. (2009).* Developing with web standards. New Riders.
- *Wilde, E. (2012).* Wilde's WWW: technical foundations of the World Wide Web. Springer Science & Business Media.

Course Title: DATA STRUCTURE & ALGORITHMS

Course Code: BVR204

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Describe how arrays, records, linked structures, stacks, queues, trees and graphs are represented in memory and used by algorithms
2. Design a program that use arrays, records, linked structures, stacks, queues and trees.
3. Develop knowledge of applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching and sorting of each data structure.
4. Classify the concept of recursion, give examples of its use, describe how it can be implemented using a stack

Course Content

UNIT I **15 Hours**

Introduction: Basic Terminologies, Elementary Data Organizations, Data Structure Operations insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.

UNIT II **15 Hours**

Stacks and ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queues: Simple Queue, Circular Queue, Priority Queue; Operations on each Types of Queues: Algorithms and their analysis.

Linked Lists: Singly linked lists, Representation in memory, Algorithms of several operations, Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, doubly linked list, operations on it and algorithmic analysis; Circular Linked Lists, all operations their algorithms and the complexity analysis.

UNIT III **15 Hours**

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree, definitions, algorithms and analysis.

UNIT IV **15 Hours**

Sorting and Hashing: Objective and properties of different sorting algorithms, Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Mark Allen Weiss. (1995). Algorithms, Data Structures, and Problem Solving with C++ Algorithms. Addison-Wesley.*
- *R. G Dromey (2006). How to Solve it by Computer. Pearson Education.*

Course Title: DIGITAL ELECTRONICS

Course Code: BVR205

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the used of fundamentals concepts and techniques in digital electronics
2. Examine the structure of various number systems and its application in digital design.
3. Analyze and design various combinational and sequential circuits.
4. Categorize a digital logic and apply it to solve real life problems.

Course Content

UNIT I **15 Hours**

Fundamentals of Digital Systems and logic families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples officiate, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lcs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

UNIT II **15 Hours**

Standard representation for logic functions: K-map representation and simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De- Multiplexer/Decoders, Adders, Sub-tractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

UNIT III **15 Hours**

Sequential circuits and systems :A 1-bit memory, the circuit properties of Bus table latch, the clocked SR flip flop, J- K-T and D- Types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, application counters, A/D and D/Converters

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, Specifications for D/A converters, examples of D/A converter lcs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope

A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converters

UNIT IV **15 Hours**

Semiconductor memories and Programmable logic devices: Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *R. P. Jain. (2009). Modern Digital Electronics. McGraw Hill Education.*
- *M. M. Mano. (2016). Digital logic and Computer design. Pearson Education India.*
- *A. Kumar. (2016). Fundamentals of Digital Circuits. Prentice Hall India.*

Course Title: WEB TECHNOLOGY LAB

Course Code: BVR206

L	T	P	Credits
0	0	2	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:

1. To gain the knowledge, usage and applicability of various scripting languages.
2. To attain the knowledge of connecting to a database and then by implementing simple projects.
3. To use various scripting approaches depending upon the time to complete, cost security and reliability of the software project.

Course Content

1. Advanced HTML & CSS: Create responsive web layouts using advanced HTML5 and CSS3features, including Flex box and CSS Grid.
2. JavaScript and Front-End Frameworks: Develop interactive web applications using modern JavaScript (ES6+) and front-end frameworks like React or Angular.
3. Server-Side Development: Build and integrate server-side applications using Node.js or another server-side technology, implementing RESTful APIs.
4. Database Integration: Design and connect web applications to databases using SQL or NoSQL databases, handling data storage and retrieval.

Course Title: OBJECT ORIENTED PROGRAMMING USING C++ LAB

Course Code: BVR207

L	T	P	Credits
0	0	2	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Develop solutions for a range of problems using objects and classes.
2. Implement the concept of constructors, destructors and operator overloading
3. Apply algorithmic problems including type casting,
4. Understand the concept of Inheritance and polymorphism.

Course Content

1. Program to show the of use cin, cout practical
2. Program to implement the operators
3. Program based on decision making statement (if else)
4. Program based on the loops (while, do while)
5. Program based on loops(for), switch statement
6. Program based on structures and enumerated data types
7. Program based functions, overloaded functions
8. Program to show usage of storage classes.
9. Program to show usage of function overloading, default arguments
10. Program to show usage of classes, objects
11. Program to show usage of constructors, destructors
12. Program to manipulate arrays and array of objects
13. Program to manipulate strings.
14. Program to show usage of inheritance of various type (multiple, multilevel etc.)
15. Program to show usage of unary operator overloading
16. Program to show usage of binary operator overloading
17. Program for conversion from basic to user defined data type
18. Program for conversion from user defined to basic
19. Program to show usage of basics of pointers
20. Program to show usage of pointers and arrays.
21. Program to show usage of pointers, function arguments
22. Program to show usage of new, delete, memory management
23. Program to show usage of virtual function
24. Program to show usage of friend, static function
25. Program to show usage of overloaded assignment operator, this pointer
26. Program to read & write contents of a text file

27. Program to show usage of file pointers.
28. Program to show usage of command line arguments
29. Program to show usage of overloading of right & left shift operators.
30. Program to show usage of exception handling mechanism
31. Program to show usage of uncaught exception (), the exception and bad exception classes
32. Program to show usage of templates
33. Program to show usage of generic classes
34. Implementation of File handling
35. Implementation of Wrapper classes
36. Implementation of container classes

Course Title: ENVIRONMENTAL SCIENCES
Course Code: BVR208

L	T	P	Credits
2	0	0	2

Total hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
2. Estimate the population - economic growth, energy requirement and demand
3. Analyze material balance for different environmental systems.
4. Realize the importance of ecosystem and biodiversity for maintaining ecological balance. Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Content

UNIT-I **5 Hours**

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

UNIT-II **10 Hours**

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity.

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: Floods, earthquake, cyclone and landslides.

UNIT-III **10 Hours**

Social Issues and the Environment from Unsustainable to Sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution)

Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

UNIT-IV **5 Hours**

Human Population and the Environment, Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Goyal, A. (2020) Environmental Studies. Notion Press, New Delhi.*
- *Kaur, N & Goyal, A. (2014) Disaster Management. PBS Education, Jalandhar.*
- *Agarwal, K. C.(1998) Environment Biology, Nidi Publ. Ltd. Bikaner.*
- *Jadhav, H & Bhosale, V.M. (2001) Environment Protection and Laws. Himalaya Pub House, Delhi*
- *Rao M. N. & Datta A.K.(1997) Waste Water Treatment. Oxford & IBH Publ. Co. Pvt. Ltd.*

Course Title: DISCRETE MATHEMATICS

L	T	P	Credits

Course Code: BVR301

4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Use mathematically correct terminology and notations
2. Construct correct direct and indirect proofs.
3. Use division into cases in a proof.
4. Analysis the counter examples.

Course Content

UNIT I **15 Hours**

Sets, Relation and Function: Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem.

Principles of Mathematical Induction: The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

UNIT II **15 Hours**

Basic counting techniques-inclusion and exclusion, pigeon-hole principle, permutation and combination. Propositional Logic: Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, The use of Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

UNIT III **15 Hours**

Algebraic Structures and Morphism: Algebraic Structures with one Binary Operation, Semi- Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. Boolean algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.

UNIT IV **15 Hours**

Graphs and Trees: Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Aurelian and Hamiltonian Walks, Graph Coloring, coloring maps and Planar Graphs, Coloring Vertices, Coloring Edges, List Coloring, Perfect Graph, definition properties and Example, rooted trees, trees and sorting, weighted trees and prefix codes, Bi- connected component and Articulation Points, Shortest distances.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *J.P. Tremblay and R. Manohar. (1997). Discrete Mathematical Structure and Its Application to Computer Science". TMG Edition,Tatamcgraw-Hill.*
- *Norman L. Biggs. (2010). Discrete Mathematics. 2nd Edition, Oxford University Press. Schaum's Outlines Series, Seymour Lipschutz, MarcLipson.*
- *Mott, Abraham Kandel. (2011). Discrete Mathematic. TataMcGraw-Hill.*

Course Title: OPERATING SYSTEM

Course Code: BVR302

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design the algorithms to write programs.
2. Understand the concept of arrays, pointers and structures to formulate algorithms and programs
3. Apply programming to solve simple numerical method problems, namely rot finding
4. Describe the Function, differentiation of function and simple integration

Course Content

UNIT I **15 Hours**

Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System**.**

Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads,

UNIT II **15 Hours**

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problematic.

Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, and Deadlock Avoidance: Banker's algorithm, Deadlock Recovery

UNIT III **15 Hours**

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation –Hardware support for paging, Protection and sharing, Disadvantages of paging. Failures and recovery management.

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, first in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

UNIT IV **15 Hours**

I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms

File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Charles Crowley. (1996). Operating System; A Design-oriented Approach. 1st Edition, Irwin Publishing.*
- *Gary J.Nutt, Addison. (2002). Operating Systems: A Modern Perspective. 2nd Edition Wesley.*
- *Maurice Bach, Prentice-Hall of India (1986). Design of the Unix Operation Systems. 8th Edition.*
- *Daniel P. Bovet, Marco Cesati, O'Reilly and Associates. (2005). Understanding the Linux Kernel. 3rd Edition*
- *Waddington, D. G., and D. Hutchison. (1999): "Resource partitioning in general purpose operating systems." ACM SIGOPS Operating Systems Review 33, no. 4*
- *Abraham Silberschatz,(2021) Peter Baer Galvin, Greg Gagne, "Operating System Principles", 10th edition.*

Course Title: DESIGN & ANALYSIS OF ALGORITHMS

Course Code: BVR303

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Describe the greedy paradigm and develop the greedy algorithms.
2. Implement and examine the divide-and-conquer paradigm.
3. Develop the dynamic programming algorithms and evaluate their computational complexity.

4. Analysis the graphs to find shortest path.

Course Content

UNIT I **15 Hours**

Introduction: Algorithm and its importance, Mathematical foundations- Growth functions, Complexity analysis of algorithms.

Divide and Conquer: Basic technique and its application on Binary Search, Finding Maximum and Minimum and on sorting techniques such as Merge Sort, Quick Sort.

UNIT II **15 Hours**

Greedy Algorithms: General method, using greedy algorithm to solve Knapsack problem, Minimum-Cost spanning trees problem, Single source shortest path problem and Travelling salesperson problem.

Dynamic Programming: Introduction to dynamic programming and application of the algorithm to solve multistage graphs, all pair's shortest path problem and Knapsack problem.

UNIT III **15 Hours**

Backtracking: General backtracking algorithm, Application of backtracking to 8 Queens' problem, Sum of subsets, Graph coloring, Hamiltonian cycles and Knapsack problem.

String Matching Algorithms: Introduction, Brute Force algorithm, Rabin-Karp algorithm, KMP algorithm, and Boyer-Moore algorithm.

UNIT IV **15 Hours**

NP-completeness and Approximation Algorithms: Introduction to P, NP, NP-hard and Complete problems, Examples of NP-complete problems, Introduction to approximation algorithms, Absolute approximations, E-approximations. **Approximation algorithms using linear programming, randomization, and specialized techniques**.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms" Galgotia Publications (Year 2002).*
- *Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, and Clifford Stein, "Introduction to Algorithms", MIT Press Year 1990.*
- *Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani, "Algorithms", McGraw-Hill Education 2006.*
- *Michael T. Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis, and Internet Examples", Wiley (Year 2002).*
- *Alfred V. Aho, John E. Hopcroft, and Jeffrey. D. Ullman, "The Design and Analysis of Computer Algorithms", Pearson Education 1974. 6. John Kleinberg and Eva Tardos, "Algorithm Design", Pearson Education 2005.*
- *T. H. CORMEN, C. E. LEISERSON, R. L. RIVEST, AND C. STEIN. Introduction to Algorithms, MIT Press, New York, 3rd edition, 2009.*

- *S. DASGUPTA, C. PAPADIMITRIOU, AND U. VAZIRANI. Algorithms, McGraw-Hill, New York, 2008*

Course Title: COMPUTER ORGANIZATION & ARCHITECTURE

Course Code: BVR304

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the basic concept of computer fundamentals, Number system, Boolean algebra, Karnaugh map and Perform problems
2. Explain the concept of stored program, role of operating system, Instruction sets and Addressing modes and Demonstrate problems on Addressing modes.
3. Use of control unit and various I/O operations
4. Classify the concept of Instruction pipeline, RISC, CISC

Course Content

UNIT I **15 Hours**

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU – registers, instruction execution cycle, RTL0interpretation of instructions, addressing modes, instruction set. Case study – instruction sets of some common cpus.

Data representation: signed number representation, fixed and floating-point representations, character representation. Computer arithmetic – integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. Multiplication – shift-and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic.

UNIT II **15 Hours**

Introduction to x86 architecture: CPU control unit design: hardwired and micro-program design approaches, Case study – design of a simple hypothetical CPU.

Memory system design: semiconductor memory technologies, memory organization.

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers-program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes– role of interrupts in process state transitions, I/O device interfaces – SCII, US

UNIT III **15 Hours**

Pipelining: Basic concepts of pipelining, through put and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel-processors, Concurrent access to Memory and cache coherency.

UNIT IV **15 Hours**

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. Block size, mapping functions, replacement algorithms, write policies.

Transaction Modes:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *John P. Hayes. (1988). Computer Architecture and Organization. 3rdEdition, WCB/McGraw- Hill.*
- *William Stallings. (2016). Computer Organization and Architecture. Designing for Performance. 10th Edition, Pearson Education.*
- *Vincent P. Heuring and Harry F. Jordan. (2004). Computer System Design and Architecture, 2nd Edition by Pearson Education.*

Course Title: OPERATING SYSTEM LAB

Course Code: BVR305

L	T	P	Credits
0	0	4	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Acquire the knowledge of Linux operating system.
2. Develop and debug the various Linux commands.
3. Perform various shell commands.
4. Discuss shell programming & its concepts.

Course Content

Installation Process of various operating systems

1. **Commands for files & directories:** cd, ls, cp, md, rm, mkdir, rmdir. Creating and viewing files using cat. File comparisons. Disk related commands: checking disk free spaces. Processes in Linux, connecting processes with pipes, background processing, managing multiple processes. Manual help. Background process: changing process priority, scheduling of processes at command, batch commands, kill, ps, who, sleep. Printing commands, grep, fgrep, find, sort, Cal, banner, touch, file. File related commands ws, sat, cut, grep.

2. **Administrative commands:** ACCEPT DATE, LIBVOLUME, EXPORT commands, IMPORT commands, LOCK commands, MOVE commands, QUERY commands, REGISTER commands, ACTIVATE POLICYSET (Activate a new policy set), ASSIGN DEFMGMTCLASS)AUDIT commands, LDAPDIRECTORY, BACKUP commands , BEGIN EVENTLOGGING (Begin logging events), CANCEL commands, CHECKIN LIBVOLUME (Check a storage volume into a library), CHECKOUT LIBVOLUME (Check a storage volume out of a library), CLEAN DRIVE (Clean a drive), COMMIT (Control committing of commands in a macro), COPY commands, DEFINE commands, DELETE commands, DISABLE commands, DISMOUNT command, DISPLAY OBJNAME (Display a full object name), ENABLE commands, EXPORT commands, IMPORT commands, LOCK commands, MOVE commands, QUERY commands, REGISTER commands, PERFORM LIBACTION, PING SERVER, QUERY ,QUIT, RECLAIM STGPOOL, RECONCILE VOLUMES, REGISTER, REMOVE commands, RENAME commands, REPLICATE NODE, REPLY, RESET PASSEXP, PASSEXP, RESET , RESTART EXPORT, RESTORE commands, MACRO, MIGRATE STGPOOL, REVOKE commands, ROLLBACK, RUN, SET commands, SELECT, SETOPT, SHRED DATA (Shred data), SETOPT, SUSPEND EXPORT UNLOCK commands, UPDATE commands, VALIDATE commands, VARY, AUDIT commands, BACKUP commands, CANCEL commands, COPY commands.
3. **Shell Programming:** Basic of shell programming, various types of shell, Shell Programming in bash, conditional & looping statement, case Statement, parameter passing and arguments, shell variables, shell keywords, creating shell programs for automate system tasks, report printing.

Course Title: DESIGN & ANALYSIS OF ALGORITHMS LAB

Course Code: BVR306

L	T	P	Credits
0	0	4	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Examine randomized algorithms.
2. Analyze the performance of algorithms.
3. Describe and implement the dynamic-programming paradigm.
4. Examine and recognize the greedy paradigm.

Course Content

1. Write a program to implement bubble sort algorithm by comparing its complexity.
2. Write a program to implement linear search algorithm by comparing it complexity.
3. Write a program to implement binary search algorithm by comparing its complexity.
4. Write a program to implement PUSH operation in stacks.
5. Write a program to implement POP operation in stacks.
6. Write a program to implement Queues.
7. Write a program to insert an element in the beginning of the link list.
8. Write a program to delete an element from the middle of the link list.
9. Write a program to implement the concept of queen's problem.

Course Title: DATA WAREHOUSING & DATA MINING

Course Code: BVR307

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design and deploy appropriate classification techniques
2. Cluster the high dimensional data for better organization of the data
3. Discover the knowledge imbibed in the high dimensional system
4. Evolve Multidimensional Intelligent model from typical system
5. Evaluate various mining techniques on complex data objects

Course Content

UNIT-1 **10 Hours**

Need for strategic information, difference between operational and Informational data stores Data warehouse definition, characteristics, Data warehouse role and structure, OLAP Operations, Data mart, Different between data mart and data warehouse, Approaches to build a data warehouse, Building a data warehouse, Metadata & its types.

UNIT-II **10 Hours**

Data Pre-processing: Need, Data Summarization, Methods. De-normalization, Multidimensional data model, Schemas for multidimensional data (Star schema, Snowflake Schema, Fact Constellation Schema, Difference between different schemas. Data warehouse architecture, OLAP servers, Indexing OLAP Data, OLAP query processing, Data cube computation

UNIT-III **10 Hours Data Mining:** Definition, Data Mining process, Data mining methodology, Data mining tasks, Mining various Data types & issues. Attribute-Oriented Induction, Association rule mining, Frequent itemset mining, The Apriori Algorithm, Mining multilevel association rules.

UNIT-IV **15 Hours**

Overview of classification, Classification process, Decision tree, Decision Tree Induction, Attribute Selection Measures. Overview of classifier's accuracy, evaluating classifier's accuracy, Techniques for accuracy estimation, increasing the accuracy of classifier. Introduction to Clustering, Types of clusters, Clustering methods, Data visualization & various data visualization tools.

Transaction Modes:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings:

- *Data Warehousing, Data Mining &Olap by Berson, Tata McGraw- Hill.*
- *Han J., Kamber M. and Pei J., Data mining concepts and techniques, Morgan Kaufmann Publishers (2011) 3rd ed.*
- *Pudi V., Krishana P.R., Data Mining, Oxford University press, (2009) 1st ed.*
- *Adriaans P., Zantinge D., Data mining, Pearson education press (1996), 1st Ed.*
- *Pooniah P., Data Warehousing Fundamentals, Willey interscience Publication, (2001)*

Course Title: BIG DATA

Course Code: BVR308

L	T	P	Credits
3	0	0	3

Total Hours:45

Learning Outcomes: After completion of this course, the learner will be able to:
1.Develop a dynamic webpage by using java script.
2.Connect a java program to a DBMS.
3.Design a well formed and valid XML and DHTML document.
4.Write a server side java application called Servlet to update and delete operations on DBMS table and design a page for internal links; when the user clicks on different links on the web page it should go to the appropriate locations/sections in the same page.

Course Content

UNIT-I **10 Hours**

Introduction to Big Data: Overview of Big Data, Stages of analytical evolution, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs. Reporting, Modern Data Analytic Tools, Statistical Concepts: Sampling Distributions - Re-Sampling, Statistical Inference - Prediction Error

UNIT-II **10 Hours**

Mining Data Streams: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform(RTAP) Applications

UNIT-III **15 Hours**

Hadoop: History of Hadoop, The Hadoop Distributed File System, Components of Hadoop, Analyzing the Data with Hadoop, Scaling Out- Hadoop Streaming, Design of HDFS-Java interfaces to HDFS Basics, developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job Run-Failures, Job Scheduling-Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features

UNIT-IV **10 Hours**

Frameworks: Applications on Big Data Using Pig and Hive, Data processing operators in Pig Hive services, Hive QL, Querying Data in Hive, Fundamentals of HBase and Zookeeper, Visualizations: Visual data analysis techniques, interaction techniques. Systems and applications.

Transaction Modes:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Hand, M. B. D. (2007). Intelligent data analysis..*
- *Zikopoulos, P., & Eaton, C. (2011). Understanding big data: Analytics for enterprise class hadoop and streaming data. McGraw-Hill Osborne Media..*
- *Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). Mining of massive data sets. Cambridge university press.*
- *Franks, B. (2012). Taming the big data tidal wave: Finding opportunities in huge data streams with advanced analytics. John Wiley & Sons.*

Course Title: INTRODUCTION TO ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Course Code: BVR309

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design expert system by using AI tools.
2. Compare and develop expert system with the help of Neural Networks
3. Understand the concept of expert system using Machine Learning.
4. Create an expert system using Fuzzy Logic.

Course Content

UNIT I **10 Hours**

Introduction: What is AI, Importance of AI, Early work in AI, Applications of AI, Knowledge and its definition. Knowledge Representation: Prepositional logic, FOPL, Properties of Well-formed formulas, Conversion to Clausal form, Inference rules, Resolution principle.

Structured Knowledge: Introduction, Associate frame structures, Conceptual dependencies and scripts.

UNIT II **8 Hours**

Knowledge Organization and Manipulation: Concepts, Uninformed or Blind search, informed search, Searching- And-OR graphs, Pattern Recognition, Recognition Classification process, Classification patterns, Recognizing and understanding speech.

Generative AI: How does generative AI work? Generative AI models, what are Dall-E, ChatGPT and Bard, use cases, benefits and its limitations, Ethics and bias, Generative AI vs. AI, Generative AI history.

UNIT III **6 Hours**

Planning: planning as search, partial order planning, construction and use of planning graphs. Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory and sample applications.

UNIT IV **6 Hours Expert**

System: Definition, Rule based architecture, dealing with uncertainty, Knowledge acquisition and validation, knowledge system building tools.

Knowledge Acquisition: Types of learning, General Learning model, Performance measures. Learning nearest neighbor, naive Bayes, and decision tree classifiers.

Transaction Modes:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learn

Suggested Readings

- *Dan W. Patterson. (1990). Introduction to Artificial Intelligence and Expert Systems.PHI Publication.*
- *Peter Jackson. (1998). Introduction to Expert System. AddisonWesley.*

Course Title: INTRODUCTION TO MACHINE LEARNING WITH PYTHON

Course Code: BVR401

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Handle various datatypes and datasets in python.
2. Understand and implement algorithms to solve simple machine learning problems.
3. Implement various machine learning models in python.
4. Analyze the performance of machine learning solutions on practical datasets.

Course Content

UNIT I **12 Hours**

Introduction to Python: Data Types, Operators, Expression, Indexing & Slicing, Strings, Conditionals, Functions, Control Flow, Nested Loops, Sets & Dictionaries.

UNIT II **18 Hours**

Introduction to Machine Learning: Machine Learning Vs Statistical Modelling, Supervised vs Unsupervised Learning, Supervised Learning Classification, Unsupervised Learning, Reinforcement Learning, Applications, Python libraries suitable for Machine Learning: Pandas, Numpy, Scikit-learn, visualization libraries: matplotlib etc.

UNIT III **15 Hours**

Regression: Simple Linear Regression, Multiple Linear Regression, Non-linear Regression, Model Evaluation in Regression Models, Evaluation Metrics in Regression Models

Classification: Introduction to Classification, K-Nearest Neighbor, Decision Trees, Logistic Regression, Support Vector Machines, Logistic regression vs Linear regression, Evaluation Metrics in Classification.

UNIT IV **15 Hours**

Unsupervised Learning: Intro to Clustering, K-Means Clustering, Hierarchical Clustering, Density-Based Clustering, Content-based recommender systems, Collaborative Filtering.

Transaction Modes:

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- Murphy, K. P. (2012). *Machine learning: a probabilistic perspective*. MIT press.
- *Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer (2009) (freely available online).*
- *Bishop, C. M., & Nasrabadi, N. M. (2006). Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: springer.*
- *Aamodt, A., & Plaza, E. (1994). Case-based reasoning: Foundational issues, methodological variations, and system approaches. AI communications, 7(1), 39-59.*

Course Title: JAVA PROGRAMMING

Course Code: : BVR402

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Discuss the basic concepts of java like if-else, control structures, array and strings.
2. Classify the structure and model of the Java programming language.
3. Synthesize Java programming language for various programming technologies
4. Develop software in the Java programming language on different platforms.

Course Content

UNIT I **15 Hours**

An overview of Java: Object oriented programming, Two paradigms, abstraction, the OOP principles, Java class libraries

Date types, variables and arrays: Integers, floating-point types, characters, Boolean, Iterates, Variable, Data types and casting, array operators.

Operators: Arithmetic operators, bit wise operators, relational operators, Boolean logical operators, assignment operators, operator precedence

Control Statement: Java's selection Statement, iteration Statement, jumps Statement.

Introduction to classes: Class fundamentals, declaring object reference variable, introducing methods, constructors, the keywords, garbage collection, the finalize () method.

Methods and Classes: Overloading methods, using objects as parameters, recursion.

UNIT II **15Hours**

Inheritance: Inheritance basics, using super, method overriding, dynamic method dispatch, using abstract Classes, using final with inheritance, Package and Interfaces, Package protection, importing packages

Exception handling: Exception handling fundamentals, Exception types, Uncaught Exceptions, using try and catch, multiple catch clauses, nested try Statement throw, and finally Java built in exception creating your own exception, sub classes, using exceptions

UNIT III **15 Hours**

Multithreaded Programming: The Java thread model, the main thread, creating thread, creating multiple thread, using is alive () and join (). Thread priorities, synchronization, inter thread communications, suspending resuming and stopping thread using multithreading.

String handling: The string constructor, string length, special string operator character extraction, string comparison, searching string, modifying string, data conversion, changing the case of characters, string buffer.

UNIT IV **15Hours**

Networking: Networking basics, Java and the Internet Address, TCP/IP client Sockets URL, URL connection, TCP/IP server Sockets, the Applet Class. Stream API

The Applet Class: Architecture displays method, The HTML APPLET, Passing parameters to Applet. The get Documentation Base () and get Code Base () methods Applet Context and Show Document ().

Micro servicing: Standards and Syntax, Advantages of Micro services, Java Micro Services Framework, Spring Cloud and Spring Boot, Different strategies used in Micro service deployment, Domain-Driven Design containers in Microservices, Contract Testing, Monolithic, SOA, and Micro Services Architecture, Docker, DC, Bounded Context

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings:

- *McGraw-Hill. (1999). Java 2 Computer Reference. Tata McGraw Hill.*
- *Horstmann. (2018). Core Java-I. Addison Wesley.*
- *E Balagurusami. (2006). Programming with JAVA. Tata McGraw-Hill Education.*
- *Ken Arnold, James Gosling and David Holmes, "The Java Programming Language", 4th ed, 2005.*
- *Bruce Eckel, "Thinking in Java", 4th ed, 2007.*

Web Links

- *https://www.codementor.io/@sureshatta/11-websites-that-help- Java Programming*
- *https://www3.ntu.edu.sg/home/ehchua/programming/howto/References.html- Java Programming*
- *https://www.tradepub.com/free-offer/advanced-java-tutorial/w_java34?sr=hicat&_t=hicat:827- Java Programming.*

Course Title: RELATIONAL DATABASE MANAGEMENT SYSTEM

Course Code: : BVR403

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Develop the queries using SQL, solutions to a broad range of query and data update problems.
2. Describe various database concepts and database management system software.
3. Understand the major DBMS components and their function.
4. Design a model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.

Course Content

UNIT I **15 Hours**

Database Management: Introduction, Types of DBMS and their advantages and disadvantages, Characteristics of Database Approach, Data Models, Data Abstraction and Knowledge Representation, Database Language.

DBMS Architecture and Data Independence: Attributes and Keys, Relationships, Relationship Types, Roles, ER Diagrams, Relational Model concepts, functional dependence.

UNIT II **15 Hours**

SQL, PL SQL, SQL *PLUS, Managing Database and Queries: Creating, Defining and Modifying Table structure, Update Operations and Dealing with Constraint Violations, Basic Relational Algebra Operations, Example of Queries in Relational Algebra, The Tuple Relational Calculus, The Domain Relational Calculus, granting and revoking privileges.

UNIT III **15 Hours**

Normalization: Overview of Recovery and Backup, Normalization & its forms.

Transaction: Processing Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp-based schedulers, multi-version and optimistic Concurrency Control schemes. Database recovery.

UNIT IV **15 Hours**

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, Integrity in Data Base. Types of Integrity, SQL injection.

SQL Server: Introduction to SQL Server and Oracle Server, Indexes, Views, Cursors, Packages, Triggers, Stored Procedures.

No SQL: Introduction to NoSQL, Key Features, Advantages and Disadvantages of NoSQL, Types of NoSQL database.

Non-relational data and NoSQL: Document data stores, columnar data stores, Key/value data stores, Graph data stores, Object data stores, External index data stores, typical requirements.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *J. D. Ullman,Computer Science Press. (2016). Principles of Database and Knowledge–Base Systems. Vol1*
- *R. Elmasri and S. Navathe,Pearson Education.(1905). Fundamentals of Database System.5th Edition*
- *Serge Abiteboul, Richard Hull, Victor Vianu,Addison-Wesley. (1995). Foundations of Databases Reprint.*
- *Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning-Course Technology, Seventh Edition, 2007.*
- *Shio Kumar Singh, Database Systems Concepts, Designs and Application, Pearson Education, Second Edition, 2011.*

Web Links

- *https://cloud.google.com/learn/- Relational Database Management System*
- *https://codeinstitute.net/global/blog/what-is-a-relational-database-management-system/- Relational Database Management System*
- *https://zenkit.com/en/blog/everything-you-need-to-know-about-web-databases/- Relational Database Management System*

Course Title: INTRODUCTION TO ROBOTICS

Course Code: : BVR404

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the basics of robotics
2. Understand game playing concepts involving robotics and AI.
3. Apply robotics to create robot driven systems.
4. Analyze and co-relate robotics with AI and use in real-world applications

Course Content

UNIT I **15 Hours**

Introduction: Introduction to Robotics Fundamentals of Robotics, Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

UNIT II **15 Hours**

Need of AI in Robotics: History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents.

UNIT III **15 Hours**

Game Playing: AI and game playing, plausible move generator, static evaluation move generator, game playing strategies, problems in game playing.

UNIT IV **15 Hours**

Robotics fundamentals: Robot Classification, Robot Specification, notation, kinematic representations and transformations, dynamics techniques; trajectory planning and control.

Robotics and Its applications: DDD concept, Intelligent robots, Robot Anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple Problems-Specifications of Robot-Speed of Robot, Robot joints and Links-Robot Classifications-Architecture of robotic Systems-Robot Drive Systems-Hydraulic, Pneumatic and Electric system.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Peter, C. (2011). Robotics, vision and control: fundamental algorithms in MATLAB.*
- *McKinnon, P. (2015). Robotics: everything you Need to know about robotics from beginner to expert. Peter McKinnon.*
- *Murphy, R. R. (2019). Introduction to AI robotics. MIT press.*
- *Govers, F. X. (2018). Artificial intelligence for robotics: Build intelligent robots that perform human tasks using AI techniques. Packt Publishing Ltd.*

Course Title: RELATIONAL DATABASE MANAGEMENT SYSTEM LAB

Course Code: : BVR405

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Explain the features of database management systems and Relational database.
2. Design conceptual models of a database using ER modeling or real-life Applications and also construct queries in Relational Algebra.
3. Create and populate a RDBMS for a real-life application, with constraints and keys, using SQL.
4. compile any type of information from a data base by formulating complex queries in SQL.

Course Content

List of Experiments:

1. Introduction to SQL and installation of SQL Server / Oracle.
2. Data Types, Creating Tables and Retrieval of Rows using Select Statement, Conditional Retrieval of Rows, Alter and Drop Statement.
3. Working with Null Values, matching a Pattern from a Table, Ordering the Result of a Query, Aggregate Functions, Grouping the Result of a Query, Update and Delete Statement.
4. Set Operators, Nested Queries, Joins, Sequences.
5. Views, Indexes, Database Security and Privileges: Grant and Revoke Commands, Commit and Rollback Commands.
6. PL/SQL Architecture, Assignments and Expressions, Writing PL/SQL Code, Referencing, Non-SQL parameters.
7. Stored Procedures and Exception Handling.
8. Triggers and Cursor Management in PL/SQL.
9. Suggested Tools – My SQL, DB2, Oracle, SQL Server 2012

Course Title: INTRODUCTION TO MACHINE LEARNING WITH PYTHON LAB

Course Code: : BVR406

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:
The students will be able to handle various datatypes and datasets in python. They will also be able to implement various machine learning model sin python.

Course Content

List of Experiments:

1. Classification and regression algorithms.
2. Artificial Neural Network (with back-propagation).
3. Mathematical computing with Python packages like: numpy,
4. Mat- plotLib, pandas Tensor Flow, Keras.
5. Implement basic ML models like SVM, KNN, K-Means, Logistic Regression, Linear Regression

Course Title: JAVA PROGRAMMING LAB

Course Code: : BVR407

L	T	P	Credits
0	0	2	1

Total Hours: 15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Solve the computational problems using basic statements like if-else, control structures, array, and strings.
2. Learn about the user requirements for software functionality and Run software applications in Java programming language.
3. Know about basic principles of creating Java applications with Applet programming.
4. Develop a given program using the basic elements like Control and Conditional statements

Course Content

List of Programs:

1. Introduction to JAVA, its features & basic program
2. Write a program for Operators in JAVA
3. Write a program to show use of IF-Else Statements in JAVA
4. Write a program use switch case in JAVA
5. Write a program to use looping in JAVA
6. Write a program to use methods in JAVA
7. Write a program to create class and objects
8. Write a program to use Method Overloading a method overriding
9. Write a program to use Final Keyword.
10. Write a program to show Implementation of Array.
11. Write a program to show Implementation of Inheritance
12. Write a program to show creation and use of package
13. Write a program to show use of Interface
14. Write a program to apply replace, concate methods on String.
15. Write a program to sort strings of array
16. Write a program to Show Implementation of Threads
17. Write a program to create applet
18. Write a program to create applet with passing parameters
19. Write a program to show use of Exception Handling
20. Write a program to make usage of JAVA lang.awt package and design GUI.
21. Usage of event handling in Java GUI (Graphical user interface) programs.

Course Title: MOBILE ROBOTS

Course Code: : BVR408

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Aerial Robot Autonomy: Implement a framework for autonomous quadrotor navigation and exploration.
2. Development Skills: Plan software development efforts that address robotics applications.
3. Software Artifacts: Develop a nontrivial mobile robot application.
4. Algorithmic Familiarity: Implement key probabilisitc algorithms in mobile robotics.

Course Content

UNIT I **12 Hours**

Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability;

Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots;

UNIT II **10 Hours**

Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering;

UNIT III **13 Hours**

Localization: Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems;

Introduction to planning and navigation: path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP);

UNIT IV **10 Hours**

Robotics Project: Students will work on a semester long project consisting of design, fabrication, and programming a mobile robotic platform.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

• R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011.

• Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.

• S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)

• Thrun, S., Burgard,W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005.

• Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012.

• H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005.

Course Title: IOT AND AUTOMATION
Course Code: : BVR409

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the revolution of internet in field of cloud, wireless network, embedded system and mobile devices.
2. Apply IOT design concepts in various dimensions implementing software and hardware.
3. Analyze various M2M and IoT architectures.
4. Design and develop various applications in IOT

Course Content

UNIT I **15 Hours**

Introduction to IoT: Definition and characteristics of IoT, Design of IOT: Physical design of IOT, Logical Design of IOT- Functional Blocks, communication models, communication APIs, IOT enabling Technologies- Wireless Sensor Networks, Cloud computing, big data analytics, embedded systems. IOT Levels and deployment templates.

UNIT II **10 Hours**

IoT Hardware and Software: Sensor and actuator, Humidity sensors, Ultrasonic sensor, Temperature Sensor, Arduino, Raspberry Pi, LiteOS, RIOTOS, Contiki OS, Tiny OS.

UNIT III **10 Hours**

Architecture and Reference Model: Introduction, Reference Model and architecture, Representational State Transfer (REST) architectural style, Uniform Resource Identifiers (URIs). Challenges in IoT- Design challenges, Development challenges, Security challenges, Other challenges. IOT and M2M: M2M, Difference and similarities between IOT and M2M, Software defined networks, network function virtualization, difference between SDN and NFV for loT.

UNIT IV **10 Hours**

Case study of IoT Applications: Domain specific IOTS- Home automation, Cities, environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Lifestyles.

Suggested Readings:

- Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. (2011). *Introduction to autonomous mobile robots*. MIT press.
- Nedjah, N., dos Santos Coelho, L., & de Macedo Mourelle, L. (Eds.). (2007). Mobile robots: The evolutionary approach (Vol. 50). Berlin: Springer.
- Holland, J. M. (2004). Designing autonomous mobile robots: Inside the mind of an intelligent machine. Elsevier.

Course Title: FORMAL LANGUAGE & AUTOMATA THEORY

Course Code: BVR501

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Write a formal notation for strings, languages and machines.
2. Design finite automata to accept a set of strings of a language.
3. Formulate the context free grammars to generate strings of context free language.
4. Determine equivalence of languages accepted by Push Down Automata and language.

Course Content

UNIT I **18 Hours**

Theory of Computation: Deterministic Finite Automata, Acceptance by Finite Automata, Transition systems, Non-Deterministic Finite Automata, Equivalence of DFA and NDFA, Moore and Mealy machines, Equivalence of Moore and Mealy machine, Minimization of Finite Automata, Applications and limitations of Finite Automata.

Formal Languages: Basics of strings, alphabets, grammar, formal language, Chomsky classification of languages, languages and their relation, operations on languages, Closure properties of language classes.

UNIT II **12 Hours**

Regular grammar: Regular grammars, Regular expressions, Algebraic method using Arden's theorem, Equivalence of Finite Automata and Regular expressions, Properties of regular languages, pumping lemma.

UNIT III **15 Hours**

Context Free Language: Derivation, ambiguity, simplification of context free grammar, normal forms- Chomsky Normal Form, Greibach Normal Form, pumping lemma. Context Sensitive Language, The model of Linear Bounded Automata, Relation between Linear Bounded Automata and Context Sensitive Language

UNIT IV **15 Hours**

Push down Automata: Description and Definition, acceptance by Push down Automata, Equivalence of Push down Automata and context free grammars and languages.

Turing Machine: Definition and Model, Representation of Turing Machine, Design of Turing Machine, Variants of Turing Machine, Decidability and Recursively Enumerable Languages, Halting Problem, Post Correspondence Problem.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Harry R. Lewis and Christos H. Papadimitriou. (1998). Elements of the Theory of Computation.*

- *Pearson Education Asia.*
- *Dexter C. Kozen. (1997). Automata and Computability. Undergraduate Texts in Computer*
- *Science, Springer.*
- *Michael Sipser. (1997). Introduction to the Theory of Computation.PWS Publishing.*
- *John Martin. (2007). Introduction to Languages and The Theory of Computation. Tata McGrawHill.*
- *Hopcroft J.E., Ullman J.D. (2006). Introduction to Automata Theory, Languages, and Computation (3rd Edn). Reading, MA: Addison-Wesley.*
- *Lewis F.D. (2007). Essentials of Theoretical Computer Science.*

Web Links

- *https://stackoverflow.com/questions/17252374/what-are-the-best-sites-to-learn-about- Formal Language & Automata Theory*
- *https://www.udemy.com/course/formal-languages-and-automata-theory-e/- Formal Language & Automata Theory*
- *https://eecs.wsu.edu/~ananth/CptS317- Formal Language & Automata Theory*

Course Title: COMPUTER NETWORKS

Course Code: BVR502

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the fundamentals of computer networking.
2. Learn the basic terminology of the computer networking area.
3. Analysis the various congestion control algorithms.
4. Describe the functions of the different layer of the OSI Protocol.

Course Content

UNIT I **15 Hours**

Data Communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN.

Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

UNIT II **15 Hours**

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CDCDMA/CA

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

UNIT III **15 Hours**

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

UNIT IV **15 Hours**

Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, and Basic concepts of Cryptography.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Andrew S. Tanenbaum, Pearson New International Edition. (2013). Computer Networks. 8th Edition.*

- *Prentice Hall of India. (2015). Internetworking with TCP/IP Volume 1. 6th Edition Douglas Comer.*
- *W. Richard Stevens, Addison-Wesley, United States of America. (2005). TCP/I Illustrated. Volume1.*
- *Kurose, J.F. and K.W. Ross (2003) Computer Networking: A Top Down Approach Featuring the Internet, Addison Wesley.*
- *Mir, N.F. (2006) Computer and Communication Networks, Prentice Hall.*

Course Title: DEEP LEARNING

Course Code: BVR503

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. To introduce the fundamentals of deep learning and the main research activities in this field.
2. To learn architectures and optimization methods for deep neural network training.
3. To analyze the given dataset for designing a neural network based solution
4. To design and deploy simple Tensor Flow-based deep learning solutions to classification problems

Course Contents:

UNIT I **15 Hours**

Introduction: History of Deep Learning, McCulloch Pitts Neuron, Multilayer Perceptions (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feed Forward Neural Networks, Back propagation.

UNIT II **15 Hours**

Module 2: Activation functions and parameters, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Principal Component Analysis and its interpretations, Singular Value Decomposition, Parameters v/s Hyper-parameters

UNIT III **15 Hours**

Auto-encoders & Regularization, Auto encoders and relation to PCA, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Encoder Decoder Models, Attention Mechanism, Attention over images, Batch Normalization

UNIT IV **15 Hours**

Deep Learning Models: Introduction to CNNs, Architecture, Convolution/pooling layers, CNN Applications, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet. Introduction to RNNs, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs

Deep Learning Applications: Image Processing, Natural Language Processing, Speech recognition, Video Analytics

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings:

- *Bengio, Y., Goodfellow, I., & Courville, A. (2017). Deep learning (Vol. 1). Cambridge, MA, USA: MIT press.*
- *Anton, K. (2023). An Introduction to Deep Learning: How Neural Networks Can Be Used to Recognize Handwritten Digits.*
- *Lee, W. M. (2019). Python machine learning. John Wiley & Sons.*

Course Title: DEEP LEARNING LAB

Course Code: BVR504

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications
4. Design of test procedures to assess the efficiency of the developed model.

Course Content

List of Programs:

1. Demonstration and implementation of Shallow architecture, using Python, Tensor flow and Keras.
2. Hyper parameter tuning and regularization practice -
3. Multilayer Perceptron (BPN)
4. Mini-batch gradient descent
5. Convolution Neural Network application using Tensor flow and Keras
6. Classification of MNIST Dataset using CNN
7. Face recognition using CNN
8. Object detection using Transfer Learning of CNN architectures
9. Image de noising (Fashion dataset) using Auto Encoders
10. Handling Color Image in Neural Network aka Stacked Auto Encoders (Denoising)
11. Text processing, Language Modeling using RNN
12. Transfer Learning models for classification problems.
13. Sentiment Analysis using LSTM.
14. Image generation using GAN

Course Title: PROJECT -I

Course Code: BVR505

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Use latest multimedia devices and programming software.
2. Design and construct a hardware and software system, component or process to meet desired needs.
3. Understand the multidisciplinary applications Problems.
4. Examine work as professionals, with portfolio ranging from data management, network configuration, designing hardware, database and software design to management and administration of entire systems.

Course Content

1. Project should include following phases: System Analysis and Design
2. Coding - Implementation Testing
3. It should be a working project Must have a future perspective
4. The Domain of project can be from: Databases
5. Application software
6. System software
7. Multimedia
8. Web Applications, etc.
9. A complete project report must be submitted along with softcopy of project. Project report may include Requirements of Project, Flow Chart, DFD's, Coding and Test Results

Course Title: OPTIMIZATION TECHNIQUES IN AI & ML

Course Code: BVR506

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes: After completion of this course, the learner will be able to:

1. The students will be able to understand and analyze how to deal with changing data.
2. They will also be able to identify and interpret potential unintended effects in your project.
3. They will understand and define procedures to operationalize and maintain your applied machine learning model.
4. To predict the results and course outcomes with the help of data mining.

Course Contents:

UNIT I **15 Hours**

Introduction: What is optimization, Formulation of LPP, Solution of LPP: Simplex method, Basic Calculus for optimization: Limits and multivariate functions, Derivatives and linear approximations: Single variate functions and multivariate functions.

UNIT II **15 Hours**

Machine Learning Strategy: ML readiness, Risk mitigation, Experimental mindset, Build/buy/partner, setting up a team, Understanding and communicating change.

UNIT III **15 Hours**

Responsible Machine Learning: I for good and all, Positive feedback loops and negative feedback loops, Metric design and observing behaviors, Secondary effects of optimization, Regulatory concerns.

UNIT IV **15 Hours**

Machine Learning in production and planning: Integrating info systems, users break things, time and space complexity in production, when to retain the model? Logging ML model versioning, Knowledge transfer, Reporting performance to stakeholders.

Care and feeding of your machine learning model:

MLPL Recap, Post deployment challenges, QUAM monitoring and logging, QUAM Testing, QUAM maintenance, QUAM updating, Separating Data stack from Production, Dashboard Essentials and Metrics monitoring.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Jose, J. (2020). Introduction to machine learning. KHANNA PUBLISHING HOUSE.*
- *Chopra, R. (2018). Machine Learning. Khanna Publishing House.*
- *Sra, S., Nowozin, S., & Wright, S. J. (Eds.). (2011). Optimization for machine learning. Mit Press.*
- *Kumar, M., Kulkarni, A. J., & Satapathy, S. C. (2019). A Hybridized Data Clustering for Breast Cancer Prognosis and Risk Exposure. Optimization in Machine Learning and Applications, 40(55), 113.*

Course Title: Cognitive Robotics

Course Code: BVR507

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes: After completion of this course, the learner will be able to:

1. understand the main types of cognitive (vision, motor control, language, social skills) robots and their driving requirements (engineering operations, navigation, cooperation)
2. To understand advanced methods for creating efficient and dynamic cognitive robots.
3. To understand the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics.
4. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards

Course Content

UNIT I **10 Hours**

Introduction 2 hours Thinking, Cognition, and Intelligence, Defining Intelligence – Embodiment and Its Implications, Synthetic Methodology for Intelligence.

Module:2 Cybernetic View of Robot Cognition and Perception 4 hours Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition.

UNIT II **10 Hours**

Module:3 Intelligent System Design, Cognition Development and control 5 hours Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic,

Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN, Introduction to CNN.

UNIT III **10 Hours**

Module:4 Map Building 5 hours Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building.

Module:5 Randomized Path Planning 5 hours Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, planning with moving obstacles, Probabilistic Roadmaps, rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

UNIT IV **15 Hours**

Module:6 Simultaneous Localization and Mapping (SLAM) 5 hours Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms.

Module:7 Robot Programming methods 3 hours Item 66/30 - Annexure - 26 Proceedings of the 66th Academic Council (16.06.2022) 695 Item 66/30 - Annexure - 26 Python Robot Programming Methods-: Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine), Follow-Wall Behavior. A Complete Program for autonomous mobile robot. Module:8 Contemporary issues 1 hours

Suggested Readings:

- *Patnaik, Srikanta, "Robot Cognition and Navigation – An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007.*
- *Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.*
- *David Vernon, "Artificial Cognitive Systems: A Primer" ,The MIT Press, 1st Edition,2014.*
- *HoomanSomani, "Cognitive Robotics", CRC Press, 2015.*
- *Jared Kroff, "Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016*

Course Title: CYBER ETHICS IN AI

Course Code: BVR508

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes: After completion of this course, the learner will be able to:

1. Analyze the concept of cybercrimes.
2. Learn about the regulation of cyber space at national and international level.
3. Understand the international legal regime related to cybercrimes.
4. Discuss the offences and penalties under it act 2000.

Course Content

UNIT – I **15 Hours**

General introduction and Cyber space regulations: Cyber Space-Meaning and characteristics Need for regulation of cyber space, Cyber-libertarianism, Cyber-paternalism, Lessing's model of regulation, Regulators in cyberspace, Introduction to Internet, ACLU v Reno, Digitization and Society, Legal Challenges of the Information Society, Information Technology Act, 2000

UNIT – II **10 Hours**

Cyber law and IPR issues: Digital Copyrights, Open Source, Linking and caching, Digital Rights Management, DMCA, - Patents, Software Patents Trademarks and domain names, Brand identities, search engines and secondary market, ICANN, Database Right

UNIT III **10 Hours**

Cyber law and privacy and taxations issues: Digitization, personal data and data industry, Data protection principles, Conditions for processing of personal data, CCTV, RFID tracking, Data retention and identity - Taxation issues of e-commerce

UNIT – IV **10 Hours**

Cyber Crimes: Computer misuse - identity theft, grooming and harassment, Hacking, Viruses, criminal damage and mail bombing, Denial of service attack, Obscenity, child abuse, Stalking. Morphing, web jacking, phishing etc., Cyber terrorism, Bandwidth theft, Convention on cybercrime.

Transactional Modes

Video based Teaching, Collaborative Teaching, Cooperative Teaching; Case based Teaching, Case Analysis, and Group Discussion.

Suggested Readings

- *Intelligence, C. Next-Gen Technologies in Cotnputational Intelligence.*
- *Singh, R., & Singh, G. (Eds.). (2004). Cyber Space and the Law: Issues and Challenges. NALSAR University.*
- *Kumar, S. (2019). Technology Influence the Evolution of Cyber Crime. Technology.*

Course Title: SPEECH AND LANGUAGE PROCESSING

Course Code: BVR601

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Be competent with fundamental concepts for natural language processing and automatic speech recognition
2. To understand technologies involved in developing speech and language applications.
3. To demonstrate the use of deep learning for building applications in speech and natural language processing

Course Outcomes

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

1. Describe the importance of different NLP modules in Text processing and fundamentals of speech production
2. Describe ways to represent speech and text
3. Demonstrate the working of sequence models for text
4. Use signal processing techniques to analyze/represent the speech signal
5. Execute trials of speech/language systems

UNIT I **15 hours**

Introduction to Natural Language Processing: Overview of NLP - Introduction to Levels of NLP - Morphology: Derivational & Inflectional Morphology - POS tagging - Parsing: Shallow and Dependency Parsing, Semantics: Word Level Semantics and Thematic roles.

Text Preprocessing & Feature Representation: Introduction to Corpora, Sentence Segmentation, stemming: Porter Stemmer, Bag of words and Vector Space Model, Topic Modeling, N-gram Language Model, Smoothing, Word Embedding's: Word2Vec, Glove and Fast text.

UNIT II **15 hours**

Applications of NLP-1: Sentiment Classification using ML & DL models, Named Entity Recognition - CRF and
LSTMs, Text Summarization - Statistical and Deep Learning models.

Applications of NLP-2: Machine Translation - Encoder & Decoder Model, Attention Models, Question Answering - Knowledge based Q&A and Deep Learning models for Q&A.

UNIT III **15 hours**

Introduction to Speech Processing: Fundamentals of speech production – Perception of sound – Vocal tract model – Phonetics - Short-Time analysis of the signal – Energy – Zero crossing – Autocorrelation – Short time Fourier analysis.

Feature Representation of Speech Signal:

Mel Frequency Cepstral Coefficients, Perceptual linear prediction (PLP), Linear prediction cepstral coefficients (LPCC), Gamma tone Frequency Cepstral Coefficients (GFCC), i-vector.

UNIT IV **15 hours**

Automatic Speech and Speaker Recognition: Automatic Speech recognition formulation: Isolated word recognition – Large vocabulary continuous speech recognition -HMM/GMM based speech recognition – DNN/HMM model -- CNN based speech recognition - RNN language Models – Evaluation metrics, Speaker Item 66/29 - Annexure -25Proceedings of the 66th Academic Council (16.06.2022) 664 recognition model – Alexa/Google assistant-based application development.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Zhang Z, Winn R, Zhao Y, Yu T and Halfond W Automatically Reproducing Android Bug Reports using Natural Language Processing and Reinforcement Learning Proceedings of the 32nd ACM SIGSOFT International Symposium on Software Testing and Analysis, (411-422).*
- He X, Xu Q, Zengt Y, Lyu L, Wu F, Li J and Jia R CATER Proceedings of the 36th International Conference on Neural Information Processing Systems, (5431-5445).

Course Title: AUTONOMOUS DRONES

Course Code: BVR602

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Complete understanding of autonomous systems.
2. Create a model of basic autonomous vehicle.
3. Understand, design and implement an autonomous robot.
4. Understand, design and implement an autonomous drone.

Course Content

UNIT I **15 Hours**

Introduction: What are autonomous systems? AI in autonomous systems, Autonomous systems vs robots

Functional architecture: Major functions in an autonomous vehicle system, Motion Modelling - Coordinate frames and transforms, point mass model

UNIT II **15 Hours**

Modelling in autonomous systems: Vehicle modelling (kinematic and dynamic bicycle model - two-track models), Sensor Modelling - encoders, inertial sensors, GPS.

UNIT III **15 Hours**

SLAM

Localization and mapping fundamentals, LIDAR and visual SLAM, Navigation - Global path planning, Local path planning, Vehicle control - Control structures, PID control, Linear quadratic regulator, Sample controllers.

UNIT IV **15 Hours**

Drones

overview, definition, applications, components platforms, propulsion, on-board flight control, payloads, communications, concepts of flight, regulatory norms and regulations, Machine learning and deep learning for autonomous driving, Case study.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Pratihar, D. K. (Ed.). (2010). Intelligent autonomous systems: foundations and applications (Vol. 275). Springer.*
- *De Gyurky, S. M., & Tarbell, M. A. (2013). The Autonomous System: A foundational synthesis of the sciences of the mind. John Wiley & Sons.*
- *Liu, S., Li, L., Tang, J., Wu, S., & Gaudiot, J. L. (2018). Creating autonomous vehicle systems. Morgan & Claypool..*

Course Title: DATA AND VISUAL ANALYTICS IN AI

Course Code: BVR603

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning
3. Design and implement various machine learning algorithms in a range of real-world applications.
4. Demonstrate intermediate proficiency in the visualization of data to communicate information and patterns that exist in the data.

Course Content

UNIT I **15 Hours**

Introduction: Data for Graphics, Design principles, Value for visualization, Categorical, time series, and statistical data graphics, Introduction to Visualization Tools

Graphics: Pipeline and Aesthetics and Perception Introduction, Primitives: vertices, edges, triangles, Model transforms: translations, rotations, scaling, View transform, Perspective transform, window transform, Graphical Perception Theory, Experimentation, and the Application, Graphical Integrity, Layering and Separation, Color and Information, Using Space

UNIT II **15 Hours**

Graphics Pipeline and Aesthetics and Perception: Introduction, Primitives: vertices, edges, triangles, Model transforms: translations, rotations, scaling, View transform, Perspective transform, window transform, Graphical Perception Theory, Experimentation, and the Application, Graphical Integrity, Layering and Separation, Color and Information, Using Space

UNIT III **15 Hours**

Visualization Design: Visual Display of Quantitative Information, Data-Ink Maximization, Graphical Design, Exploratory Data Analysis, Heat Map

Collaboration: Graph Visualization and Navigation, Online Social Networks, Social Data Analysis, Collaborative Visual Analytics, Text, Map, Geospatial data

UNIT IV **15 Hours**

Multidimensional Data and Interaction: Query, Analysis and Visualization of Multi-Dimensional Relational Databases, Interactive Exploration, tSNE, Interactive Dynamics

for Visual Analysis, Visual Queries, Finding Patterns in Time Series Data, Trend visualization, Animation, Dashboard, Visual Storytelling.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings

- *Tufte, E., & Graves-Morris, P. (2014). The visual display of quantitative information.; 1983. Diagrammatik-Reader. Grundlegende Texte aus Theorie und Geschichte. Berlin: De Gruyter, 219-230.*
- *BRANCH, I. BE ELECTRONICS AND INSTRUMENTATION ENGINEERING (Full-Time) (Choice Based Credit System).*
- *Wikgren, W. (2019). Beyond shape–An exploration in alternative forms for data visualization (Master's thesis).*
- *Lima, M. (2014). The book of trees: Visualizing branches of knowledge.*

Course Title: GAME PROGRAMMING USING AI

Course Code: BVR604

L	T	P	Credits
4	0	0	4

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Design, develop, test, evaluate, debug, and modify code to meet design specifications for games.
2. Design unique gaming environments, levels and characters by choosing appropriate game strategies and patterns based on an analysis of past and present trends.
3. Create and document the games by applying programming concepts using various tools to meet requirements of the current marketplace.
4. The integration of AI in educational game design raises ethical considerations regarding **cultural sensitivity**, **inclusivity**, **data privacy**, and algorithmic fairness.

Course Content

UNIT I **15 Hours**

Introduction to Game Programming & Game engine architecture: Overview of game programming, Structure of a typical game team, game industry- game engine history- Real Time Game Architecture, Engine Support: Subsystem Start-Up and Shut-Down, Memory Management, Containers and Strings.

UNIT II **15 Hours**

Basics of 2D & 3D Graphics and Mathematics in Gaming & Rendering Engine:
2D Graphics: Sprites, Tiled Images and Backgrounds - 3D Graphics: 3D Graphics Pipeline, 3D Math, Coordinates and Coordinate Systems, Quaternion Mathematics, Transformations & Geometry - Rendering Pipeline.

UNIT III **15 Hours**

Lighting and Texturing Effects in game environment:
Ray Tracing, lighting in Computer Graphics, Types of Light Sources, Light Models - Materials: Lambert Diffuse, Phong -Bump Mapping - Lighting Technique: Point Lights, Bloom - Shadows in Games: Real-Time Versus Preprocessed Shadows - Types of Shadows -Texture mapping techniques - Special Effects: Blurring, Particle Systems, Weapon Effects.

UNIT IV **15 Hours**

Artificial Intelligence in Game for move prediction and optimization:
Games for Artificial Intelligence, Game AI Panoram; AI Methods: Tree Search, Evolutionary Computation, Supervised Learning & Reinforcement Learning.

Virtual and Augmented Reality: Immersive reality application areas - Entertainment, Education, Training, Medical, Industrial, Military. VR: Position and Motion Trackers - Magnetic, Mechanical and Ultrasonic Trackers- Navigation and Manipulation Interfaces;

AR: Selection of AR Platform, Integrating Hardware and Software, Optical & Inertial Calibration – Tracking – AR Computer Vision.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Gregory, J. (2018). Game engine architecture. AK Peters/CRC Press.*
- *Palmer, G. (2005). Physics for game programmers.*
- *Yannakakis, G. N., & Togelius, J. (2018). Artificial intelligence and games (Vol. 2, pp. 2475-1502). New York: Springer.*
- *Sherrod, A. (2008). Game Graphic Programming. Cengage Learning.*
- *Sirigos, C. E. C. I. L. I. A., & Kirsch, B. (2014). Levels of game creation. Games in Libraries: Essays on Using Play to Connect and Instruct, 9-29.*

Course Title: PROJECT -II

Course Code: BVR605

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Use latest multimedia devices and programming software.
2. Design and construct a hardware and software system, component or process to meet desired needs.
3. Classify the multidisciplinary Problems of project.
4. Work as professionals, with portfolio ranging from data management, network configuration, designing hardware, database and software design to management and administration of entire systems.

Course Content

1. Project should include following phases: System Analysis and Design
2. Coding - Implementation Testing, It should be a working project Must have a future perspective.
3. The Domain of project can be from:
   - Databases
   - Application software
   - System software
   - Multimedia
   - Web Applications, etc.

A complete project report must be submitted along with softcopy of project. Project report may include Requirements of Project, Flow Chart, DFD's, Coding and Test Results

Course Title: ADVANCED MACHINE LEARNING LAB

Course Code: BVR606

L	T	P	Credits
0	0	4	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:
To introduce advanced concepts and methods of machine learning and to develop an understanding of the role of machine learning in massive scale automation. To design and implement various machine learning algorithms in a range of real-world applications

Course Content

List of Experiments:

1. Classification and regression algorithms.
2. K-Means Clustering.
3. Artificial Neural Network (with back-propagation).
4. Decision Trees.
5. Random Forest.

Course Title: GRAPH THEORY ALGORITHMS FOR ROBOTICS

Course Code: BVR607

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

Course Content

UNIT-I **10 Hours**

Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, Paths and Circuits, Components and Connectedness algorithms, shortest path algorithm.

UNIT-II **10 Hours**

Tree: Trees, properties of trees, Pedant vertices in a tree, center of a tree, rooted binary trees, spanning trees and minimal spanning tree algorithms, Tree traversals.

UNIT-III **12 Hours**

Graph connectivity: Graph connectivity, maximal flow algorithm. Euler and Hamiltonian graphs. Travelling salesman algorithm. Network flow problems, Ford-Fulkerson algorithm

UNIT-IV **13 Hours**

Planar Graph: Planar graph, Euler theorem and applications of planar graphs. Coloring of graphs. Lab Practice: Graph theory applications in robotics motion and path planning, collision and obstacle avoidance.

Suggested Readings

- *Strug, B., Ślusarczyk, G., Paszyńska, A., & Palacz, W. (2022). A survey of different graph structures used in modeling design, engineering and computer science problems. Graph-Based Modelling in Science, Technology and Art, 243-275.*
- *Deo, N. (2016). Graph theory with applications to engineering and computer science. Courier Dover Publications.*
- *Frank, C. (2017). Modern robotics-mechanics, planning, and control. Cambridge University Press.*

Course Title: ROBOT OPERATING SYSTEM

Course Code: BVR608

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes: After completion of this course, the learner will be able to:

UNIT-I **10 Hours**

Introduction: The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases. UNIX commands - file system – redirection of input and output - File system security - Changing access rights– process commands – compiling, building and running commands – handling variables

UNIT-II **10 Hours**

File system: packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands. Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.

UNIT-III **15 Hours**

Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo– Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS. Lab Components ♣ Experiment on Creating, building, modifying packages and Writing, building source code and nodes ♣ Creating and Running Publisher and Subscriber Nodes ♣ Creating and Running Service Servers and Client Nodes ♣ Writing and Running the Action Server and Client Node ♣ Programming experiment on nodes with setting, reading, building, running, displaying parameters list.

UNIT-IV **10 Hours**

Experiment of ROS launch, Experiment on 3D visualization tool (RViz), Design and development of graphical user interface in ROS environment, Establish communication

between robot client and server, and analysis of data packet loss ♣ Visualization of robot and their movements in Rviz ROS .

Suggested Readings:

- *Joseph, L. (2018). Robot operating system (ros) for absolute beginners (Vol. 2018). Berlin/Heidelberg, Germany: Springer.*
- *Fernandez, E., Crespo, L. S., Mahtani, A., & Martinez, A. (2015). Learning ROS for robotics programming. Packt Publishing Ltd.*
- *O'Kane, J. M. (2014). A gentle introduction to ROS.*
- *Koubaa, A. (Ed.). (2017). Robot Operating System (ROS) (Vol. 1, pp. 112-156). Cham, Switzerland: Springer.*
- *Newman, W. (2017). A systematic approach to learning robot programming with ROS. Chapman and Hall/CRC.*

Course Title: PERSONALITY DEVELOPMENT PROGRAMME

Course Code: BVR609

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Assess the commercial viability of new technologies, business opportunities and existing companies
2. Plan, organize, and execute a project or new venture with the goal of bringing new products and service to the market
3. Carry out scientific research in the field of entrepreneurship
4. Improved your interpersonal and collaborative skills and Write scientific reports and communicate the results in a professional manner

Course Content

UNIT-I **8 Hours**

Introduction to Generic Skills: Importance of Generic Skill Development (GSD), Global and Local Scenario of GSD, Life Long Learning (LLL) and associated importance of GSD.

Managing Self: Knowing Self for Self Development- Self-concept, personality, traits, multiple intelligence such as language intelligence, numerical intelligence, psychological intelligence etc., Managing Self – Physical- Personal grooming, Health, Hygiene, Time Management, Managing Self – Intellectual development -Information Search: Sources of information, Reading: Purpose of reading, different styles of reading, techniques of systematic reading, Note Taking: Importance of note taking, techniques of note taking, Writing: Writing a rough draft, review and final draft. Managing Self – Psychological, Stress, Emotions, Anxiety-concepts and significance, Techniques to manage the above.

UNIT-II **5 Hours**

Managing in Team: Team - definition, hierarchy, team dynamics, Team related skills- sympathy, empathy, co-operation, concern, lead and negotiate, work well with people from culturally diverse background, Communication in group - conversation and listening skills.

UNIT-III **7 Hours**

Task Management: Task Initiation, Task Planning, Task execution, Task close out, Exercises/case studies on task planning towards development of skills for task management

Problem Solving: Prerequisites of problem solving- meaningful learning, ability to apply knowledge in problem solving, Different approaches for problem solving. Steps followed in problem solving. Exercises/case studies on problem solving.

UNIT-IV **10 Hours**

Entrepreneurship: Introduction, Concept/Meaning and its need, Competencies/qualities of an entrepreneur, Entrepreneurial Support System e.g., District Industry Centre's (DICs), Commercial Banks, State Financial Corporations, Small Industries Service Institute (SISIs), Small Industries Development Bank of India (SIDBI), National Bank of Agriculture and Rural Development (NABARD), National Small Industries Corporation (NSIC) and other relevant institutions/organizations at State/National level. Market Survey and Opportunity Identification (Business Planning)- How to start a small scale industry, Procedures for registration of small-scale industry, List of items reserved for exclusive manufacture in small-scale industry, Assessment of demand and supply in potential areas of growth, understanding business opportunity, Considerations in product selection, Data collection for setting up small ventures. Project Report Preparation- Preliminary Project Report, Techno-Economic Feasibility Report, Exercises regarding "Project Report Writing" for small projects.

Transaction Modes

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning.

Suggested Readings:

- *Sinha, S. (2014). Complete Personality Devlopment Course. Diamond Pocket Books Pvt Ltd.*
- *Bandura, A. (1963). Social learning and personality development. Holt, Rynehart and Winston.*
- *Dweck, C. S. (2013). Self-theories: Their role in motivation, personality, and development. Psychology press.*