Course Structure (B.Voc.)

Applied Computer Science

Preamble

It is well identified that the regular curriculum gives an indepth knowledge about the subject, however, problem identification and its solution is rarely horned among the students. This often is a remark made by on-campus placement companies. In view of this, under the Deen Dayal Upadhaya Kaushal Kendra scheme, UGC envisages to develop a curriculum with more emphasis on skill than theoretical concepts. The present syllabus is designed to

- ***Train students in computational skills in various branches of sciences using standard and popular softwares.***
- ***The students would be introduced to various techniques with adequate theory exposure as per the problem they pick-up for solving.***
- ***Simulate the situation entry level programmers face when they enter an IT job.***

In each paper, more than 60% of time is allocated for hands-on/ lab training with a clear idea that the subject is to be taught on project mode. To encourage and train students to be industry ready, partners from industry would be invited to teach papers and challenge students with industry related projects. It hence becomes mandatory that the students evaluation will be made based on his/ her ability to solve problems and to be evaluated parallely by experts from the industry. The semester has been designed for 30 hours per week class-room/ lab interaction with the students, of which only 12 hours will be for theory. The student hence at the end of the semester will be evaluated in a ratio of 25:50:25, where 25 marks worth of final theory examination will be held by University and 50 marks lab evaluation will be done by University appointed faculty and expert from industry. 25 marks will be reserved for continuous evaluation by the concerned faculty

Course Listing

Semester I:

Course	Paper Title	Credit Skill/Educational	
BVCS11	Computer Programming with Python	3	3
BVCS12	Programming in Linux	3	3
BVCS13	Java Applet programming	3	3
BVCS14	Network Configuration and Management	6	0
BVCS15	Technical Documentation and Communication	3	3
	TOTAL	**18+12**	

Semester II:

Course	Paper Title	Credit Skill/Educational	
BVCS21	Website Designing	6	0
BVCS22	Data Base Management System	3	3
BVCS23	Android Programming	3	3
BVCS24	Animation and Motion Graphics	3	3
BVCS25	Technical Entrepreneurship and IPR	3	3
	TOTAL	**18+12**	

Semester III:

Course	Paper Title	Credit Skill/Educational	
BVCS31	Digital Logic and Processors	3	3
BVCS32	Introduction to IoT	3	3
BVCS33	Analog and Digital Communication	3	3
BVCS34	Robotics with Arduino	6	0
BVCS35	Microprocessor 8085	3	3
	TOTAL	**18+12**	

Semester IV:

Course	Paper Title	Credit Skill/Educational	
BVCS41	Math I: Real Analysis	3	3
BVCS42	Data Structure and Algorithms	3	3
BVCS43	Cloud Computing	6	0
BVCS44	Probability and Statistics	3	3
BVCS45	Critical Design Thinking in Social Science	3	3
	TOTAL	**18+12**	

Semester V:

Course	Paper Title	Credit Skill/Educational	
BVCS51	Computational Applied Biology	3	3
BVCS52	Data Analytics	3	3
BVCS53	Numerical Analysis in Python/Matlab	6	0
BVCS54	Modelling and Simulation using ODE and PDE in C++/ Python	3	3
BVCS55	Software Testing and Verification	3	3
	TOTAL	**18+12**	

Semester VI:

Course	Paper Title	Credit Skill/Educational	
BVCS61	Math II: Linear Algebra	3	3
BVCS62	Data Warehousing and Data Mining	3	3
BVCS63	Language and speech Processing	3	3
BVCS64	Cryptography and Network Security	3	3
BVCS65	Project/ Dissertation	6	0
	TOTAL	**18+12**	

SEMESTER 1

BVCS11: Computer Programming with Python
CREDITS: 6
Learning Outcomes:
After pursuing this paper, students would be able to:

- *Use procedural statements — assignments, conditional statements, loops, method calls — and arrays.*
- *Design, code, and test small Python programs that meet requirements expressed in English.*
- *Use concepts of object-oriented programming: classes, sub-classes, properties, inheritance*
- *Write a code for basic searching and sorting*
- *Work independently in order to develop simple programs of up to several hundred lines, either from scratch or making use of standard libraries.*

Unit 1

The Python Interpreter, Basic Syntax, Variable and Data Types, Mathematical Operators, Output and Input, Conditional Statements like if, if-else, nested if-else, looping with for, while, nested loops. Control Statements like break, continue, pass.

Unit 2

String manipulation, accessing strings, basic operations, string slices, function and methods. Lists, operations and working with list. Printing on screen, reading data from keyboard, file handling, formating output.

Unit 3

User defined functions, calling function, global and local variables, recursuve functions, Numpy: Arrays, Difference of arrays and lists, Reading arrays from files, writing arrays in files, Arithmetic with arrays. Plotting Graphs: Using Matplotlib, 1-d and 2-d graphs, customising scale, range and legends, polar graphs.

Unit 4
Making modules and packages, importing packages. Object oriented Programming, Classes, Instances, Objects and methods, subclassing, derivation and inheritance.

Readings:

1. Chun, Wesley J. (2006). *Core Python Programming.* Prentice Hall.
2. Guttag, John V. (2013). *Introduction to computation and programming using python*, MIT Press.
3. Slatkil, B. (2015). *Effective Python-- 59 ways to write better python.* Addison-Wesley.
4. David Beazley, D. and Jones, Brian K. (2013). *Python Cook Book.* O'Reilly.

BVCS12: Programming in Linux

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would

- *Identify and use Linux utilities to create and manage simple file processing operations, organize directory structures with appropriate security, and develop shellscripts to perform more complex tasks.*
- *Effectively use the Linux system to accomplish typical personal, office, technical, and software development tasks.*
- *Monitor system performance and network activities.*
- *Effectively use software development tools including libraries, preprocessors, compilers, linkers, and make files.*

Unit 1

The Linux Foundation, Linux Philosophy and Concepts

Unit 2

Linux Basics and System Startup, Graphical Interface, System Configuration From The Graphical Interface,

Unit 3

Common Applications, Command Line Operations, Finding Linux Documentation, Processes, File Operations, Text Editors, User Environment, Manipulating Text, Network Operations,

Unit 4

The Bash Shell and Basic Scripting, More on Bash Scripting, Printing, Local Security Principles

Readings:

1. Negus, C. (2015). *Linux Bible.* Wiley.
2. Kernighan, Brian W. and Pike, R. (2015). *The Unix Programming Environment. Pearson Education India*
3. Shotts, William E. (2019). *The Linux Command Line: A complete* Introduction. No Starch Press.
4. Bryant, Randal E. And O'Hallaron, David R. (2015). *Computer Systems A Programmer's Perspective (CSAPP).* Pearson.

BVCS13: JAVA Applet Programming

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would have the knowledge and skills to:

- *Read and understand Java-based software code of medium-to-high complexity.*
- *Use standard and third party Java's API's when writing applications.*
- *Understand the basic principles of creating Java applications with graphical user interface (GUI).*
- *Create rich user-interface applications using modern API's such as JAVAFX.*
- *Test a Java application of medium complexity, consisting of multiple classes.*

Unit 1

Java Introduction to sdk installation and Eclipse IDE setup.

Unit 2

Understanding the Programming Environment (byte-code generation, JDK, JRE, JVM), Program Structure-packages, classes, fields, methods. Data Types, Variables, operators supported. Type Conversion.

Unit 3

Local and global variables. Block scope. Control flow statements(conditionals, loops). Input/Output from/to console. Working with Objects- Role of constructor. Using imports. Strings in Java.

Unit 4

Introducing arrays (1D,2D), array of objects, File reading. Java Module: Introduction to Classes and Objects Programming

Readings:

1. Schildt, H. (2017). *Java: A Beginner's Guide*. McGraw-Hill Education.
2. Horstmann, Cay S. (2016). *Core Java Volume I – Fundamentals.* Prentice Hall.
3. Blokdyk, G. (2019). *Java Applet a Clear and Concise Reference.*
4. Boese, Elizabeth S. (2009). *An Introduction to Programming with Java Applets.* Jones & Bartlett Learning.
5. Deitel, Paul J. and Deitel, Harvey M. (2017). *Java-- How to Program.* Pearson.

BVCS14: Network Configuration and Management

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Independently understand basic computer network technology.*
- *Understand and explain Data Communications System and its components.*
- *Identify the different types of network topologies and protocols.*
- *Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.*
- *Identify the different types of network devices and their functions within a network*
- *Understand and building the skills of subnetting and routing mechanisms.*
- *Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation*
- *be enabled to diagnose and troubleshoot Network problems and manage various Internet Application Servers.*

Unit 1

Computer Network Design: Introduction, Topology, Components of Computer Network, Open system Interconnect (OSI), TCP/IP Model. Physical Media: Copper, Fiber and Wireless.

Unit 2

LAN Architecture: Ethernet CSMA/CD protocol, 10/100/1000/10 G Ethernet, Switching and Routing: L2 & L3 switching, Routing, VLAN, CISCO L2 & L3 switch configuration, WAN architecture: STM Leased line, Metro Ethernet, DSL Broadband, GPON, 3G/4G/LTE Mobile Data, IP Addressing and Transport Protocols: IPv4 addressing, Subnetting, IPv6, TCP/UDP/RTP.

Unit 3

Wireless LAN 802.11 a/b/g/n/ac protocol, Access Point, Wireless Controller and Wireless Router configurations, WLAN Planning and Performance, Internet Architecture: ISP architecture, BGP routing, Content Mirroring.

Unit 4

Internet Applications: DNS, Web, Mail, Proxy, NTP, Remote Login, SSH, SFTP, SCP. Perimeter Security: Frewall, UTM. Network Security: LAN & WLAN security issues, IP/MAC spoofing, Dictionary, DoS/DDoS attacks, Rogue/Misconfigured/External APs, Network Troubleshooting: Ping, traceroute, nslookup/dig, tcpdump, Wireshark, Wireless Monitoring. Network Monitoring: SNMP, MRTG/PRTG

Readings:

1. Stallings, W. (2014). *Data and Computer Communications.* Pearson Education India.
2. Blokdyk, G. (2019). *Computer Network Administration A Clear and Conscise Reference.* 5STARCooks.
3. Wetherall, David J. and Tanenbaum, Andrew S. (2013) *Computer Networks*. Pearson Higher Education.

BVCS15: Technical Documentation and Communication

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *Recognize, explain, and use the formal elements of specific genres of organizational communication: white papers, recommendation and analytical reports, proposals, memorandums, web pages, wikis, blogs, business letters, and promotional documents.*
- *Understand the ethical, international, social, and professional constraints of audience, style, and content for writing situations (a.) among managers or co-workers and colleagues of an organization, and (b) between organizations, or between an organization and the public.*
- *Understand the current resources (such as search engines and databases) for locating secondary information, and also understand the strategies of effective primary data gathering.*
- *Understand how to critically analyze data from research; incorporate it into assigned writing clearly, concisely, and logically; and attribute the source with proper citation.*
- *Practice the unique qualities of professional rhetoric and writing style, such as sentence conciseness, clarity, accuracy, honesty, avoiding wordiness or ambiguity, using direct order organization, readability, coherence and transitional devices.*
- *Explore different format features in both print, multimedia and html documents, and develop document design skills.*
- *Revise and edit effectively in all assignments, including informal media (such as email messages to the instructor).*
- *Develop professional work habits, including those necessary for effective collaboration and cooperation with other students, instructors and Service Learning contact representatives.*

Unit 1

Introduction to Technical Writing: Definition of Technical Writing, Characteristics of Effective Technical Communication, Accuracy, Clarity, Conciseness, Coherence, Appropriateness. Planning and Producing Documents: Document Purpose, Problem Statement, Audience, Technical writing process.

Unit 2

Document: Types. Memoranda: Literature Reviews, Research Articles, Progress Reports, Letters, References and Letters of Recommendation, Technical-Information Letters and Memoranda. Software Documentation and Source code comments: Writing Software Documentation, Tools for software documentation. Proposals. Task-Oriented Documents: Specifications, Documentation (Manuals),

Unit 3

Technical Documentation. Thesis: Writing Process, Thesis Proposal, Format of the Thesis. Oral Presentations: A Design Review. Elements of Technical Documents: Sections and Subsections, Headings and Subheadings, Front Matter, Body, End matter. Graphs and Figures: Common Graphics, Tables, Bar Graphs, Illustration, Diagrams, Photographs, Schematic-Graphs, Flowcharts, Timetables, Paragraphs, Sentence, Words, Technical terms, Vague language, biased language. Punctuation, Citing and Listing Reference, Part of Speech,

Unit 4

Writer's Resources: Introduction to Scientific Word and LaTeX, review PowerPoint, MS-word/LibreOffice, Common Writing Problems for Non-Native Speakers of English.

Readings:

1. Perelman, Leslie C., Paradis, P., Parrett, E. (1998). *The Mayfield Handbook of Technical and Science Writing.* Mayfield Publishing Company, Inc.
2. Guark, Laura J. and Lannon, John M. (2007). *Concise Guide to Technical communication.* Longman.
3. Daniel, R. and Wisconsin, P. (2002). *Technical Report Writing Today.* Houghton Mifflin College Division.
4. Alley, M. (1998). *The Craft of Scientific Writing.* Springer-Verlag.

SEMESTER 2

BVCS21: Website Designing

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *Employ fundamental computer theory to basic programming techniques.*
- *Use fundamental skills to maintain web server services required to host a website.*
- *Select and apply markup languages for processing, identifying, and presenting of information in web pages.*
- *Use scripting languages and web services to transfer data and add interactive components to web pages.*
- *Create and manipulate web media objects using editing software.*
- *Incorporate aesthetics and formal concepts of layout and organization to design websites that effectively communicate using visual elements.*
- *Conceptualize and plan an internet-based business that applies appropriate business models and web technologies.*
- *Combine multiple web technologies to create advanced web components.*
- *Design websites using appropriate security principles, focusing specifically on the vulnerabilities inherent in common web implementations.*

Introduction to the Internet, Creating a Basic Web Page, Basic XHTML tags, Lists, Tables, Links, Images, Intro to Cascading Style Sheets, CSS Value and Common CSS Properties, Understanding URL, Using Different CSS Selector, Page Layout Techniques, Dreamweaver Introduction, JavaScript Introduction; Variable, If-Else, Switch, JS-Operator, Popups, Function; Loop, Forms, Events and Handling Events, Try-Catch Throw, JavaScript Objects, Intro to JS Objects, JS Built in Objects.

Readings:

1. Duckett, J. (2011). *HTML & CSS: Design and Build Web Sites.* Wiley.
2. Robbins, Jennifer N. (2012). *Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics.* O'Reilly Media.

BVCS22: Data Base Management system

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *have a broad understanding of database concepts and database management system software*
- *have a high-level understanding of major DBMS components and their function*
- *be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.*
- *be able to write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.*
- *be able to program a data-intensive application using DBMS APIs.*

Unit 1

Introduction and File Structures

Unit 2

Linear Hashing (LH), Comaprison of Linear and Extendible hashing, Variant of LH,

Unit 3

Index Structures, bit sliced indices, techniques for Ad-hoc OLAP quesries, Query Processing, Query Optimization, Introduction to Transactions, Concurrency Control, Recovery,

Unit 4

Database Security, multi-level security, explicit and implicit flows,Timing covert channel, Distributed Databases

Readings:

1. Elmasri, R. and S. Navathe, S. (2015). *Fundamentals of Database Systems.* Pearson.
2. Silberschatz, A., Korth, H. and Sudashan, S. (2013). *Database System Concepts.* McGraw Hill.

BVCS23: Android Programming

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *Understanding of Mobile Operating Systems (w.r.t. Android) and its limitations vis – a –vis normal operating system - concurrency, resource consumption etc.*
- *Install and configure Android application development tools.*
- *Design and develop user Interfaces for the Android platform.*
- *Save state information across important operating system events.*
- *Apply Java programming concepts to Android application development.*
- *Ability to design end-to-end mobile applications, using platforms such as Node.js, Google App Engine etc.*
- *Ability to write JVM unit test, device UI test, debugging and fixing application crash*

Unit 1

Introduction to Android Programming, Different Platforms, Architecture and working of Android. Android Development Environment: What is Android, Advantages and Future of Android, Tools and about Android SDK, Installing Java, Eclipse, and Android,

Unit 2

Android Software Development Kit for Eclipse, Android Development Tool: Android Tools for Eclipse, AVDs: Smartphone Emulators, Image Editing, Android Software Development Platform: Understanding Java SE and the Dalvik Virtual Machine, Directory Structure of an Android Project, Common Default Resources Folders, The Values Folder, Leveraging Android XML, Screen Sizes,

Unit 3

Launching Your Application: The AndroidManifest.xml File, Creating Your First Android Application. Android Framework Overview: The Foundation of OOP, The APK File, Android Application Components, Android Activities: Defining the User Interface, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications, Content Providers: Data Management, Android Intent Objects: Messaging for Components, Android Manifest XML: Declaring Your Components. Views and Layouts, Buttons, Menus, and Dialogs, Graphics Resources in Android: Introducing the Drawables, Implementing Images, Core Drawable Subclasses, Using Bitmap, PNG, JPEG and GIF Images in Android, Creating Animation in Android

Unit 4

Handling User Interface(UI) Events: An Overview of UI Events in Android, Listening for and Handling Events, Handling UI Events via the View Class, Event Callback Methods, Handling Click Events, Touchscreen Events, Keyboard Events, Context Menus, Controlling the Focus. Working with a Database.

Readings:

1. Raj K. (2011).*Mobile Computing.* Oxford University Press.
2. Griffiths, D. and Griffith, D. (2017). *Head Fiirst Android Development: A Brain-Friendly Guide.* O'Reilly Media.

3. Darwin, Ean F. (2017). *Android Cook Book*. O'Reilly Media.

BVCS24: Animation and Motion Graphics

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *Choose appropriate colour combinations for presentations*
- *To create digital art*
- *Understand concepts of Isometric and Perspective drawing*
- *Create Simple or complex objects and architectural structures*
- *Create 3d 'walk-throughs'*
- *Make Photo Realistic Scenes*
- *Create Animated Montages for Television or for presentations*
- *Create Titles for Films*
- *Make Short Animation sequences*
- *For the more ambitious making a career in media will be a possibility*

Unit 1

Digital Art, Visual Chemistry of Colours, Principles of Engineering Drawing, Isometric Drawing and Perspective,

Unit 2

Modelling of 3d Objects, Materials of Objects, Surface Mapping of Images and materials, Lighting.

Unit 3

Principles of Animation, Creating Movement Paths,

Unit 4

Virtual Camera Positioning and movements. AutoCAD.

Readings:

1. Carey, B. (2000). *Grokking the GIMP: Advanced Techniques for working with Digital Images. New Riders.*
2. Kulagin, B. (2006). *3ds max 8: From Modeling To Animation.* A-List Publishing.
3. Kulagin, B. (2003). *Advanced 3ds max 5: Modeling & Animating. A-List Publishing.*

BVCS25: Technical Entrepreneurship and IPR

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would know:

- *The concepts and practice of entrepreneurship, difference and relationship between entrepreneurship and innovation*
- *How to identify the attitudes, values, characteristics, and processes associated with successful entrepreneurial behaviour and entrepreneurial process of turning an idea into a viable and sustainable venture and to communicate these ideas and concepts effectively*
- *To have an understanding of the fundamental legal principles relating to confidential information, copyright, patents, designs, trade marks and unfair competition;*
- *To be able to identify, apply and assess principles of law relating to each of these areas of intellectual property;*
- *To understand current and emerging issues relating to the intellectual property protection, including those relating to indigenous knowledge or culture, information technology especially the distribution of material on the internet, biotechnology and international trade*

Unit 1

Entrepreneurial motivation, Entrepreneurial creativity, Entrepreneurial opportunities and the "inevitabilities"

Unit 2

Business models, Platform standards, Intellectual property search techniques, Entrepreneurial role and identity, Entrepreneurial journeys,

Unit 3

Licensing agreements, Business Model Review, Growth & Exit.

Unit 4

IPR: Overview of Intellectual Property, Patents, Copyright, Trademarks, Geographical indications, industrial designs, new plant varieties, unfair competition, enforcement of intellectual property right

Readings:

1. *Gerard, G. and Bock, Adam J. (2008). Inventing Entrepreneurs: Technology Innovators and their Entrepreneurial Journey.* Prentice Hall Professional.

2. Murray, Thomas H. and Mehlman, Maxweell J. (2000) *Encyclopedia of Ethical, Legal and Policy issues in Biotechnology.* Wiley-Interscience.

SEMESTER 3

BVCS31: Digital Logic and Processors

CREDITS: 6

Learning Outcomes:

After pursuing this paper, students would:

- *Understand the logical behaviour of digital circuits*
- *Understand the advantages and disadvantages of programmable logic devices*
- *Know how to describe digital hardware using a software-style language*
- *Design, simulate and implement basic combinational and sequential logic circuits.*
- *Understand how a basic microprocessor can be built from standard building blocks*

Unit 1

Digital Processing of Information: Analog and Digital representations of information; Data vs signal; Information processing steps – logic and arithmetic. Digital Logic :- Binary variables; Basic logic operations – AND, OR, NOT;

Unit 2

Basic gates, Essentials of Boolean algebra, De Morgan's laws, Truth Table, Boolean functions; Transforming a logical problem statement into a Boolean expression. Number Systems and Arithmetic: Positional number systems-Binary, Decimal, Octal, Hexadecimal; Signed number representations; Arithmetic operations.

Unit 3

Combinational Circuit Design –Realisation of Boolean functions using gates; Karnaugh map; Minimisation of Boolean functions; Multiplexer-based realization of K-maps; Combinational circuit design using multiplexers and gates.

Unit 4

Sequential Circuit Design –Latches and Flip-flops; Ripple counters; Sequence generator using flip-flops; State Table and State Diagram; Synchronous counters; Shift Registers; Ring and MLS counters. Pipelining:Pipelining with Edge Triggered Flip Flop, Pulse Triggered Flip Flop and Latches. Introduce the concepts of Skew and Jitter. Introduction to Verilog. Writing of Verilog codes for combinational circuits.

Readings:

1. Mano, Morris R. And Ciletti, Michael D. (2012). *Digital Design* : *With an Introduction to the Verilog HDL, VHDL, and SystemVerilog.* Prentice Hall.
2. Brown, S. and Vranesic, Z. (2017). *Fundamentals of Digital Logic with Verilog Design (SIE).* McGraw Hill Education.
3. Mano, Morris M. (2016). *Digital Logic and Computer Design.* Pearson Education India.

BVCS32: Introduction to Internet of Things (IoT)

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *explain the definition and usage of the term 'the internet of things' in different contexts*
- *understand where the IoT concept fits within the broader ICT industry and possible future trends*
- *understand the various network protocols used in IoT*
- *be familiar with the key wireless technologies used in IoT systems, such as WiFi, 6LoWPAN, bluetooth and ZigBee.*
- *understand and be able to explain the role of big data, cloud computing and data analytics in a typical IoT system*
- *design a simple IoT system made up of sensors, wireless network connection, data analytics and display/actuators, and write the necessary control software*
- *build and test a complete working IoT system*

Unit 1

Comprehensive introduction, training in sensing mechanisms, protocols for such devices, as well as an in-depth understanding of networking mechanisms.

Unit 2

Exposure to sensors: motion sensors, pressure sensure, temperature sensors, humidity sensor etc.

Unit 3

Deployment and configuration of these sensors in the real world with a focus on energy efficiency, challenging deployment conditions, routing and data gathering.

Unit 4

A substantial emphasis will be placed on software implementation. All students are expected to learn (largely on their own) how to program (hardware) and run simulations.

Readings:

1. Guinard D. And Trifa, V. 2016). *Building the Web of Things: With Examples in Node.js and Raspberry Pi.* Manning Publications.
2. Zhou, H. (2012). *Internet of things in the cloud : a middleware perspective.* CRC Press.
3. Internet of things in the cloud : a middleware perspective
4. Pfister, C. (2011). *Getting started with the Internet of things – Connecting sensors and microcontrollers to the cloud.* Maker Media, Inc.
5. Doukas, C. (2012). *Building internet of things with the Arduino : vol.1.* Createspace Independent publication Platform.

BVCS33: Analog and Digital Communication

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Understand basic elements of a communication system*
- *Conduct analysis of baseband signals in time domain and in frequency domain*
- *Demonstrate understanding of various analog and digital modulation and demodulation techniques.*
- *Analyse the performance of modulation and demodulation techniques in various transmission environments*

Unit 1

Introduction to analog and digital communication system, Classification of Signals and Systems, Probability and Random process, Fundamentals of digital modulation/ Demodulation,

Unit 2

PAM, Phase modulation and QAM, Power spectrum of digital modulated signals. Detection of Signals in AWGN : Maximum likelihood detection, Matched filtering, Impact of phase and timing uncertainties,.

Unit 3

Error correcting coding: Linear block codes, Cyclic codes, Convolutional codes, Performance Analysis. Inter symbol Interference: Nyquist criterion, Equalization techniques.

Unit 4

Brief Introduction to modulation and coding in different wireless standards: Cellular standards (2g, 3g, 4g), IEEE 802.11a, b, g and n (Wi-Fi), Other existing standards.

Readings:

1. Sklar, B. (2013). *Digital Communications: Fundamentals and Applications.* Pearson.
2. Haykin, S. (2013). *Digital Communication Systems. Wiley.*
3. Lathi, B.P. and Ding, Z. (2017). *Modern digital and analog communication systems.* Oxford University Press.
4. Ziemer, Rodger E. and Tranter, William H. (2014). *Principles of communications – Systems, Modulation and Noise.* Wiley.
5. Barry, John R., Lee, Edward A. and Messerschmitt, David G. (2004). *Digital communication.* Springer.
6. Proakis, J. and Salehi, M. (2014). *Fundamentals of Communication Systems.* Pearson.

BVCS34: Robotics with Arduino

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Program a microcontroller by writing programs that display messages, remember values, make computations with math operators, and interact with external circuits.*
- *Build circuits to apply principles of electronics, including voltage, resistance, current, signal generation, and signal monitoring.*
- *Build and adjust an autonomous control system that monitors sensor input and responds with motion output.*
- *Identify and apply additional STEM concepts including physics (the light spectrum, frequency, sound, motion) and engineering skills (mechanics, troubleshooting, problemsolving, subsystem testing, and setpoints).*
- *Implement computing and electronics in the classroom.*

Robotic motion and collision avoidance, localization, and vision-based control. Use ROS as the software platform on which the simulations will be carried out and the projects can be carried on hardware. ROS allows seamless integration from simulation to real-world implementation.

Readings:

1. Lavalle, Steven M. (2006). *Planning Algorithms*. Cambridge University Press.
2. Choset, H., Lynch, Kevin M., Hutchinson, S., Kantor, George A., Burgard, W., Kavraki, Lydia E., Thrun, S. (2005). *Principles of Robot Motion: Theory, Algorithms, and Implementations.* MIT press.

BVCS35: Microprocessor 8085

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would be able to

- *understand and apply the fundamentals of of microprocessors and microcontroller.*
- *Work with standard microprocessor real time interfaces including GPIO, serial ports, digital-to-analog converters and analog-to-digital converters;*
- *Troubleshoot interactions between software and hardware;*
- *Analyze abstract problems and apply a combination of hardware and software to address the problem;*
- *Use standard test and measurement equipment to evaluate digital interfaces.*

Unit 1

Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used) Microprocessor 8085: Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses.

Unit 2

Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O. 8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions.

Unit 3

Assembly language programming examples. Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T-states, time delay.

Unit 4

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts. Interfacing with 8255.

Readings:

1. Gaonkar, R. (2013). *Microprocessor Architecture, Programming and Applications with 8085.* Penram International Publishing.
2. Umashankar B.S. and Udaya Kumar K. (2008). *The 8085 Microprocessor: Architecture, Programming and Interfacing*. Pearson India.
3. Mandal, S. (2017). *Microprocessors and Microcontrollers Architecture, Programming and interfaacing Using 8085, 8086 and 8051*. McGraw Hill Education.

SEMESTER 4

BVCS41: Math I: Real Analysis

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would

- *Analyze behavior of multi-variate functions,*
- *Use calculus to build approximations to functions and*
- *Determine the fourier series of piece-wise continuous functions.*

Unit 1

The course will start with review of differential calculus (limits, continuity, differentiation) of functions of single variable, series of functions, convergence (point-wise and uniform convergence),

Unit 2

multi-variate functions, Taylor's Theorem, vector algebra, gradient, divergence and curl of a vector field.

Unit 3

Cartesian, spherical polar and cylindrical coordinate systems and basic idea of conversion.

Unit 4

Piecewise continuous periodic functions and their fourier series representation.

Readings:

1. Stewart, J. (2013). *Calculus with Early Transcendental Functions.* Cengage.
2. Wade, W. (2017). *An Introduction to Aanalysis.* Peaarson Modern Classic.
3. Spiegel, M. , Lipschutz, S. and Spellman, D. (2017). *Vector Analysis : Schaum's Outlines Series*. McGraw Hill Education.
4. Kreyszig, E. (2015). *Advanced Engineering Mathematics.* Wiley.

BVCS42: Data Structure and Algorithms

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Students develop knowledge of basic data structures for storage and retrieval of ordered or unordered data. Data structures include: arrays, linked lists, binary trees, heaps, and hash tables.*
- *Students 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.*
- *Students learn to analyze and compare algorithms for efficiency using Big-O notation.*

Unit 1

Review of Java Programming, handling arrays, methods, linear search, insertion sort, selection sort and Bubble sort, Binary search, Time Complexity, Asymptotic Analysis, Big O notation,

Unit 2

Recurrence relation, Revision of Recursion:-Fibonacci sequence generation, Tower of Hanoi, Lists and Implementations:- Linked lists , Recursive functions on lists, Deletion, insertion, reversing, joining, Stacks, Queues using linked lists, handling Polynomials,

Unit 3

Tree data structure and Implementations: binary and complete trees, tree traversals, tree algorithms, Binary search trees, insertion and deletion Sorting Algorithms:- Merge and Quick sort, AVL trees, B-Trees, Heap Trees - Priority Queues, heap sort, Hashing:-Chained Hash Tables, Linear Probing, Double Hashing, Disjoint Set Class:-Smart Union Algorithms, Path compression,

Unit 4

Graph and Direct Acyclic Graph Algorithms:-BFS, DFS,Topological sort,Minimum spanning trees, Huffman coding, Shortest path

Readings:

1. Cormen, Thomas H., Leiserson, Charles E., Rivest, Ronald L. and Stein, C. (2009). *Introduction to Algorithms.* The MIT Press.
2. Sahni, S. (2004). *Data Structures, Algorithms and Applications in JAVA*. Silicon Press.
3. Weiss, Mark A. (2011). *Data Structures and Algorithm Analysis in Java.* Pearson.
4. Goodrich, Michael T., Tamassia, R. and Goldwasser, Michael H. (2014). *Data Structures and Algorithms.* Wiley.

BVCS43: Cloud Computing

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing*
- *identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.*
- *explain the core issues of cloud computing such as security, privacy, and interoperability.*
- *choose the appropriate technologies, algorithms, and approaches for the related issues.*
- *identify problems, and explain, analyze, and evaluate various cloud computing solutions.*
- *provide the appropriate cloud computing solutions and recommendations according to the applications used.*

Introduction to Cloud Computing, Cloud Computing Architecture, Service Management in Cloud Computing, Data Management in Cloud Computing, Resource Management in Cloud, Cloud Security, Open Source and Commercial Clouds, Cloud Simulator, Research trend in Cloud Computing, Fog Computing

Readings:

1. *Buyya, Broberg, J., Goscinski, Andrzej M. (2011). Cloud Computing: Principles and Paradigms*, Editors: Wiley.
2. Shroff, G. (2010). *Enterprise Cloud Computing - Technology, Architecture, Applications.* Cambridge University Press.
3. Sosinsky, B. (2011). *Cloud Computing Bible.* John Wiley & Sons.
4. Krutz, Ronald L., Vines, Russell D. (2010). *Cloud Security: A Comprehensive Guide to Secure Cloud Computing.* Wiley.

BVCS44: *Probability and Statistics*

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Perform quantitative uncertainty analysis with emphasis on engineering applications.*
- *Know about conditional PDF(s) and PMF(s), of common random variables.*
- *Estimate the parameters of common probability distributions and test hypothesis for random samples.*
- *Implement all above on MATLAB/SCILAB*

Unit 1

Introduction to probability mass and density functions, conditional probability,

Unit 2

Bayes' Theorem, Discrete and Continuous Random Variables and vectors, Cumulative Density Functions, Probability Density Functions (Binomal, Poisson and Normal), Sample mean and variance,

Unit 3

Markov and Chebyshev Inequality, Central Limit Theorem, Weak Law of Large Numbers, statistical hypothesis testing, univariate regression analysis and parameter estimation, maximum likelihood and method of least squares, uncertainty in estimation of parameters, goodness of fit (correlation coefficient and chi-squared test),

Unit 4

Kolmogorov-Smirnov statistic, Confidence Level and intervals and Hypothesis test

Readings:

1. Ross, Sheldon M. (2014). *Introduction to Probability and Statistics for Scientists and Engineers.* Academic Press.
2. *Barlow, R. J. (1993). Statistics – a guide to the use of S*tatistical M*ethods in Physical Sciences.* Wiley.
3. Bevan, A. (2013). *Statistical Data Analysis for Physical Sciences.* Cambridge University Press.
4. Spiegel, Murray R., Schiller, J. and Srinivasan, R. Alu (2009). *Schaum's Outlines: Probability and Statistics.* McGraw-Hill.

BVCS45: Critical Design Thinking in Social Sciences

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Possess a well-developed awareness of professional practice in the context of the communication industries*
- *Apply theoretically informed understanding of the communication industries in independent and collaborative projects across a range of media*
- *Possess information literacy skills to locate, gather, organise and synthesise information across diverse platforms to inform the understanding of the communication industries*
- *Be reflexive critical thinkers and creative practitioners who are intellectually curious, imaginative and innovative, with an ability to evaluate their own and others' work*
- *Possess the awareness of ethical practice in the personal, political and professional contexts of civil society*
- *Possess well-developed skills and proficiencies to communicate and respond effectively and appropriately across different contexts*
- *Demonstrate digital literacy and production skills across a range of media and media texts*

Unit 1

This course introduces the learner to the fundamentals of critical thinking and informal logic. This subject uses design-thinking methodologies to empower students to lead social entrepreneurship and innovation movements using interdisciplinary perspectives. It introduces students to the process of design thinking (defining the problem, empathising, ideating and innovating) using experimentation, and facilitates solutions through radical cross-boundary thinking in order to effect social change using a human-centred approach. This subject helps students develop the essential design-thinking skills of observing, interviewing, listening, empathising, team building, communicating, and analysing in order to imagine and create innovative solutions to common social issues by approaching it at a community level.

Unit 2

Students, in teams that mimic professional roles, collaboratively develop a design solution for a real-world scenario through the process of generating, iterating, and evolving an innovative project plan that they can add to their portfolios. We will use a ‘mixed’ instructional methodology that includes lecture, Q&A, learning team activities, discussion of videos, slides, print articles and the text.

Unit 3

Interactions with select external partner organisations that are corporate, government and not-for-profit groups seeking to engage with social innovation projects. The partners are invited to bring forward their social innovation challenges for students to tackle, from which each group will choose one problem to engage with through the session. This is achieved through critical inquiry, question-asking, rigorous creativity, participatory design, and informed ethics. Throughout the session, student teams prototype and test their ideas and in the end create a proposed solution that is presented back to partners at the end of the session in a pitching event.

Readings:

1. Ruggiero, Vincent R. (2011). *The Art of Thinking: A Guide to Critical and Creative Thought*. Longman.
2. Bassham, G., Irwin, W., Nardone, H. ,Wallace, James M. (2012). *Critical Thinking--A Student's Introduction*. McGraw-Hill Education.
3. Hayakawa, S.I (1991). *Language in Thought and Action*. Harcourt Brace International.
4. Watzlawick, P. (1977). *How Real is Real?* Vintage.
5. *Bono, E. (2000). Po-Beyond Yes and No*. Penguin.
6. Nardi, (2017). *Critical Thinking: Tools for evaluating Research.* University of California Press.
7. Kuhn, Thomas S. (2012), *The structure of scientific revolution*. University of Chicago Press.

SEMESTER 5

BVCS51: Computational Applied Biology

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Have a basic grasp of fundamental molecular biology concepts as relevant to this module*
- *Understand the statistical and algorithmic approach for detecting cell types from single-cell expression data of thousands of cells*
- *Have an understanding of how tissue slides are imaged with high throughput*
- *Understand some basic and commonly used algorithms in bioinformatics*
- *Know algorithms to compute sequence alignments and how these are applied in current research*

Unit 1

Basics of genetics and molecular biology; transcription and translation (DNA → mRNA → Protein); genotype and phenotype; 1-2 selective papers in the field; the role of genetics in diseases, Gene regulation mechanisms splicing, enhancers, chromosomal organization, epigenome,

Unit 2

Quantitative analysis of gene expression data, Cells as a basic unit of living organisms; cellular organization and cellular contents; different cell types (organs and tissues); control of cell number and cell size, Protein structure and function, Computation inside a cell: cells as a "chemical factory" (thermodynamic principles govern chemical reactions: energy and entropy); electrical signals are used by neural cells for information propagation; Generation and use of energy by cells, Cellular transport mechanisms (diffusion and directed transport),

Unit 3

Some basic cellular processes (cell growth, cell division, cell cycle, cell death); concept of cellular signaling; metabolic processes; Cells as a sensor for extracellular stimuli: ligands molecules, heat (temperature), pressure, shear stress, electrical stimulation, radiation. Quantitative approaches in elucidating cellular phenotype generation (genome → phenome), Systems level study in biology; network biology and its application in health studies and medicine, Data analysis for systems/network biology (for cellular activation),

Unit 4

Biology of diseases; mechanisms for generation of disease phenotypes; role of somatic mutations. Some disease types: infectious, autoimmune, degenerative and cancer. Precision/Personalized approaches to diseases and medicine.

Readings:

1. Bruce, A., Bray,D., Hopkin, K., Johnson, Alexander D., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. (2009). *Essential Cell Biology.* Garland Science.
2. Ahmed, N, Dawson, M., Smith, C.,Wood, Ed. (2006). *Biology of Diseasae*. Taylor & Francis.

3. Waterman, Michael S. (1995). *Introduction to Computational Biology: Maps, Sequences and genomes.* Chapman and Hall/CRC.

BVCS52: Data Analytics

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Perform data gathering of large data from a range of data sources.*
- *Critically analyse existing Data datasets and implementations, taking practicality, and usefulness metrics into consideration.*
- *Understand and demonstrate the role of statistics in the analysis of large of datasets*
- *Select and apply suitable statistical measures and analyses techniques for data of various structure and content and present summary statistics*
- *Understand and demonstrate advanced knowledge of statistical data analytics as applied to data sets*
- *Employ advanced statistical analytical skills to test assumptions, and to generate and present new information and insights from datasets*

Unit 1

Data Analysis: Overview of Analytics, Data Analysis,

Unit 2

Data Management. Data Science: Linear & Logistic Regression, Time Series, Machine Learning,

Unit 3

Bayesian Network & Neural Network Models. Introduction to Big Data and Hadoop.

Unit 4

Functional Analytics: Store Data Analytics, Customer Analytics, Pig, Hive, Hbase, Spark and Scala.

Readings:

1. Haider, M. (2015). *Getting Started with Data Science*. IBM Press.
2. O'Neil, C. and Schutt, R. (2013). *Doing Data Science: Straight Talk from the Frontline*. O'Reilly Media.
3. White, T. (2015). *Hadoop: The definitive Guide*. O'Reilly Media.

BVCS53: Numerical Analysis with Python/Matlab

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Apply appropriate algorithms to solve selected problems, both manually and by writing computer programs in C++/Matlab*
- *Compare different algorithms with respect to accuracy and efficiency of solution.*
- *Analyse the errors obtained in the numerical solution of problems.*
- *Using appropriate numerical methods, determine the solutions to given non-linear equations.*
- *Using appropriate numerical methods, determine approximate solutions to systems of linear equations.*
- *Demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.*

Topics include fundamental principles of digital computing and the implications for algorithm accuracy and stability, error propagation and stability, numerical techniques for root finding (Bisection, Secant, Newton Raphson), interpolation (Newton and Lagrange), approximation of functions, numerical differentiation and integration (Trapezoidal, Simpson and quadrature methods of integration) of functions (brief introduction to set of orthonormal functions – Legendre, Lagaurre and Hermite), direct (Gauss elimination) and iterative (Gauss Seidel) methods in linear algebra, eigen value problems. The course will also involve the application of these techniques for solving physical science problems and their implementation python/matlab/scilab.

Readings:

1. Gerald, Curtis F. and Wheatley, P. O. (2007). *Applied Numerical Analysis.* Pearson Education, India
2. Press, W. H. et. al. (2013). *Numerical Recipes in C ++ : The Art of Scientific Computing*. Cambridge University Press.
3. Burden, Richard L., Faires, J. D., Burden, Annette M. (2015). *Numerical Aanalysis.* Cengage Learning.

BVCS54: Modeling and Simulation using ODE and PDE in C++/Python

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Formulate a partial differential equation as a model for a simple problem.*
- *Classify 2nd order PDEs and describe their characteristic properties.*
- *Analyze and simulate partial differential equations by the methods taught in the course.*
- *Construct, implement and analyze numerical methods to compute (approximate) solutions to partial differential equations.*
- *Be able to write algorithms for simulations to solve physical problems based on these mathematical tools.*
- *Give a seminar presentation of the individual project and answer supplementary questions*

Unit 1

First order ODE, analytic solution of second order linear (homogeneous and non-homogneous) differential equations with constant coefficients. Initial value and boundary value problems, numerical methods (Euler, Runge Kutta) to solve first order and second order initial value problems – study of mechanical (driven pendulum) and electric (LCR) resonant systems. Techniques to solve boundary value problems (finite difference method, shooting method, relaxation method, eigen value method).

Unit 2

Singular Points of Second Order Linear Differential Equations, Frobenius method and its applications to Legendre, Bessel, Hermite, Lagaurre differential equations, Properties of Legendre, Hermite and Lagaurre Polynomials, Bessel functions. Gamma and Beta functions. Dirac delta function.

Unit 3

Application of Laplace Transforms to second order coupled Differential Equations – coupled oscillator problem.

Unit 4

Modelling of multi-variable problems by Partial Differential Equations. Solutions to partial differential equations, using separation of variables, parabolic (heat equation), elliptic (Laplace's Equation) and hyperbolic (wave equation) PDE and their canonical forms, initial and boundary conditions. Fourier method to solve 1-d and 2-d wave equation (vibrations of a string and circular membrane), BVP for Laplace equation, steady state solution of the heat equation, solution of 1-d and 2-d Heat conduction equation. Numerical methods to solve partial differential equations (finite difference and finite element methods Crank-Nicholson algorithm and relaxation method), Stability, consistency, and convergence analyses.

Readings:

1. Simmons, George F. and Krantz, Steven G. (2006). *Differential Equations Theory, Technique, and Practice.* McGrawHill Education Private Ltd.

2. Farlow, Stanley J. (1993). *Partial Differential Equations for Scientists and Engineers*, Dover Publications.

3. Kreyszig, E. (2015). *Advanced Engineering Mathematics.* Wiley.

4. Pang, T. (2010). *An Introduction to Computational Physics*, Cambridge University Press.

5. Newman, M. (2012). *Computational Physics.* CreateSpace Independent Publishing Platform.

6. Press, W. H. et. al. (2013). *Numerical Recipes in C ++ : The Art of Scientific Computing*. Cambridge University Press.

BVCS55: Software Testing and Verification

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Understand software testing and quality assurance as a fundamental component of software life cycle*
- *Define the scope of SW Testing projects*
- *Efficiently perform Testing activities using modern software tools*
- *Prepare test plans and schedules for a Testing project*

Unit 1

Introduction to Software Testing, Basic concepts of Unit Testing, and how they are supported by JUnit a framework for writing tests.

Unit 2

Testing in the Lifecycle: Software Testing with respect to different software development processes and relevant factors (e.g. risk, cost, etc.). Specification-Based Testing: Introduction to functional testing, model-based testing, coverage criteria and test cases generated from relevant software models, e.g., control flow graphs, finate state machines and grammars.

Unit 3

Structural Testing: Basic concepts of structural testing: Statement Coverage, Branch Coverage, Condition Coverage and Path Coverage. Data Flow Coverage: Basic concepts of Data Flow Coverage, main coverage criteria.

Unit 4

Mutation Testing, Integration Testing, Regression Testing, GUI Testing. System Testing: software features to be tested at the system level. Aspects of higher-order testing. This extends/relates to System Testing.

Readings:

1. Pezze, M. and Young, M. (2008). *Software Testing and Analysis: Process, Principles and Techniques.* Wiley
2. Beizner, B. (2009). *Softwaare Testing Teechniques.* International Thomson Computer press.
3. Myers, Glenford J., Sandler, C. Badgett, T. (2011). *The Art of software Testing.* John Wiley & Sons.

SEMESTER 6

BVCS61: Math II: Linear Algebra

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Know the matrix theory and linear algebra.*
- *Apply the theory of Linear Algebra in physical science, engineering and machine learning.*

Unit 1

Solution of a linear system, reduced row echelon form (RREF), Linear Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Homomorphism and Isomorphism of Vector Spaces.

Unit 2

Linear Transformations. Algebra of Linear Transformations., rank and nullity Non-singular Transformations. Representation of Linear Transformations by Matrices, matrix algebra, special matrices, Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem, Change of basis – search for a good basis,

Unit 3

Diagonalization of Matrices, Orthogonality and least squares, inner product, length, orthogonal projections, Gram-Schmidt orthogonalization, QR decomposition, positive definite matrices and singular value decomposition,

Unit 4

Solutions of Coupled Linear Ordinary Differential Equations.

Readings:

1. Strang, G. (2016). *Introduction to Linear Algebra. W*ellesley-Cambridge Press.
2. Finkbeiner, Daniel T. (2011). *Introduction to Matrices & Linear Transformations.* Dover Books.

BVCS62: Data Warehousing and Data Mining

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *know about Data preprocessing and data quality.*
- *Know Modeling and design of data warehouses.*
- *Knnow Algorithms for data mining.*
- *Be able to design data warehouses.*
- *Be able to apply acquired knowledge for understanding data and select suitable methods for data analysis.*

Unit 1

Data Pre-processing: Curse of Dimensionality, Principal Component Analysis, Singular Value Decomposition.

Unit 2

Classification Algorithms: Decision Trees, KNN, Full Bayes, Naïve Bayes, LDA, SVM, Accuracy measures, ROC curve.

Unit 3

Association Rule Mining: Apriori, ECLAT, PCY, Multi-stage, Multihash, Toivonon, SON, FP-growth.

Unit 4

Sequence Mining: GPS, Prefix-span, SPADE. Clustering: K-means, K-medians, Agglomerative, DB-Scan

Readings:

1. Zaki, Mohammed J. and Meira Jr. (2014). *Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press.*
2. Tan, P. N., Steinback, M. and Kumar, V. (2006). *Introduction to Data Mining.* Addison Wesley.
3. Leskovec, J., Rajaraman, A. and Ullman, Jeffrey D. (2014). *Mining of Massive Datasets.* Cambridge University Press.

BVCS63: Language and speech Processing

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Achieve an understanding of the theoretical principles and practical aspects of using statistical pattern recognition/machine learning; speech, speech production and perception; principles and methods for speech analysis, statistical modeling of speech and language; and achieve insight in how the basic principles can be employed to construct systems for automatic speech recognition.*
- *Achieve skill to use and/or design software for use in train and evaluate models based on machine learning methods; to use and/or design software for speech analysis and interpret the analysis results; to construct simple systems for automatic speech recognition based on statistical pattern recognition; to evaluate the performance of speech recognizers.*

Unit 1

Introduction, Regular Expressions, Text Normalization, and Edit Distance Regular Language & FSA,

Unit 2

Morphology & Finite-state Transducers, Probabilistic models & Spelling correction, N-grams, smoothing and entrop, HMM, viterbi and A* decoding, Word classes and POS tagging, CFG for English and Parsing,

Unit 3

Semantics: Introduction & Distributional semantics, Lexical semantics & Word Sense disambiguation,

Unit 4

Text classification, Text Summarization, Sentiment analysis, Stylometry analysis, Web mining, Named-entity disambiguation.

Readings:

1. Jurafsky, D. and Martin, James H. (2008). *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition.* Prentice Hall.
2. Manning, Christopher D. and Schütze, H. (1999). *Foundations of Statistical Natural Language Processing. The MIT Press.*

BVCS64: Cryptography and Network Security

CREDITS: 6

Learning Outcomes:
After pursuing this paper, students would:

- *Identify computer and network security threats, classify the threats and develop a security model to prevent, detect and recover from the attacks. (ABET Outcomes: a, c, e, j, k)*
- *Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms. (ABET Outcomes: c, e, k)*
- *Analyze existing authentication and key agreement protocols, identify the weaknesses of these protocols. (ABET Outcomes: c, e, k)*
- *Download and install an e-mail and file security software, PGP, and efficiently use the code to encrypt and sign messages. (ABET Outcomes: c, e, k)*
- *Develop SSL or Firewall based solutions against security threats, employ access control techniques to the existing computer platforms such as Unix and Windows NT. (ABET Outcomes: a, c, e, i, k)*

Unit 1

Perfect Secrecy, Differential Cryptanalysis of DES, DES Algorithm, Linear Cryptanalysis, MD4 (hash function) Cryptoanalysis, Crypto in SSL/TLS protocol, Cycle Detection Algorithm, Public Key Algorithm, Public key encryption, Pretty Good Privacy (PGP), Secure Multi-party Computation, Full Homomorphic Encryption, Application of cyclic Detection Algorithms.

Readings:

1. Stinson, Douglas R. and Paterson, M. (2018). *Cryptography: Theory and Practice.* Chapman and Hall/CRC.
2. Menezes, Alferd J., Katz, J., VanOorschot, Paul C. and Vanstone, Scott A. (1997). *Handbook of Applied Cryptography*. CRC Press.
3. Katz, J. and Lindell, Y. (2007). *Introduction to Modern Cryptography*. CRC Press.
4. Goldreich, O. (2007). *Foundations of Cryptography.* Cambridge University Press.

BVCS65: Project/ Dissertation

CREDITS: 6

Learning Outcomes:
Upon completion of the Dissertation, students would:

- *show ability to work independently;*
- *present a professional documentation of his/ her work;*
- *gain indepth knowledge in the area of work.*

To be allocated by faculty and industrial partners. Project evaluation will be done by faculty/ university appointed examiner from academia and industry. Along with weightage to the dissertation report, the examiner should evaluate whether the work took 100 man-hours to complete.