

Engineering

Scheme & Syllabus of
Bachelor of Technology
Computer Science & Engg. (BlockChain)/
Comp. Sc. & Design/
(Batch2023 onwards)

Bachelor of Technology
Robotics & Artificial Intelligence
Batch 2023 onwards
3rd & 4th semester



By

Department of Academics
(BoS- CSE/ IT)

IK Gujral Punjab Technical
University

**Bachelor of Technology in : Computer Science & Engg. (BlockChain)/ Comp. Sc. & Design/
 Robotics & Artificial Intelligence**

It is a Graduate (UG) Programme of 4 years duration (8 semesters)

Scheme: Third Semester

Course Code	Type of Course	Course Title	Hours per Week			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTES 301-18	Engineering Science Course	Digital Electronics	3	0	0	40	60	100	3
BTCS 301-18	Professional Core Courses	Data structure & Algorithms	3	0	0	40	60	100	3
BTCS 302-18	Professional Core Courses	Object Oriented Programming	3	0	0	40	60	100	3
BTAM 302-23	Basic Science Course	Mathematics-III* (Probability and Statistics)	4	1	0	40	60	100	3
HSMC 101/102-18	Humanities & Social Sciences Including Management \Courses	Foundation Course in Humanities (Development of Societies/Philosophy)	2	1	0	40	60	100	3
BTES 302-18	Engineering Science Course	Digital Electronics Lab	0	0	2	30	20	50	1
BTCS 303-18	Professional Core Courses	Data structure & Algorithms Lab	0	0	4	30	20	50	2
BTCS 304-18	Professional Core Courses	Object Oriented Programming lab.	0	0	4	30	20	50	2
BTCS 305-18	Professional Core Courses	IT Workshop**	0	0	2	30	20	50	1
		Summer Institutional Training	0	0	0	0	0	0	Satisfactory/Unsatisfactory
Total			15	2	12	320	380	700	21

* These are the minimum contact hrs. allocated. The contact hrs. may be increased by an institute as per the requirement of the subject.

** Syllabus to be decided by respective institute internally. It may include latest technologies.

IK Gujral Punjab Technical University, Kapurthala
BoS- CSE/IT, B.Tech Program

Fourth Semester

Course Code	Type of Course	Course Title	Hours per Week			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCS 401-18	Professional Core Courses	Discrete Mathematics	3	1	0	40	60	100	4
BTES 401-18	Engineering Science Course	Computer Organization & Architecture	3	0	0	40	60	100	3
BTCS 402-18	Professional Core Courses	Operating Systems	3	0	0	40	60	100	3
BTCS 403-18	Professional Core Courses	Design & Analysis of Algorithms	3	0	0	40	60	100	3
HSMC 122-18	Humanities & Social Sciences including Management Courses	Universal Human Values 2	2	1	0	40	60	100	3
EVS101-18	Mandatory Courses	Environmental Sciences	3	-	-	100	-	100	S/US
BTES 402-18	Engineering Science Course	Computer Organization & Architecture Lab	0	0	2	30	20	50	1
BTCS 404-18	Professional Core Courses	Operating Systems Lab	0	0	4	30	20	50	2
BTCS 405-18	Professional Core Courses	Design & Analysis of Algorithms Lab	0	0	4	30	20	50	2
Total			15	2	10	390	360	750	24

Students will take up summer internship of 4-6 weeks at industry or organizations of repute after 4th sem, that will be accredited in 5th semester.

Third Semester

Course Code: BTCS301-18	Course Title: Data Structure & Algorithms	3L:0T:P	3Credits
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Detailed Contents:

Module 1: 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.

[6 hrs] (CO1)

Module 2: Stacks and Queues

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 Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

[10 hrs] (CO2, CO4, CO5)

Module 3: 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.

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.

[10 hrs] (CO2, CO4, CO5)

Module 4: 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.

[10 hrs] (CO3)

Module 4: Graph

Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

[6 hrs] (CO2, CO4)

Course Outcomes:

The student will be able to:

1. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness;
2. Student will be able to handle operation like searching, insertion, deletion, traversing on various Data Structures and determine time and computational complexity;
3. Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity;
4. Students will be able to choose appropriate Data Structure as applied to specific problem definition; &

5. Demonstrate the reusability of Data Structures for implementing complex iterative problems.

Suggested Books:

1. “Classic Data Structures”, Samanta and Debasis, 2nd edition, PHI publishers.
2. “Fundamentals of Data Structures”, Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
3. “Data Structures with C (Schaum's Outline Series)”, Seymour Lipschutz, 1st edition, McGraw Hill Education.

Reference Books:

1. Algorithms, Data Structures, and Problem Solving with C++”, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.
2. “How to Solve it by Computer”, 2nd Impression by R. G. Dromey, Pearson Education.

Course Code: BTCS302-18	Course Title: Object Oriented Programming	3L:0T:0P	3Credits
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Pre-requisites: Programming in C

Detailed Contents:

Module 1: Introduction

Overview of C++, Sample C++ program, Different data types, operators, expressions, and statements, arrays and strings, pointers & function components, recursive functions, user - defined types, function overloading, inline functions, Classes & Objects – I: classes, Scope resolution operator, passing objects as arguments, returning objects, and object assignment.

[8 hrs] (CO1)

Module 2: Classes & Objects –II

Constructors, Destructors, friend functions, Parameterized constructors, Static data members, Functions, Arrays of objects, Pointers to objects, this pointer, and reference parameter, Dynamic allocation of objects, Copyconstructors, Operator overloading using friend functions, overloading.

[8 hrs] (CO1, CO2)

Module 3: Inheritance

Base Class, Inheritance and protected members, Protected base class inheritance, Inheriting multiple base classes, Constructors, Destructors and Inheritance, Passing parameters to base class constructors, Granting access, Virtual base classes.

[8 hrs] (CO3, CO4)

Module 4: Virtual functions, Polymorphism

Virtual function, calling a Virtual function through a base class reference, Virtual attribute is inherited, Virtual functions are hierarchical, pure virtual functions, Abstract classes, Using virtual functions, Early and late binding.

[8 hrs] (CO3, CO4)

Module 5: Exception Handling

Basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, I/O System Basics, File I/O: Exception handling fundamentals, Exception handling options. C++ stream classes, Formatted I/O, fstream and the File classes, Opening and closing a file, Reading and writing text files.

[10 hrs] (CO5)

Course Outcomes:

The student will be able to:

1. Identify classes, objects, members of a class and the relationships among them needed to solve a specific problem;
2. Demonstrate the concept of constructors and destructors. And create new definitions for some of the operators;
3. Create function templates, overload function templates;
4. Understand and demonstrate the concept of data encapsulation, inheritance, polymorphism with virtual functions; &
5. Demonstrate the concept of file operations, streams in C++ and various I/O manipulators.

Suggested Books:

1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill.

Reference Books:

1. Stanley B.Lippmann, JoseeLajoie: C++ Primer, 4th Edition, Addison Wesley, 2012.
2. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2011.

Course Code: BTCS303-18	Course Title: Data Structure & AlgorithmsLab	0L:0T:4P	2Credits
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List of Experiment:

- Task 1:** Write a program to insert a new element at end as well as at a given position in an array.
- Task 2:** Write a program to delete an element from a given whose value is given or whose position is given.
- Task 3:** Write a program to find the location of a given element using Linear Search.
- Task 4:** Write a program to find the location of a given element using Binary Search.
- Task 5:** Write a program to implement push and pop operations on a stack using linear array.
- Task 6:** Write a program to convert an infix expression to a postfix expression using stacks.
- Task 7:** Write a program to evaluate a postfix expression using stacks.
- Task 8:** Write a recursive function for Tower of Hanoi problem.
- Task 9:** Write a program to implement insertion and deletion operations in a queue using linear array.
- Task 10:** Write a menu driven program to perform following insertion

operations in a single linked list:

- i. Insertion at beginning
- ii. Insertion at end
- iii. Insertion after a given node
- iv. Traversing a linked list

Task 11: Write a menu driven program to perform following deletion operations in a single linked list:

- i. Deletion at beginning
- ii. Deletion at end
- iii. Deletion after a given node

Task 12: Write a program to implement push and pop operations on a stack using linked list.

Task 13: Write a program to implement push and pop operations on a queue using linked list.

Task 14: Program to sort an array of integers in ascending order using bubble sort.

Task 15: Program to sort an array of integers in ascending order using selection sort.

Task 16: Program to sort an array of integers in ascending order using insertion sort.

Task 17: Program to sort an array of integers in ascending order using quick sort.

Task 18: Program to traverse a Binary search tree in Pre-order, In-order and Post-order.

Task 19: Program to traverse graphs using BFS.

Task 20: Program to traverse graphs using DFS.

Lab Outcomes:

The student will be able to:

1. Improve practical skills in designing and implementing basic linear data structure algorithms;
2. Improve practical skills in designing and implementing Non-linear data structure algorithms;
3. Use Linear and Non-Linear data structures to solve relevant problems;
4. Choose appropriate Data Structure as applied to specific problem definition; &
5. Implement Various searching algorithms and become familiar with their design methods.

Reference Books:

1. “Data Structures with C (Schaum's Outline Series)”, Seymour Lipschutz, 1st edition, McGraw Hill Education.

Course Code: BTCS304-18	Course Title: Object Oriented Programming Lab	0L:0T:4P	2Credits
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List of Experiment:

- Task 1:** Write a program that uses a class where the member functions are defined inside a class.
- Task 2:** Write a program that uses a class where the member functions are defined outside a class.
- Task 3:** Write a program to demonstrate the use of static data members.
- Task 4:** Write a program to demonstrate the use of const data members.
- Task 5:** Write a program to demonstrate the use of zero argument and parameterized constructors.
- Task 6:** Write a program to demonstrate the use of dynamic constructor.
- Task 7:** Write a program to demonstrate the use of explicit constructor.
- Task 8:** Write a program to demonstrate the use of initializer list.
- Task 9:** Write a program to demonstrate the overloading of increment and decrement operators.
- Task 10:** Write a program to demonstrate the overloading of memory management operators.
- Task 11:** Write a program to demonstrate the typecasting of basic type to class type.
- Task 12:** Write a program to demonstrate the typecasting of class type to basic type.
- Task 13:** Write a program to demonstrate the typecasting of class type to class type.
- Task 14:** Write a program to demonstrate the multiple inheritances.
- Task 15:** Write a program to demonstrate the runtime polymorphism.
- Task 16:** Write a program to demonstrate the exception handling.
- Task 17:** Write a program to demonstrate the use of class template.
- Task 18:** Write a program to demonstrate the reading and writing of mixed type of data.

Lab Outcomes:

The student will be able to:

1. Develop classes incorporating object-oriented techniques;
2. Design and implement object-oriented concepts of inheritance and polymorphism;
3. Illustrate and implement STL class of containers and need for exceptions to handle errors for object oriented programs; &
4. Design and implement any real world based problem involving GUI interface using object-oriented concepts.

Reference Books:

1. Stanley B.Lippmann, JoseeLajoie: C++ Primer, 4th Edition, Addison Wesley, 2012.
2. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill.

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B. Tech, Computer Science & Engg.

BTAM 302-23	Mathematics-III (Probability and Statistics)	L-4, T-1, P-0	4 Credits
Pre-requisite: Intermediate Calculus and Basic algebra			
Course Objectives: The objective of this course is to familiarize the students with fundamental concepts of theory of probability and statistics. The major focus of the course will be on a systematic mathematical treatment of these concepts and their applications.			
Course Outcomes: At the end of the course, the student will be able to			
CO1	Analyze given data using measures of central tendency, skewness and kurtosis.		
CO2	Understand and deal with randomness occurring in real world phenomena.		
CO3	Apply theoretical discrete and continuous probability distributions to deal with real world problems.		
CO4	Analyze given data using the concepts of correlation and regression and fitting of curves.		
CO5	Analyze hypothesis based on small and large samples using different tests of significance.		

Detailed Content:

Unit I

Measures of Central tendency: Moments, skewness and Kurtosis, Random experiment, Probability axioms, Definition of Probability, conditional probability, Discrete and Continuous random variables, Expectation of Discrete and Continuous random variables.

Unit II

Probability distributions: Binomial, Poisson and Normal, Poisson approximation to the binomial distribution, Evaluation of statistical parameters for these three distributions, Bivariate distributions and their properties.

Unit III

Correlation and regression for bivariate data, Rank correlation. Curve fitting by the method of least squares, fitting of straight lines, second degree parabolas and more general curves.

Unit IV

Test of significances: Sampling and standard error, Tests of significance for large samples and small samples (t-distribution, F-distribution), Chi-square test for goodness of fit and independence of attributes.

Recommended Books:

1. S.P. Gupta, Statistical Methods, Sultan Chand & Sons, 33rd Edition, 2005.
2. S.C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014.
3. S. Ross, A First Course in Probability, 6th Edition, Pearson Education India, 2002.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
5. Robert V. Hogg, Joseph W. Mckean and Allen T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.

Development of Societies
Course code: HSMC101-18

Credits: 3

COURSE TOPICS:

2.1 Unit I: Social Development (5 hours)

1. Concepts behind the origin of Family, Clan and Society
2. Different Social Systems
3. Relation between Human being and Society
4. Comparative studies on different models of Social Structures and their evolution

2.2 Unit II: Political Development (3 hours)

1. Ideas of Political Systems as learnt from History
2. Different models of Governing system and their comparative study

2.3 Unit III: Economic Development (18 hours)

1. Birth of Capitalism, Socialism, Marxism
2. Concept of development in pre-British, British and post British period- Barter, Jajmani
3. Idea of development in current context.
4. E. F. Schumacher's idea of development, Buddhist economics. Gandhian idea of development. Swaraj and Decentralization.

3. READINGS

- 3.1 TEXTBOOK:
- 3.2 *REFERENCE BOOKS:

4. OTHER SESSIONS

- 4.1 *TUTORIALS:
- 4.2 *LABORATORY:
- 4.3 *PROJECT: Possible projects in this course could be
 - a) Interact with local communities and understand their issues.
 - b) Study local cottage industry and agricultural practices. Role of engineering and specialized knowledge.
 - c) Evaluation of technology in the context of its application. Social impact of technology. Environmental impact of technology. Evaluation from a holistic perspective.

PHILOSOPHY Course
code: HSMC102-18

Credits: 3

COURSE TOPICS:

2.1 Unit 1:

The difference between knowledge (Vidya) and Ignorance (Avidya):

- a. Upanishads;
- b. Six systems orthodox and Heterodox Schools of Indian Philosophy.
- c. Greek Philosophy:

2.2 Unit 2:

Origin of the Universe:

- NasidiyaSukta: "Who really knows?"
- Brhadaranyaka Upanishad; Chandogya Upanishad: Non-self, Self, real and unreal.
- Taittiriya Upanishad: SikshaValli.
- Plato's Symposium: Lack as the source of desire and knowledge.
- Socratic's method of knowledge as discovery.
- Language: Word as root of knowledge (Bhartrahari's Vakyapadiyam)
- Fourteen Knowledge basis as a sources of Vidya: Four Vedas; Six auxiliary sciences (Vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.

2.3 Unit 3:

Knowledge as Power: Francis Bacon. Knowledge as both power and self-realization in Bagavad Gita.

2.4 Unit 4:

Knowledge as oppression: M. Foucault. Discrimination between Rtam and Satyam in Indian Philosophy.

2.5 Unit 5:

Knowledge as invention: Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.

2.6 Unit 6:

Knowledge about the self, transcendental self; knowledge about society, polity and nature.

2.7 Unit 7:

Knowledge about moral and ethics codes.

2.8 Unit 8:

Tools of acquiring knowledge: Tantrayuktis, a system of inquiry (Caraka, Sushruta, Kautilya, Vyasa)

3. READINGS

1. Copleston, Frederick, History of Philosophy, Vol. 1. Great Britain: Continuum.
2. Hiriyanna, M. Outlines of Indian Philosophy, Motilal Banarsidass Publishers; Fifth Reprint edition (2009)
3. Sathaye, Avinash, Translation of Nasadiya Sukta
4. Ralph T. H. Griffith. The Hymns of the R̥gveda. Motilal Banarsidass: Delhi: 1973.
5. Raju, P. T. Structural Depths of Indian Thought, Albany: State University of New York Press.
6. Plato, Symposium, Hamilton Press.
7. Kautilya Artha Sastra. Penguin Books, New Delhi.
8. Bacon, Nova Organum
9. Arnold, Edwin. The Song Celestial.
10. Foucault, Knowledge/Power.
11. Wildon, Anthony, System of Structure.
12. Lele, W.K. The Doctrine of Tantrayukti. Varanasi: Chowkamba Series.
13. Dasgupta, S. N. History of Indian Philosophy, Motilal Banarsidas, Delhi.
14. Passmore, John, Hundred Years of Philosophy, Penguin.

4. OTHER SESSIONS:

4.1 Mode of Conduct

5. ASSESSMENT (indicative only):

Ask students to do term papers, for example, writing biographical details of founders, sustainers, transmitters, modifiers, rewriters; translating monographs of less known philosophers such as K. C. Bhattacharyas, Daya Krishna, Gopinath Bhattacharya; comparative study of philosophical system such as Madhyastha Darshan.

6. OUTCOME OF THE COURSE:

Students will develop strong natural familiarity with humanities along with right understanding enabling them to eliminate conflict and strife in the individual and society. Students shall be able to relate philosophy to literature, culture, society and lived experience can be considered.

Detailed Contents:

Module 1:

NUMBER SYSTEMS: Binary, Octal, Decimal, Hexadecimal. Number base conversions, 1's, 2's complements, signed Binary numbers. Binary Arithmetic, Binary codes: Weighted BCD, Gray code, Excess 3 code, ASCII.

LOGIC GATES: AND, OR, NOT, NAND, NOR, Exclusive-OR and Exclusive-NOR. Implementations of Logic Functions using gates, NAND-NOR implementations.

Module 2 :

BOOLEAN ALGEBRA: Boolean postulates and laws – De-Morgan's Theorem, Principle of Duality, Boolean expression – Boolean function, Minimization of Boolean expressions – Sum of Products (SOP), Product of Sums (POS), Minterm, Maxterm, Canonical forms, Conversion between canonical forms, Karnaugh map Minimization, Don't care conditions, Quine-McCluskey method.

Module 3:

COMBINATIONAL CIRCUITS: Design procedure – Adders, Subtractors, BCD adder, Magnitude Comparator, Multiplexer/Demultiplexer, encoder/decoder, parity checker, code converters. Implementation of combinational logic using MUX, BCD to 7 segment decoder.

SEQUENTIAL CIRCUITS: Flip flops SR, JK, T, D and Master slave, Excitation table, Edge triggering, Level Triggering, Realization of one flip flop using other flip flops. Asynchronous/Ripple counters, Synchronous counters, Modulo-n counter, Ring Counters. Design of Synchronous counters: state diagram, Circuit implementation. Shift registers.

Module 4:

MEMORY DEVICES: Classification of memories, RAM organization, Write operation, Read operation, Memory cycle. ROM organization, PROM, EPROM, EEPROM, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

A/D & D/A CONVERTORS : Analog & Digital signals. sample and hold circuit, A/D and D/A conversion techniques (Weighted type, R-2R Ladder type, Counter Type, Dual Slope type, Successive Approximation type).

COURSE OUTCOME:At the end of course the student will be able to:

1. Demonstrate the operation of simple digital gates, identify the symbols, develop the truth table for those gates; combine simple gates into more complex circuits; change binary, hexadecimal, octal numbers to their decimal equivalent and vice versa.
2. Demonstrate the operation of a flip-flop. Design counters and clear the concept of shift registers.
3. Study different types of memories and their applications. Convert digital signal into analog and vice versa.

Suggested Readings/ Books:

- Morris Mano, **Digital Design**, Prentice Hall of India Pvt. Ltd
- Donald P. Leach and Albert Paul Malvino, **Digital Principles and Applications**, 5 ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
- R.P. Jain, **Modern Digital Electronics**, 3 ed., Tata McGraw–Hill publishing company limited, New Delhi, 2003.
- Thomas L. Floyd, **Digital Fundamentals**, Pearson Education, Inc, New Delhi, 2003
- Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, **Digital System - Principles and Applications**, Pearson Education.
- Ghosal, **Digital Electronics**, Cengage Learning.

Course Code: BTES302-18	Course Title: Digital Electronics Lab	0L:0T:2P	1Credits
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List of Experiments:

1. To verify the Truth-tables of all logic gates.
2. To realize and verify the Half & full adder circuits using logic gates.
3. To realize Half & full subtractor circuits using logic gates.
4. To realize Encoder and Decoder circuits
5. To realize Multiplexer circuits
6. To realize 4-bit binary-gray & gray-binary converters.
7. To realize comparator circuit for two binary numbers of 2-bit each.
8. To realize Full adder & full subtractor circuits using encoder.
9. To design Full adder & full subtractor circuits using multiplexer.
10. To design and verify the Truth tables of all flip-flops.
11. To design Mod-6/Mod-9 synchronous up-down counter.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Realize combinational circuits using logic gates.
2. Realize sequential circuits using logic gates.
3. Realize various types of Flip-flops and counters

Fourth Semester

Pre-requisites: Digital Electronics

Detailed Contents:

Module 1: Functional blocks of a computer

CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU – registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study – instruction set of 8085 processor.

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.

[10 hrs] (CO1, CO2)

Module 2: Introduction to x86 architecture.

CPU control unit design: Hardwired and micro-programmed 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, USB.

[12 hrs] (CO2, CO4)

Module 3: Pipelining

Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallelprocessors, Concurrent access to memory and cache coherency.

[10 hrs] (CO5)

Module 4: Memory Organization

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

[10 hrs] (CO3)

Course Outcomes:

The student will be able to:

1. Understand functional block diagram of microprocessor;
2. Apply instruction set for Writingassembly language programs;
3. Design a memory module and analyze its operation by interfacing with the CPU;
4. Classify hardwired and microprogrammed control units; &
5. Understand the concept of pipelining and its performance metrics.

Suggested Books:

1. “ComputerOrganization and Architecture”, Moris Mano,
2. “ComputerOrganization and Design: The Hardware/Software Interface”, 5th Edition by David A. Patterson and John L. Hennessy, Elsevier.
3. “Computer Organization and Embedded Systems”, 6th Edition by CarlHamacher, McGraw Hill Higher Education.

Reference Books:

1. “Computer Architecture and Organization”, 3rd Edition by John P. Hayes, WCB/McGraw-Hill
2. “Computer Organization and Architecture: Designing for Performance”, 10th Edition by William Stallings, Pearson Education.
3. “Computer System Design and Architecture”, 2nd Edition by Vincent P. Heuring and Harry F. Jordan, Pearson Education.

Course Code: BTCS402-18	Course Title: Operating Systems	3L:0T:0P	3Credits
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Detailed Contents:

Module 1: 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.

[6 hrs] (CO1)

Module 2: 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,

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.

[10 hrs] (CO2, CO3)

Module 3: 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, Dining Philosopher Problem etc.

[8 hrs] (CO2)

Module 4: Deadlocks

Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker’s algorithm, Deadlock detection and Recovery.

[8 hrs] (CO3)

Module 5: 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.

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).

[10 hrs] (CO4)

Module 6: 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.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

[8 hrs] (CO5, CO6)

Course Outcomes:

The student will be able to:

1. Explain basic operating system concepts such as overall architecture, system calls, user mode and kernel mode;
2. Distinguish concepts related to processes, threads, process scheduling, race conditions and critical sections;
3. Analyze and apply CPU scheduling algorithms, deadlock detection and prevention algorithms;
4. Examine and categorize various memory management techniques like caching, paging, segmentation, virtual memory, and thrashing;
5. Design and implement file management system; &
6. Appraise high-level operating systems concepts such as file systems, disk-scheduling algorithms and various file systems.

Suggested Books:

1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.

Reference Books:

1. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
2. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison-Wesley
3. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
4. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Pre-requisites: Data Structures

Detailed Contents:

Module 1: Introduction

Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters’ theorem.

[8 hrs] (CO1)

Module 2: Fundamental Algorithmic Strategies

Brute-Force, Greedy, Dynamic Programming, Branch- and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving: Bin Packing, Knap Sack, TSP.

[10 hrs] (CO1, CO2)

Module 3: Graph and Tree Algorithms

Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

[10 hrs] (CO3)

Module 4: Tractable and Intractable Problems

Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook’s theorem, Standard NP-complete problems and Reduction techniques.

[8 hrs] (CO5)

Module 5: Advanced Topics

Approximation algorithms, Randomized algorithms, Heuristics and their characteristics.

[6 hrs] (CO1, CO4, CO5)

Course Outcomes:

The student will be able to:

1. For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms;
2. Explain when an algorithmic design situation calls for which design paradigm (greedy/ divide and conquer/backtrack etc.);
3. Explain model for a given engineering problem, using tree or graph, and write the corresponding algorithm to solve the problems;
4. Demonstrate the ways to analyze approximation/randomized algorithms (expected running time, probability of error); &
5. Examine the necessity for NP class based problems and explain the use of heuristic techniques.

Suggested Books:

1. Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Data Structures and Algorithms in C++, Weiss, 4th edition, Pearson.
3. Fundamentals of Computer Algorithms – E. Horowitz, Sartaj Saini, Galgota Publications.

Reference Books

1. Algorithm Design, 1st Edition, Jon Kleinberg and Éva Tardos, Pearson.
 2. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
 3. Algorithms -- A Creative Approach, 3RD Edition, Udi Manber, Addison-Wesley, Reading, MA.
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Course Code: BTES402-18	Course Title: Computer Organization & Architecture Lab	0L:0T:2P	1Credits
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List of Experiment:

- Task 1:** Computer Anatomy- Memory, Ports, Motherboard and add-on cards.
- Task 2:** Dismantling and assembling PC.
- Task 3:** Introduction to 8085 kit.
- Task 4:** 2. Addition of two 8 bit numbers, sum 8 bit.
- Task 5:** Subtraction of two 8 bit numbers.
- Task 6:** Find 1's complement of 8-bit number.
- Task 7:** Find 2's complement of 8-bit number.
- Task 8:** Shift an 8-bit no. by one bit.
- Task 9:** Find Largest of two 8 bit numbers.
- Task 10:** Find Largest among an array of ten numbers (8 bit).
- Task 11:** Sum of series of 8 bit numbers.
- Task 12:** Introduction to 8086 kit.
- Task 13:** Addition and subtraction of two 16 bit numbers, sum 16 bit.
- Task 14:** Implement of Booth's algorithm for arithmetic operations.
- Task 15:** Find 1's and 2's complement of 16-bit number.
- Task 16:** Implement simple programs using I/O based interface.

Lab Outcomes:

The student will be able to:

1. Assemble personal computer;
2. Implement the various assembly language programs for basic arithmetic and logical operations; &
3. Demonstrate the functioning of microprocessor/microcontroller based systems with I/O interface.

Reference Books:

1. Fundamentals of Microprocessors and Microcontrollers by B. Ram, Dhanpat Rai Publications.
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List of Experiment:

- Task 1:** Installation Process of various operating systems.
- Task 2:** Implementation of CPU scheduling algorithms to find turnaround time and waiting time. a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority.
- Task 3:** Virtualization, Installation of Virtual Machine Software and installation of Operating System on Virtual Machine.
- Task 4:** 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. 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.
- Task 5:** Shell Programming: Basic of shell programming, various types of shell, Shell Programming in bash, conditional & looping statement, case statements, parameter passing and arguments, shell variables, shell keywords, creating shell programs for automate system tasks, report printing.
- Task 6:** Implementation of Bankers algorithm for the purpose of deadlock avoidance.

Lab Outcomes:

The student will be able to:

1. Understand and implement basic services and functionalities of the operating system;
2. Analyze and simulate CPU Scheduling Algorithms like FCFS, Round Robin, SJF, and Priority;
3. Implement commands for files and directories;
4. Understand and implement the concepts of shell programming;
5. Simulate file allocation and organization techniques; &
6. Understand the concepts of deadlock in operating systems and implement them in multiprogramming system.

Reference Books:

1. Operating Systems: Design and Implementation, Albert S. Woodhull and Andrew S. Tanenbaum, Pearson Education.

List of Experiment:

- Task 1:** Code and analyze solutions to following problem with given strategies:
- Knap Sack using greedy approach
 - Knap Sack using dynamic approach
- Task 2:** Code and analyze to find an optimal solution to matrix chain multiplication using dynamic programming.
- Task 3:** Code and analyze to find an optimal solution to TSP using dynamic programming.
- Task 4:** Implementing an application of DFS such as:
- to find the topological sort of a directed acyclic graph
 - to find a path from source to goal in a maze.
- Task 5:** Implement an application of BFS such as:
- to find connected components of an undirected graph
 - to check whether a given graph is bipartite.
- Task 6:** Code and analyze to find shortest paths in a graph with positive edge weights using Dijkstra's algorithm.
- Task 7:** Code and analyze to find shortest paths in a graph with arbitrary edge weights using Bellman-Ford algorithm.
- Task 8:** Code and analyze to find shortest paths in a graph with arbitrary edge weights using Flyods' algorithm.
- Task 9:** Code and analyze to find the minimum spanning tree in a weighted, undirected graph using Prims' algorithm
- Task 10:** Code and analyze to find the minimum spanning tree in a weighted, undirected graph using Kruskals' algorithm.
- Task 11:** Coding any real world problem or TSP algorithm using any heuristic technique.

Lab Outcomes:

The student will be able to:

1. Improve practical skills in designing and implementing complex problems with different techniques;
2. Understand comparative performance of strategies and hence choose appropriate, to apply to specific problem definition;
3. Implement Various tree and graph based algorithms and become familiar with their design methods; &
4. Design and Implement heuristics for real world problems.

Reference Books

1. Data Structures and Algorithms in C++, Weiss, 4th edition, Pearson
2. Data Structures and Algorithms using Python and C++, David M. Reed and John Zelle, 2009 edition (available as e book), Franklin Beedle& Associates.

UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

Course code: HSMC122-18

Credits: 3

COURSE TOPICS:

The course has 28 lectures and 14 practice sessions in 5 modules:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration—what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario.
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

7. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
8. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility
9. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
14. Understanding the meaning of Trust; Difference between intention and competence
15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.
17. Visualizing a universal harmonious order in society- Undivided Society,

Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

18. Understanding the harmony in the Nature

19. Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature

20. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

21. Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

22. Natural acceptance of human values

23. Definitiveness of Ethical Human Conduct

24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of peoplefriendly and eco -friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

26. Case studies of typical holistic technologies, management models and production systems.

27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.

28. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

3. READINGS:

3.1 Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

3.2 Reference Books

1. Jeevan Vidya: EkParichaya, A. Nagaraj, Jeevan VidyaPrakashan, Amarkantak, 1999.

2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

3. The Story of Stuff (Book).

4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi

5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J CKumarappa
8. Bharat Mein Angreji Raj -PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

- a) Faculty -student or mentor-mentee programs throughout their time with the institution.
- b) Higher level courses on human values in every aspect of living. E.g. as a professional.

Course Code: EVS101-18	Course Title: Environmental Studies-	L:2; T:0; P:0	0Credits
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.Detailed Contents

Module 1 : Natural Resources :Renewable and non-renewable resources

Natural resources and associated problems.

- a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
- b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
- c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
- e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.
- f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.
-

Module 2 : Ecosystems

Concept of an ecosystem. Structure and function of an ecosystem.

Food chains, food webs and ecological pyramids. Introduction, types, characteristic features,

structure and function of following ecosystems:

- a. Forest ecosystem
- b. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Module 3 : Biodiversity and its conservation

- Introduction – Definition : genetic, species and ecosystem diversity.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-spots of biodiversity.
- Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
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Module 4 : Social Issues and the Environment

- From Unsustainable to Sustainable development
- Resettlement and rehabilitation of people; its problems and concerns.
- Environmental ethics : Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, Nuclear accidents and holocaust. Case Studies.
- Public awareness.

***ACTIVITIES**

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity)

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.

Following activities must be included.

Identify a tree fruit flower peculiar to a place or having origin from the place.

Making high resolution big photographs of small creatures (bees, spiders, ants, mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).

Videography/ photography/ information collections on specialties/unique features of different types of common creatures.

Search and explore patents and rights related to animals, trees etc. Studying miracles of mechanisms of different body systems.

1(A) Awareness Activities:

- a) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
- b) Slogan making event
- c) Poster making event
- d) Cycle rally
- e) Lectures from experts
- f) Plantation
- g) Gifting a tree to see its full growth
- h) Cleanliness drive
- i) Drive for segregation of waste
- i) To live with some eminent environmentalist for a week or so to understand his work
- vi) To work in kitchen garden for mess
- j) To know about the different varieties of plants
- k) Shutting down the fans and ACs of the campus for an hour or so
- l) Visit to a local area to document environmental assets
river/forest/grassland/hill/mountain/lake/Estuary/Wetlands

- m) Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- n) Visit to a Wildlife sanctuary, National Park or Biosphere Reserve

Suggested Readings

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
8. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
9. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
11. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
12. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
13. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
14. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

Course Code: HSMC101-18	Course Title: Development of Societies	3L:0T:0P	3Credits
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Detailed Contents:

Unit I: Social Development

(5 hours)

1. Concepts behind the origin of Family, Clan and Society
2. Different Social Systems
3. Relation between Human being and Society
4. Comparative studies on different models of Social Structures and their evolution

Unit II: Political Development

(3 hours)

1. Ideas of Political Systems as learnt from History
2. Different models of Governing system and their comparative study

Unit III: Economic Development

(18 hours)

1. Birth of Capitalism, Socialism, Marxism
2. Concept of development in pre-British, British and post British period- Barter, Jajmani
3. Idea of development in current context.
4. E. F. Schumacher's idea of development, Buddhist economics. Gandhian idea of development. Swaraj and Decentralization.

PROJECT: Possible projects in this course could be

- a) Interact with local communities and understand their issues.
- b) Study local cottage industry and agricultural practices. Role of engineering and specialized knowledge.
- c) Evaluation of technology in the context of its application. Social impact of technology. Environmental impact of technology. Evaluation from a holistic perspective.

Course Code: HSMC102-18	Course Title: PHILOSOPHY	3L:0T:0P	3Credits
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Detailed Contents:

Unit 1:

The difference between knowledge (Vidya) and Ignorance (Avidya):

- a. Upanishads;
- b. Six systems orthodox and Heterodox Schools of Indian Philosophy.
- c. Greek Philosophy:

Unit 2:

Origin of the Universe:

- NasidiyaSukta: "Who really knows?"
- Brhadaranyaka Upanishad; Chandogya Upanishad: Non-self, Self, real and unreal.
- Taittiriya Upanishad: SikshaValli.
- Plato's Symposium: Lack as the source of desire and knowledge.
- Socratic's method of knowledge as discovery.
- Language: Word as root of knowledge (Bhartrahari'sVakyapadiyam)
- Fourteen Knowledge basis as a sources of Vidya: Four Vedas; Six auxiliary sciences (Vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.

Unit 3:

Knowledge as Power: Francis Bacon. Knowledge as both power and self-realization in Bagavad Gita.

Unit 4:

Knowledge as oppression: M. Foucault. Discrimination between Rtam and Satyam in Indian Philosophy.

Unit 5:

Knowledge as invention: Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.

Unit 6:

Knowledge about the self, transcendental self; knowledge about society, polity and nature.

Unit 7:

Knowledge about moral and ethics codes.

Unit 8:

Tools of acquiring knowledge: Tantrayuktis, a system of inquiry (Caraka, Sushruta, Kautilya, Vyasa)

READINGS

1. Copleston, Frederick, History of Philosophy, Vol. 1. Great Britain: Continuum.
2. Hiriyanna, M. Outlines of Indian Philosophy, MotilalBanarsidass Publishers; Fifth Reprint edition (2009)
3. Sathaye, Avinash, Translation of NasadiyaSukta
4. Ralph T. H. Griffith. The Hymns of the R̥gveda. MotilalBanarsidass: Delhi: 1973.
5. Raju, P. T. Structural Depths of Indian Thought, Albany: State University of New York Press.
6. Plato, Symposium, Hamilton Press.
7. KautilyaArtha Sastra. Penguin Books, New Delhi.
8. Bacon, Nova Orgum
9. Arnold, Edwin. The Song Celestial.
10. Foucault, Knowledge/Power.
11. Wildon, Anthony, System of Structure.
12. Lele, W.K. The Doctrine of Tantrayukti. Varanasi: Chowkamba Series.
13. Dasgupta, S. N. History of Indian Philosophy, MotilalBanarsidas, Delhi.

14. Passmore, John, Hundred Years of Philosophy, Penguin.

ASSESSMENT (indicative only):

Ask students to do term papers, for example, writing biographical details of founders, sustainers, transmitters, modifiers, rewriters; translating monographs of less known philosophers such as K. C. Bhattacharys, Daya Krishna, Gopinath Bhattacharya; comparative study of philosophical system such as MadhyasthaDarshan.

OUTCOME OF THE COURSE:

Students will develop strong natural familiarity with humanities along with right understanding enabling them to eliminate conflict and strife in the individual and society. Students shall be able to relate philosophy to literature, culture, society and lived experience can be considered.

BTCS401-18	Discrete Mathematics	3L:1T:0P	4 Credits
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Detailed contents:

Module 1:

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. CO1, CO2

Module 2:

Basic counting techniques-inclusion and exclusion, pigeon-hole principle, permutation and combination. CO3

Module 3:

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. CO3, CO4

Module 4:

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 CO4

Module 5:

Graphs and Trees: Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Colouring, Colouring maps and Planar Graphs, Colouring Vertices, Colouring Edges, List Colouring, Perfect Graph, definition properties and Example, rooted trees, trees and sorting, weighted trees and prefix codes, Bi-connected component and Articulation Points, Shortest distances. CO5

Suggested books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill
2. Susanna S. Epp, Discrete Mathematics with Applications, 4th edition, Wadsworth Publishing Co. Inc.
3. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.

Suggested reference books:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structure and Its Application to Computer Science”, TMG Edition, TataMcgraw-Hill
2. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press. Schaum’s Outlines Series, Seymour Lipschutz, Marc Lipson,
3. Discrete Mathematics, Tata McGraw - Hill

Course Outcomes

1. To be able to express logical sentence in terms of predicates, quantifiers, and logical connectives
 2. To derive the solution for a given problem using deductive logic and prove the solution based on logical inference
 3. For a given a mathematical problem, classify its algebraic structure
 4. To evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
 5. To develop the given problem as graph networks and solve with techniques of graph theory.
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B.Tech Robotics and AI

5th Semester

Course Code	Type of Course	Course Title	Hours per Week			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCS 501-18	Professional Core Courses	Database Management Systems	3	0	0	40	60	100	3
BTCS 502-18	Professional Core Courses	Formal Language & Automata Theory	3	0	0	40	60	100	3
BTCS 504-18	Professional Core Courses	Computer Networks	3	0	0	40	60	100	3
BTRA 501-23	Professional Core Courses	Fundamentals of Robotics and Artificial Intelligence	3	0	0	40	60	100	3
BTRA 503-23	Professional Core Courses	Sensors and Actuators	3	0	0	40	60	100	3
BTCS XXX-XX	Professional Elective	Elective-I	3	0	0	40	60	100	3
MC	Mandatory Courses	Constitution of India/ Essence of Indian Traditional Knowledge	2	-	-	100	-	100	S/US
BTCS 505-18	Professional Core Courses	Database Management Systems Lab	0	0	4	30	20	50	2
BTCS 507-18	Professional Core Courses	Computer Networks Lab	0	0	2	30	20	50	1
BTRA 502-23	Professional Core Courses	Fundamentals of Robotics and Artificial Intelligence Lab	0	0	2	30	20	50	1
BTRA 504-23	Professional Core Courses	Sensors and Actuators Lab	0	0	2	30	20	50	1
BTCS XXX-XX	Professional Elective	Elective-I Lab	0	0	2	30	20	50	1
Total			20	0	12	490	460	950	24

Elective-I

BTCS 510-18 Programming in Python

BTCS 513-18 Programming in Python Lab

BTIT 503-18 Programming in Java

BTIT 506-18 Programming in Java Lab

BTRA 505-23 Microprocessor and Interfacing

BTRA 506-23 Microprocessor and Interfacing Lab

Course Code: BTCS501-18 Course Title: Database Management Systems 3L:0T:0P 3Credits

Detailed Contents:

Module 1: Database system architecture

Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). Data models: Entity-relationship model, network model, relational and object oriented Data models, integrity constraints, data manipulation operations.

[7hrs] (CO1,2)

Module 2: Relational query languages

Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQL server. Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design. Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

[10hrs] (CO2,4)

Module 3:

Storage strategies, Indices, B-trees, hashing.

[3hrs] (CO3)

Module 4: Transaction processing

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

[6hrs] (CO3)

Module 5: Database Security

Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

[8hrs] (CO 4,5)

Module 6: Advanced Topics

Object oriented and object relational databases, Logical databases, Web databases, Distributed databases.

[8hrs] (CO 5)

Course Outcomes:

At the end of study the student shall be able to:

CO1: write relational algebra expressions for a query and optimize the Developed expressions

CO2: design the databases using ER method and normalization.

CO3: construct the SQL queries for Open source and Commercial DBMS-MYSQL, ORACLE, and DB2.

CO4: determine the transaction atomicity, consistency, isolation, and durability.

CO5: Implement the isolation property, including locking, time stamping based on concurrency control and Serializability of scheduling.

Text Books:

Course Code: BTCS501-18 Course Title: Database Management Systems 3L:0T:0P 3Credits

1. “Database System Concepts”, 6th Edition by Abraham Silberschatz, Henry F. Korth, S.

Sudarshan, McGraw-Hill.

Reference Books:

1. “Principles of Database and Knowledge–Base Systems”, Vol1 by J. D. Ullman, Computer Science Press.

2. “Fundamentals of Database Systems”, 5th Edition by R. Elmasri and S. Navathe, Pearson Education.

3. “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley.

Course Code: BTCS502-18 Course Title: Formal Language & Automata Theory 3L:1T:0P
3Credits

Detailed Contents

Module 1: Introduction

Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.

[3hrs] (CO1)

Module 2: Regular languages and finite automata:

Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata.

[8hrs] (CO2)

Module 3: Context-free languages and pushdown automata

Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.

[8hrs] (CO3)

Module 4: Context-sensitive languages

Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.

[5hrs] (CO4)

Module 5: Turing machines

The basic model for Turing machines (TM), Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.

[8hrs] (CO 5)

Module 6: Undecidability & Intractability:

Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

Intractability: Notion of tractability/feasibility. The classes NP and co-NP, their importance. Polynomial time many-one reduction. Completeness under this reduction. Cook-Levin theorem: NP-completeness of propositional satisfiability, other variants of satisfiability. NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover

[12hrs] (CO5)

Course Outcomes: The student will be able to:

CO1: Write a formal notation for strings, languages and machines.

CO2: Design finite automata to accept a set of strings of a language.

CO3: Design context free grammars to generate strings of context free language .

CO4: Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars

CO5: Distinguish between computability and non-computability and Decidability and undecidability.

Text Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

Reference Books:

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.

2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.

3. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.

4. John Martin, Introduction to Languages and The Theory of Computation, Tata McGraw Hill.

Course Code: BTCS 504-18 Course Title: Computer Networks 3L:1T:0P 3Credits 42 Hours

Detailed Contents:

Module 1: 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.

[8hrs] (CO1)

Module 2: 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.

[10 hrs] (CO2)

Module 3: Network Layer

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

[8 hrs] (CO3)

Module 4: 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.

[8 hrs] (CO3)

Module 5: Application Layer

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

[8 hrs] (CO4)

Course Outcomes: The student will be able to:

CO1: Explain the functions of the different layer of the OSI Protocol;

CO2: Describe the function of each block of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs);

CO3: Develop the network programming for a given problem related TCP/IP protocol; &

CO4: Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

Text Books:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.

Reference Books:

1. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
2. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
3. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

Fundamentals of Robotics and Artificial Intelligence

Course Code: BTRA 501-23

3L:0T, 3 Credits

Unit 1: Introduction to Robotics

Understanding Robots, Evolution of Robots; Laws of Robotics, Classification of Robots, Real world Robots and their applications, Application of robots in different fields such as domestic, industry, medical, defence, entertainment, agriculture etc.

Unit 2: Robotic System

Building blocks of Robots, Block diagram of a robot; Mechanical, electronic and computational blocks; functioning and working principle of each block. Design aspects using examples of humanoid, aerial, underwater and mobile robots. Identification of robots through demonstration/ video/graphic details. Types of motion; motion in one-dimension and two-dimension; Types of motion (linear, angular, and circular); Degree of freedom of a robot

Unit 3: Introduction to Artificial Intelligence (AI)

Definition of Artificial Intelligence; brief history of AI, Applications of AI in different fields: commercial, industry, medical/health care, defence, banking, entertainment, transport, security and agriculture. Introduction to augmented/ virtual reality. Ethical considerations in AI.

Unit 4: Role of Data and Information, Evolution of Computing, Types of Data (audio, visual, numeric, text); Data to Information. AI Project Cycle. Evolution of Computing: Pre AI/ML Binary Logic System, Conditional Gates, Deterministic computing for deterministic problems.

Unit 5: Searching Techniques: uninformed search strategies, informed (heuristic) search strategies, local search algorithms, searching in non-deterministic and partially observable environment, adversarial search, Temporal Probability models and inference in temporal models: filtering, prediction, smoothing, Dynamic Bayesian Networks, Hidden Markov Model.

Suggested Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence A Modern Approach, 3rd Edition, Pearson, 2014.
2. Fu. K.S., Gonzalez R.C. and Lee C.S.G., Robotics: Control, Sensing, Vision and Intelligence, Tata McGraw Hill, 2008.
3. Ghosal A. Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
4. Craig J.J., Introduction to Robotics – Mechanics and Control, Pearson Prentice Hall, 2005.
5. Saha. S.K., Introduction to Robotics, McGraw Hill Education (India) Private Limited, 2014.

SENSORS AND ACTUATORS

Course Code: BTRA 503-23

3L:0T, 3 Credits

COURSE OBJECTIVES:

The course should enable the students to:

1. Understanding basic laws and phenomena on which operation of sensors and actuators- Transformation of energy
2. Create analytical design and development solutions for sensors and actuators.
3. To know the basic laws of behaviour of sensors and actuators.
4. To able to know about the Standards for Smart Sensor Interface
5. Analyse the development and application of sensors and actuators.

UNIT-I Sensors / Transducers

Sensors / Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges, Inductive Sensors- Sensitivity and Linearity of the Sensor, Types- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors

UNIT-II Thermal Sensors

Thermal Sensors: Introduction, Gas thermometric Sensors, Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index Thermo-sensors, Helium Low Temperature Thermometer, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type Thermometric Sensors, Thermo-EMF Sensors, Junction Semiconductor Types, Thermal Radiation Sensors, Quartz Crystal Thermo-electric Sensors, NQR Thermometry, Spectroscopic Thermometry, Noise Thermometry, Heat Flux Sensors.

UNIT-III Radiation Sensors Classes

Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors. Electro Analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization– Reference Electrodes – Sensor Electrodes – Electro ceramics in Gas Media .

UNIT-IV Smart Sensors

Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface,

the Automation. Sensors Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

UNIT-V Actuators

Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves, Process control valves, Rotary actuators.

COURSE OUTCOMES:

Upon successful completion of the course, the student is able to

1. Apply the fundamental physical and technical base of sensors and actuators,
2. Analyse various premises, approaches, procedures and results related to sensors and actuators
3. Analyse basic laws and phenomena that define behaviour of sensors and actuators.
4. Apply the Smart Sensor Interface in various applications
5. Develop the application of sensors and actuators

Text Books:

1. D. Patranabis, —Sensors and Transducers, PHI Learning Private Limited.
2. W. Bolton, —Mechatronics, Pearson Education Limited.

Reference Books:

1. Renganathan S., Transducer Engineering, Allied Publishers (P) Ltd., 2003

Web Link:

<https://www.journals.elsevier.com/sensors-and-actuators>

E Text books:

<https://www.sciencedirect.com/handbook/handbook-of-sensors-and-actuators>

Moocs:

<https://www.classcentral.com/course/swayam-sensors-and-actuators-14285>

Course Code: BTCS505-18 Course Title: Database management System lab 0L:0T:4P 2Credits

List of Experiments:

Task 1: Introduction to SQL and installation of SQL Server / Oracle.

Task 2: Data Types, Creating Tables, Retrieval of Rows using Select Statement, Conditional Retrieval of Rows, Alter and Drop Statements.

Task 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 Statements.

Task 4: Set Operators, Nested Queries, Joins, Sequences.

Task 5: Views, Indexes, Database Security and Privileges: Grant and Revoke Commands, Commit and Rollback Commands.

Task 6: PL/SQL Architecture, Assignments and Expressions, Writing PL/SQL Code, Referencing Non-SQL parameters.

Task 7: Stored Procedures and Exception Handling.

Task 8: Triggers and Cursor Management in PL/SQL. Suggested Tools – MySQL, DB2, Oracle, SQL Server 2012, Postgre SQL, SQL lite

Course Outcomes:

CO1: This practical will enable students to retrieve data from relational databases using SQL.

CO2: students will be able to implement generation of tables using datatypes

CO3: Students will be able to design and execute the various data manipulation queries.

CO4: Students will also learn to execute triggers, cursors, stored procedures etc.

Course Code: BTCS507-18 Course Title: Computer Networks Lab 0L:0T:2P 1 Credits

List of Experiments:

- Task 1: To study the different types of Network cables and network topologies.
- Task 2: Practically implement and test the cross-wired cable and straight through cable using clamping tool and network lab cable tester.
- Task 3: Study and familiarization with various network devices.
- Task 4: Familiarization with Packet Tracer Simulation tool/any other related tool.
- Task 5: Study and Implementation of IP Addressing Schemes
- Task 6: Creation of Simple Networking topologies using hubs and switches
- Task 7: Simulation of web traffic in Packet Tracer
- Task 8: Study and implementation of various router configuration commands
- Task 9: Creation of Networks using routers.
- Task 10: Configuring networks using the concept of subnetting
- Task 11: Practical implementation of basic network command and Network configuration commands like ping, ipconfig, netstat, tracert etc. for troubleshooting network related problems.
- Task 12: Configuration of networks using static and default routes.

Course Outcomes:

The students will be able to:

- CO1: Know about the various networking devices, tools and also understand the implementation of network topologies;
- CO2: Create various networking cables and know how to test these cables;
- CO3: Create and configure networks in packet trace rtool using various network devices and topologies;
- CO4: Understand IP addressing and configure networks using the subnet in;
- CO5: Configure routers using various router configuration commands.

Suggested Tools - NS2/3, Cisco packet tracer, Netsim etc..

Fundamentals of Robotics and Artificial Intelligence Lab

Course Code: BTRA 502-23

0L:0T:2P 1Credits

Lab may be designed by instructor based on theory curriculum.

SENSORS AND ACTUATORS LAB

Course Code: BTRA 504-23

0L:0T:2P 1Credits

Lab may be designed by instructor based on theory curriculum.

Course Code: BTCS 510-18 Course Title: Programming in Python 3L:0T:0P 3 Credits 42 Hours

Detailed Contents:

Module 1:

Python Basics, Objects- Python Objects, Standard Types, Other Built-in Types, Internal Types, Standard Type Operators, Standard Type Built-in Functions, Categorizing the Standard Types, Unsupported Types Numbers - Introduction to Numbers, Integers, Floating Point Real Numbers, Complex Numbers, Operators, Built-in Functions, Related Modules Sequences - Strings, Lists, and Tuples, Mapping and Set Types.

[8hrs] (CO1)

Module 2:

FILES: File Objects, File Built-in Function [open()], File Built-in Methods, File Built-in Attributes, Standard Files, Command-line Arguments, File System, File Execution, Persistent Storage Modules, Related Modules

Exceptions: Exceptions in Python, Detecting and Handling Exceptions, Context Management, *Exceptions as Strings, Raising Exceptions, Assertions, Standard Exceptions, *Creating Exceptions, Why Exceptions (Now)?, Why Exceptions at All?, Exceptions and the sys Module, Related Modules

Modules: Modules and Files, Namespaces, Importing Modules, Importing Module Attributes, Module Built-in Functions, Packages, Other Features of Modules.

[10hrs] (CO1,2)

Module 3:

Regular Expressions: Introduction, Special Symbols and Characters, Res and Python Multithreaded Programming: Introduction, Threads and Processes, Python, Threads, and the Global Interpreter Lock, Thread Module, Threading Module, Related Modules.

[8hrs] (CO 2,3)

Module 4:

GUI Programming: Introduction, Tkinter and Python Programming, Brief Tour of Other GUIs, Related Modules and Other GUIs

WEB Programming: Introduction, Web Surfing with Python, Creating Simple Web Clients, Advanced Web Clients, CGI-Helping Servers Process Client Data, Building CGI ApplicationAdvanced CGI, Web (HTTP) Servers.

[10hrs] (CO 4,6)

Module 5:

Database Programming: Introduction, Python Database Application Programmer's Interface (DB-API), Object Relational Managers (ORMs), Related Modules. [6 hrs] (CO5)

Text Books:

1. Core Python Programming, Wesley J. Chun, Second Edition, Pearson.

Course Outcomes:

The students should be able to:

CO1: Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

CO2: Demonstrate proficiency in handling Strings and File Systems.

CO3: Create, run and manipulate Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.

CO4: Interpret the concepts of Object-Oriented Programming as used in Python.

CO5: Implement exemplary applications related to Network Programming, Web Services and Databases in Python.

Course Code: BTCS 513-18 Course Title: Programming in Python Lab 0L:0T:2P 1 Credits 2 Hours/ week

Prerequisites: Students should install Python.

List of Experiments:

Task 1: Write a program to demonstrate different number data types in Python.

Task 2: Write a program to perform different Arithmetic Operations on numbers in Python.

Task 3: Write a program to create, concatenate and print a string and accessing sub-string from a given string.

Task 4: Write a python script to print the current date in the following format “Sun May 29 02:26:23 IST 2017”

Task 5: Write a program to create, append, and remove lists in python.

Task 6: Write a program to demonstrate working with tuples in python.

Task 7: Write a program to demonstrate working with dictionaries in python.

Task 8: Write a python program to find largest of three numbers.

Task 9: Write a Python program to convert temperatures to and from Celsius, Fahrenheit. [Formula: $c/5 = f-32/9$]

Task 10: Write a Python program to construct the following pattern, using a nested for

loop

```
*
 *
* *
* * *
* * * *
* * *
* * *
* *
*
*
```

Task 11: Write a Python script that prints prime numbers less than 20.

Task 12: Write a python program to find factorial of a number using Recursion.

Task 13: Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the

Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides).

Task 14: Write a python program to define a module to find Fibonacci Numbers and import the module to another program.

Task 15: Write a python program to define a module and import a specific function in that module to another program.

Task 16: Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.

Task 17: Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.

Task 18: Write a Python class to convert an integer to a roman numeral.

Task 19: Write a Python class to implement $\text{pow}(x, n)$

Task 20: Write a Python class to reverse a string word by word.

Course code: BTIT 503-18

Programming in JAVA

3L:0T:0P 3 Credits

Detailed contents:

Unit 1:

Overview: Object oriented programming principles, Java essentials, java virtual machine, program structure in java ,Java class libraries, Data types, Variables and Arrays, Data types and casting, automatic type promotion in expressions, arrays.

Operators and Control Statements: Arithmetic operators, bit wise operators, relational operators, Boolean logical operators, the ? Operator, operator precedence, Java's selection statements, iteration statements, jump statements.

UNIT 2:

Introduction to Classes: Class fundamentals, declaring class, creating objects, introducing methods: method declaration, overloading, using objects as parameters, recursion, Constructors, this keyword, garbage collection, the finalization. [9hrs., CO1]

UNIT 3:

Inheritance: Inheritance basics, using super and final, method overriding, dynamic method dispatch, Abstract Class, Interface: variables and extending Interfaces, Package: Creating and importing packages, Package access protection, Exception Handling: Exception handling fundamentals, Exception types, Uncaught Exceptions Using try and catch, multiple catch clauses, nested try statements, throw, Java's built-in exceptions. [12hrs.,CO1,2]

UNIT 4:

Multithreaded Programming: The Java thread model, the main thread, creating thread, creating multiple threads, using isAlive () and join (), Thread priorities, synchronization, Inter thread communications, suspending resuming and stopping threads. [4hrs., CO3]

UNIT5:

I/O : I/O Basics, Reading Console Input, Writing Console Output, Reading and Writing Files, Applets: Applet Fundamentals, Applet Architecture, The HTML Applet tag, Passing parameters to Applets., Networking: Networking basics, Java and the Net, TCP/IP Client Sockets URL, URL Connection, TCP/IP Server Sockets, Database connectivity. [6hrs., CO4]

Course Outcomes: At the end of the course the student should be able to:

CO1. Understand the features of Java such as operators, classes, objects, inheritance, packages and exception handling

CO2. Learn latest features of Java like garbage collection, Console class, Network interface, APIs

CO3.Acquire competence in Java through the use of multithreading, applets

CO4. Get exposure to advance concepts like socket and database connectivity.

Suggested Readings/Books :

1. Herbert Schildt, The Complete Reference Java2, McGraw-Hill.
2. Joyce Farrell, Java for Beginners, Cengage Learning.
3. Deitel and Deitel, Java: How to Program, 6th Edition, Pearson Education.
4. James Edward Keogh, Jim Keogh, J2EE: The complete Reference, McGrawHill
5. Khalid A. Mughal, Torill Hamre, Rolf W. Rasmussen, Java Actually, Cengage Learning.
6. Shirish Chavan, Java for Beginners, 2nd Edition, Shroff Publishers

Programming in Java Lab

Course Code: BTIT 506-18

0L:0T,2P 1 Credits

1. WAP in Java to show implementation of classes.
2. WAP in Java to show implementation of inheritance.
3. WAP in Java to show Implementation of packages and interfaces.

To accomplish CO2;

4. WAP in Java to show Implementation of threads.
5. WAP in Java Using exception handling mechanisms.
6. WAP in Java to show Implementation of Applets.

To accomplish CO3;

7. WAP in Java to show Implementation of mouse events, and keyboard events.
8. WAP in Java to show Implementing basic file reading and writing methods.
9. Using basic networking features, WAP in Java

To accomplish CO4;

10. WAP in Java to show Connecting to Database using JDBC

MICROPROCESSORS & INTERFACING

Course Code: BTRA 505-23

3L:0T:0P 3Credits

Course Objectives:

- To become familiar with 8085 & 8086 Microprocessor Architecture, Instructions, Operating Modes and Programming.
- To use 8086 microprocessor for various applications.
- To study various peripherals for microprocessor based systems.

UNIT I

Introduction to 8085 Microprocessor: Development of microprocessors, 8085 Microprocessor - Architecture, Organization, Instruction set, Addressing modes, Basic Timing Diagrams, Interrupts and Simple Programs.

UNIT II

Introduction to 8086 Microprocessor: 8086 Microprocessor - Architecture, Organization, Instruction set, Addressing modes, Interrupt system. Pin diagram, Minimum mode 8086 system and timings, Maximum mode 8086 system and timings.

UNIT III

Assembly Language Programming: Assembler directives, Assembly language programs (8086) with Assembler directives for addition, subtraction, multiplication, division etc., sorting and searching, bit manipulation, look-up tables, string manipulations, Macros and Delay subroutines, Debugging.

UNIT IV

Data transfer schemes and Peripheral Interfacing: Synchronous, Asynchronous, Interrupt driven and DMA type schemes, 8255 PPI and its interfacing, Programmable Communication Interface (8251 USART) and its interfacing, Programmable Interval Timer (8254) and its interfacing, Programmable interrupt controller (8259) and its interfacing, Programmable DMA controller (8257) and its interfacing.

UNIT V

Memory and I/O Interfacing to 8086: Address decoding techniques, Interfacing Static RAM and ROM chips, ADC and DAC Interfacing.
Case studies: Traffic light controller, Stepper motor control, Data acquisition, Temperature measurement and control.

Course Outcomes: On successful completion of this course, the students will be able to

CO 1 Describe the DC and AC characteristics of Operational Amplifier and their compensation techniques.

CO 2 Understand the applications of Operational Amplifier.

CO 3 Analyze different analog active filters.

CO 4 Generate various waveforms using OP-Amp / 555 timers.

CO 5 Understand the principles of data converters

Text Books:

1. Ramesh S. Gaonkar, "Microprocessor architecture, programming and its applications with 8085", Penram Interantional Publications, 4th Edition.
2. A. K. Ray and K.M. Bhurchandi, "Advanced Microprocessors and Peripherals", TMH.
3. Douglas V. Hall, "Microprocessors and Interfacing: Programming and Hardware", 2nd Edition, Tata McGraw-Hill.
4. Barry B. Brey, "The Intel Microprocessors-Architecture, Programming and Interfacing", 8th Edition, PHI.

Reference Books:

1. Raj Kamal, Microcontrollers Architecture, Programming, Interfacing and System Design , Pearson Education, 2005.
2. Steve Furbur, ARM System onchip Architecture, 2nd Edition, Addison Wesley, 2000.
3. Y. Liu and Glenn A. Gibson, "Microcomputer Systems: 8086/8088 Family Architecture, Programming and Design", 2nd Edition, PHI.
4. Y. Liu and Glenn A. Gibson, "Microcomputer Systems: 8086/8088 Family Architecture, Programming and Design", 2nd Edition, PHI

MICROPROCESSORS & INTERFACING LAB

Course Code: BTRA 506-23

0L:0T:2P 1Credits

Lab may be designed by instructor based on theory curriculum.

B.Tech Robotics and AI

6th Semester

Course Code	Type of Course	Course Title	Hours per Week			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTRA 601-22	Professional Core Courses	Advanced Artificial Intelligence	3	0	0	40	60	100	3
BTRA 603-22	Professional Core Courses	Kinematics and Robotics	3	0	0	40	60	100	3
BTRA XXX-22	Professional Elective Courses	Elective-II	3	0	0	40	60	100	3
BTRA XXX-22	Professional Elective Courses	Elective-III	3	0	0	40	60	100	3
BTOE XXX-XX	Open Elective Courses	Open Elective-I	3	0	0	40	60	100	3
BTRA 617-22	Project	Project-1	0	0	6	60	40	100	3
BTRA 602-22	Professional Core Courses	Advanced Artificial Intelligence Lab	0	0	2	30	20	50	1
BTRA 604-22	Professional Core Courses	Kinematics and Robotics Lab	0	0	2	30	20	50	1
BTRA XXX-22	Professional Core Courses	Elective-II Lab	0	0	2	30	20	50	1
BTRA XXX-22	Professional Core Courses	Elective-III Lab	0	0	2	30	20	50	1
Total			20	0	12	380	420	800	22

Elective-II

BTRA 605-22 Embedded System Design
BTRA 606-22 Embedded System Design Lab
BTRA 607-22 Robot Operating System
BTRA 608-22 Robot Operating System Lab
BTRA 609-22 Control System
BTRA 610-22 Control System Lab

Elective-III

BTRA 611-22 Mobile and Micro Robotics
BTRA 612-22 Mobile and Micro Robotics Lab
BTRA 613-22 Data Analytics
BTRA 614-22 Data Analytics Lab
BTRA 615-22 Intelligent Manufacturing
BTRA 616-22 Intelligent Manufacturing Lab

Unit 1:

Overview of Probability Theory, Bayes Networks, Independence, I-Maps, Undirected Graphical Models, Bayes Networks and Markov Networks,

Unit 2:

Local Models, Template Based Representations, Exact Inference: Variable Elimination; Clique Trees, Belief Propagation Tree Construction.

Unit 3:

Introduction to Optimization, Approximate Inference: Sampling, Markov Chains, MAP Inference, Inference in Temporal Models, Learning Graphical Models: Intro Parameter Estimation, Bayesian Networks and Shared Parameters.

Unit 4:

Structure Learning, Structure Search Partially Observed Data, Gradient Descent, EM, Hidden Variables, Undirected Models, Undirected Structure Learning, Causality, Utility Functions,

Unit 5:

Decision Problems, Expected Utility, Value of Information, Decision- Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample application.

Suggested Text Books:

(i) Russell, Stuart and Norvig, Peter, "Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.

(ii) Zhongzhi Shi, "Advanced Artificial Intelligence", World Scientific Publishing Company, March 2011.

(iii) Luger "Artificial Intelligence", Edition 5, Pearson, 2008.

Suggested Reference Books:

(i) Daphne Koller and Nir Friedman, "Probabilistic Graphical Models", MIT Press, 2009.

(ii) Russell and P. Norvig, "Artificial Intelligence", Pearson Publication, 2020.

(iii) Christopher Bishop: "Pattern Recognition and Machine Learning", Springer, 2006.

Course Outcomes:

After the completion of this course, the students will be able to:

- Explain in detail how the techniques in the perceive-inference-action loop work.
- Choose, compare, and apply suitable basic learning algorithms to simple applications.
- Ability to explain how deep neural networks are constructed and trained, and apply deep neural networks to work with large scale datasets.
- Understand and develop deep reinforcement learning algorithms for suitable applications.

Unit 1: Introduction

Vector Representations and Operations, Transformations, Translational and Rotational, Coordinate Reference Frames, Properties of Transformation Matrices, Matrix Creation and Manipulation using MATLAB.

Unit 2: Homogeneous Transformations

Pure Translation, Pure Rotation about an Axis, Representation of Combined Transformations, Transformations Relative to a Moving Frame, Homogeneous Transformations using MATLAB.

Unit 3: Kinematics:

Kinematic Parameters, The Denavit-Hartenberg (DH) Representation, Forward & Inverse Kinematic Equations: Position, Cartesian Coordinates, Cylindrical Coordinates, Spherical Coordinates, Articulated Coordinates, Kinematics of Industrial Robots, Kinematics using MATLAB.

Unit 4: Forward & Inverse Kinematic:

Orientation Description, Forward & Inverse Kinematic Equations Orientation, Roll, Pitch and Yaw (RPY) Angles, Euler Angles, Geometric Approach to Inverse Kinematics, Forward and Inverse Kinematics of Industrial Robots, Design Project: A 3-DOF Robot.

Unit 5: Velocity & Acceleration Analysis:

Differential Motions and Relationships, Jacobian, Forward and Inverse Velocity Analysis, Acceleration Analysis, Design Project: A 3-DOF Robot.

Suggested Text Books

- (i) S. K. Saha, "Introduction to Robotics", McGraw Hill Education (India) Pvt. Ltd., 2014.
- (ii) John J. Craig, "Introduction to Robotics – Mechanics and Control", Pearson Education, 2004.

Suggested Text Books

- (i) Saeed B. Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., 2010.
- (ii) Reza N. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics, and Control", Springer July 2010.
- (iii) Tuna Balkan, "Robot Kinematics: Forward and Inverse Kinematics", Intech, Dec. 2006.

Course Outcomes:

After the completion of this course, the students will be able to:

- Explain position and orientation parameters for describing the pose of industrial robots.
- Apply mathematical tools for solving robot kinematics problems.
- Assign the coordinate frames to industrial robots and derive their forward and inverse kinematic equations.
- Use software tools for obtaining solutions to forward and inverse kinematics problems.

Suggested List of Assignments

- Implement A* algorithm.
- Implement AO* algorithm.
- Implementation of other Searching algorithms.
- Implementation of Min/MAX search procedure for game Playing.
- Implementation of variants of Min/ Max search procedure.
- Implementation of a mini Project using the concepts studied in the AI course.

This list is a guideline. The instructor is expected to improve it continuously.

Suggested Text Books:

- (i) Luger "Artificial Intelligence", Edition 5, Pearson, 2008.
- (ii) Michael Negnevitsky, "Artificial Intelligence: A Guide to Intelligent Systems", Addison-Wesley, May 2011.

Suggested Reference Books:

- (i) Russell, Stuart and Norvig, Peter, "Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.
- (ii) Bench-Capon, T. J. M., "Knowledge Representation: An approach to artificial intelligence", Academic Press, 1990.
- (iii) Mohamad H. Hassoun, "Fundamentals of Artificial Neural Networks", The MIT Press, 1995.

Course Outcomes:

Upon successful completion of the course, the students will be able to:

- Develop an Explanation of what is involved in learning models from data.
- Implement a wide variety of learning algorithms.
- Apply principles and algorithms to evaluate models generated from data.
- Apply the algorithms to a real-world problem.

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

- demonstrate the mechanism of various robots
- determine the end-effector positions and joint variables using forward and inverse kinematics respectively (L3)
- apply principles of kinematics to generate workspaces of planar and spatial robots
- determine joint velocities and accelerations of a 2R planar robot for the given input torques
- demonstrate trajectory planning, loading unloading, and pick and place operations of an industrial robot

LIST OF EXERCISES

1. Simulate the robot motion for various inputs of the joint angular value for Move master RM-501 robotic arm
2. Solve direct kinematics of a PUMA 560 robotic arm for the given joint variables and simulate the robot remotely to identify the end-effector trajectory
3. Determine the joint variables of a PUMA 560 robotic arm for a given Cartesian trajectory and compare with simulation
4. Forward kinematic analysis of a 2R planar robot and 6 DoF robots
5. Inverse kinematic analysis of a 2R planar robot and 6 DoF robots
6. Generate workspace of planar robots
7. Generate workspace of spatial robots
8. Generate a 3D model of a robot based on DH parameters
9. Forward dynamic analysis of a 2R planar robot
10. Inverse dynamic analysis of a 2R planar robot
11. Program for loading and unloading operations on 6 DoF Articulated robot
12. Program for palletizing application on 6 DoF Articulated robot
13. Program for conveyor belt application on SCARA robot
14. Program for deburring and assembly application on SCARA robot

Weblinks:

1. <http://vlabs.iitkgp.ernet.in/mr/index.html#> (IIT Kharagpur)
2. RoboAnalyzer (IIT Delhi)
3. RT Toolbox (Mitsubishi Robots)

Unit 1: ARM-Cortex Series Architecture:

Embedded systems, classification, ARM 32-bit microcontroller Tiva, architecture technology overview, Architectural Features of ARM Cortex M series: Tiva Block Diagram, CPU modes, register organization, ROM, RAM, timers, data and address bus, Memory and I/O interfacing concepts, memory mapped I/O. CISC Vs RISC design philosophy, Von-Neumann Vs Harvard architecture, instruction set, pipelining, exceptions and its handling, memory, I/O's and addressing modes.

Unit 2: Operating system based development:

Operating systems fundamentals, operating system services, memory management, process management, device management, file management, operating system services- program execution, I/O operation, file manipulation, communication, operating system properties- multitasking, parallel programming, interactivity, scheduling and scheduling algorithms. Linux: An overview of Red Hat Linux, installing Ubuntu, Linux commands, shell scrip programming, embedded Linux.

Unit 3: Development Tools (Open Source):

GNU tools, text editors-vi, nano, pico, etc. IDE-Eclipse, code lite, compilers-gcc, g++, debuggers, cross- compilers, gcc- arm specific tool chains and in line assembly, Writing and compiling C/C++ programs, cross-compilation for ARM development board, Basics of make file, static and dynamic libraries.

Unit 4: Kernel programming:

Kernel, basic functionalities of kernel, kernel module programming, Linux kernel sources, kernel configuration, booting kernel, kernel booting parameters, root file system, bootloader, U- boot, porting Linux ARM board, device driver programming, architecture, I/O communication, writing simple character device driver.

Unit 5: RTOS:

RTOS concepts using Tiva: foreground and background systems, critical section, shared resources, tasks, multitasking, context switching, kernels, pre-emptive and non- pre-emptive schedulers, static and dynamic priorities, priority inversion, mutual exclusion, synchronization, inter task communication mechanisms, Interrupts: latency, response and recovery, clock tick, memory requirements.

Unit 6: Interfacing and application development

Interfacing of peripherals using Tiva: LED and sensors, ADC, Timer, PWM, UART, SPI, I2C. Development of web server, wireless module interfacing, camera interfacing, open CV on Beagle Bone Black. Control application, Java programming on Beagle Bone Black, porting android for mobile applications like controlling Beagle Bone Black I/O through mobile.

Suggested Text Books:

- (i) Sloss Andrew N, Symes Dominic, Wright Chris, "ARM System Developer's Guide: Designing and Optimizing", Morgan Kaufman Publication, 2004.
- (ii) Michael Beck, "Linux Kernel Programming", Addison-Wesley Professional, 3rd ed., 2002.

Suggested Reference Books:

- (i) Raj Kamal, "Embedded Systems – Architecture: Programming and Design", Tata McGraw- Hill Education, 3rd edition, 2003.
- (ii) Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2014, Jonathan W Valvano Create space publications ISBN: 978-1463590154.
- (iii) Embedded Systems: Introduction to ARM Cortex - M Microcontrollers, 5th edition Jonathan W Valvano, Create space publications ISBN-13: 978-1477508992.

Course Outcomes:

- Hands on usage of IDE of processors and algorithm development.
- To understand the concept of OS, RTOS and application perspectives.
- Understanding of RISC architecture of processor, its features and application.
- Study, design, analyze and prototype various embedded systems.

Laboratory Experiments:

1. Study of ARM evaluation system.
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDs.
10. Interfacing stepper motor and temperature sensor.
11. Implementing ZigBee protocol with ARM.

Suggested Text Books:

- (i) Sloss Andrew N, Symes Dominic, Wright Chris, “ARM System Developer's Guide: Designing and Optimizing”, Morgan Kaufman Publication, 2004.
- (ii) Michael Beck, “Linux Kernel Programming”, Addison-Wesley Professional, 3rd edition 2002.

Suggested Reference Books:

- (i) Raj Kamal, “Embedded Systems – Architecture: Programming and Design”, Tata McGraw-Hill Education, 3rd edition, 2003.
- (ii) Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2014, Jonathan W Valvano Create space publications ISBN: 978-1463590154.
- (iii) Embedded Systems: Introduction to ARM Cortex - M Microcontrollers, 5th edition Jonathan W Valvano, Create space publications ISBN-13: 978-1477508992.

Course Outcomes:

- Write programs in ARM for a specific Application.
- Interface memory and Write programs related to memory operations.
- Interface A/D and D/A convertors with ARM system.
- Analyze the performance of interrupt.
- Write programmes for interfacing keyboard, display, motor and sensor.
- Formulate a mini project using embedded system.

BTRA 607-22 Robot Operating Systems**3L:0T:0P 3 credits**

Unit 1: Basic principles, Operating System Structures, System Calls & Types, Processes: Concept Scheduling, Inter Process Communication, Introduction to distributed Operating System, Types of network based OS.

Unit 2: Overview of RTOS, RTOS Task and Task State, Pre-emptive Scheduler, Process Synchronization, Message Queues, Mailboxes, Pipes, critical Section, Semaphores, Classical Synchronization Problem, Deadlocks.

Unit 3: Inserting BSP in Kernel Build Procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem, Timers - UART- Power Management. Embedded Storage: MTD – MTD Architecture - MTD driver for NOR Flash – Flash Mapping driver

Unit 4: Embedded kernel & components, Embedded File System: RAM Disk – RAMFS – CRAMFS, Journaling Flash File Systems: JFFS and JFSS2, NFS: PROC File system, Optimizing storage Space: Kernel space optimization - Application Space Optimization, Applications for Embedded Linux - Tuning kernel memory.

Unit 5: Linux Devices Drivers, Embedded Drivers: Linux Serial Driver - Ethernet Driver - I 2C Subsystem on Linux - USB Gadgets, Watchdog Timer, Kernel Modules.

Text Books:

- Silberschatz, Galvin, Gagne, “Operating System Concepts”, 6th edition, John Wiley, 2003.
- Raj Kamal, “Embedded Systems -Architecture, Programming and Design”, Tata McGraw Hill, 2006.
- P. Raghavan, Amol Lad, SRIRam Neelakandan, “Embedded Linux System Design and development”, Auerbach Publications 2005.
- Jonathan Corbet, Allesandro Rubini & Greg Kroah-Hartman, “Linux Device DRIVERS”, O’Reilly, 3rdedition, 2005.

Reference Books:

- LENTIN JOSEPH “ Robot operating system (ROS) for absolute beginners”. Released May 2018 Publisher(s): Apress ISBN: 9781484234051.
- Anis Koubaa Robot Operating System (ROS) The Complete Reference (Volume 6)

Laboratory Experiments:

1. Endowing mobile autonomous robots with planning, perception, and decision- making capabilities.
2. Trajectory optimization.
3. Robot motion planning and perception.
4. Robot, localization, and simultaneous localization and mapping.
5. Robot Operating System (ROS) for demonstrations and hands-on activities.

Suggested Text Books:

- (i) Morgan Quigley, “Programming Robots with ROS: A Practical Introduction to the Robot Operating System” , O'Reilly Media, 2015.
- (ii) Carol Fairchild, Dr. Thomas L. Harman, “ROS Robotics by Example”, Packt, 2016.

Suggested Reference Books:

- (i) Anis Koubaa, “Robot Operating System”, Springer link, 2016.
- (ii) Anil Mahtani, “Effective Robotics Programming with ROS”, Packt Publishing, 2016.
- (iii) Ramkumar Gandhinathan , Lentin Joseph , “ ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality”, Packt Publishing Limited, December 2019.

Course Outcomes:

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

- Learn fundamentals, including key ROS concepts, tools, and patterns.
- Program robots that perform an increasingly complex set of behaviors, using the powerful packages in ROS.
- See how to easily add perception and navigation abilities to your robots.
- Integrate your own sensors, actuators, software libraries, and even a whole robot into the ROS ecosystem.
- Learn tips and tricks for using ROS tools and community resources, debugging robot behavior using C++ in ROS.

Unit 1: Introduction to Control System: Introduction to control system block diagram. Importance of Control Systems. Components of control. Explanation with the help of the liquid level control system. Significance of actuators and sensors. Types of actuators, Types of sensors. Open loop control and closed loop control. Use of relays, switches and contactors for simple and sequential control systems.

Module 2: Control system representation:

Mathematical representation of simple mechanical, electrical, thermal, hydraulic systems. Block diagram representation and reduction. Signal flow graph. Transfer function of these systems. Pole zero concepts.

Module 3: Time domain analysis:

Time response of first order, second order systems. Analysis of steady state error, Type of system and steady state error, Time response specifications. Effect of parameter variation on open loop and closed loop system response, sensitivity. Effect of feedback on system response, stability and disturbance.

Module 4: Stability:

Concept of stability, Effect of pole zero location on stability, Routh- Hurwitz criterion. Root Locus method for analysis of gain margin, phase margin and stability.

Module 5: Control system analysis in frequency domain:

Concept of frequency domain behavior, Bode Plot for analyzing systems in frequency domain. Frequency domain performance specifications. Correlation between time domain and frequency domain specification. Nyquist Analysis.

Module 6: State Space Approach:

Representation of system in state space, Converting transfer function model into state space model. Non uniqueness of state space model, Canonical representation, Eigenvalues, Solution of state equations, Concept of State feedback control, controllability, Observability.

Suggested Text Books:

- (i) Nagrath & M. Gopal "Control System Engineering", Anshan, 2008.
- (ii) Norman S. Nice, "Control System Engineering", Wiley, 2008.

Suggested Reference Books:

- (i) Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education, 2007.
- (ii) Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 2010.
- (iii) Norman S. Nise, "Control System Engineering", Wiley, 2014.

Course Outcomes:

At the end of this course, the students will demonstrate the ability to:

- Appreciate the role of the control system.
- Analyze the mathematical model of the control system.
- Solve to get a time domain response.
- Analyze stability of the system.
- Use bode plot for frequency domain analysis.
- Analyze the control system in state space.

Experiments:

- To study input out characteristic of various control system components.
- To obtain step response and find time response specification of electrical system, hydraulic system, pneumatic system and thermal system.
- To obtain transfer function and poles zeros of DC motor experimentally.
- To obtain root locus experimentally.
- Use Matlab to study the effect of feedback gain on system response.
- Use Matlab to study the effect of damping factor zeta on time control performance specifications.
- Use Matlab to obtain root locus for a given system and find performance specifications there from. Study effect of addition of zero and pole on root locus.
- Use Matlab to get a bode plot and obtain gain margin and phase margin for various systems.
- Use Matlab to obtain state space representation from transfer function, find Eigenvalues, Analyze controllability, observability and stability.

Suggested Text Books:

- (i) Nagrath & M. Gopal “Control System Engineering”, Anshan, 2008.
- (ii) Norman S. Nice, “Control System Engineering”, Wiley, 2008.

Suggested Reference Books:

- (i) Smarajit Ghosh, “Control Systems Theory & Applications”, Pearson Education 2007.
- (ii) Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hall, 2010.
- (iii) Norman S. Nise, “Control System Engineering”, Wiley, 2014.

Course Outcomes:

At the end of this course, the students will demonstrate the ability to:

- Develop the mathematical model of different components of linear feedback control system using simulation and experiments.
- Analyze the transient characteristics of different first order and second order systems using simulation and experiments.
- Determine the performance of system using root locus.
- Carry out the stability analysis of linear feedback control system using Bode plot and Nyquist plot.
- Carry out the stability analysis of linear feedback control system using Modern control techniques.
- Analyze the different types of controllers like PI, PD, PID and tuning of these controllers using simulation and experiments.
- Describe various applications like temperature controller experimentally.
- Demonstrate an industrial application (like Bottle filling/ Pick and Place control) using PLC

Unit 1: Introduction to Mobile Robots - Tasks of mobile robots, robots manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots.

Unit 2: Kinematics and Dynamics of Wheeled Mobile Robots (two, three, four - wheeled robots, omnidirectional and macanum wheeled robots). Sensors for localization: magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system.

Unit 3:

Localization and Mapping in mobile robotics. Motion Control of Mobile Robots (Model and Motion based Controllers): Lyapunov-based Motion Control Designs and Case Studies. Understand the current application and limitations of Mobile Robots. Introduction to Mobile Manipulators and Cooperative Mobile Robots.

Unit 4:

Micro-robotics: Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro-robots - Mobility and Functional-based definition of microrobots - Applications for MEMS based micro-robots. Implementation of Micro-robots: Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators.

Unit 5:

Design of locomotive micro-robot devices based on arrayed actuators. Micro-robotics devices: Micro- grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots– Multirobot system: Micro-robot powering, Micro-robot communication. Microfabrication and Microassembly: Micro-fabrication principles - Design selection criteria for micromachining- Packaging and Integration aspects – Micro-assembly platforms and manipulators.

Suggested Reference Books:

(i) Roland Siegwart, Illah Reza Nourbakhsh, Davide Sacramuzza, Introduction to Autonomous Mobile Robots, MIT press, 2nd edition, 2011.

(ii) Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, —Principles of Robot Motion-Theory, Algorithms, and Implementation, MIT Press, Cambridge, 2005.

Suggested Text Books:

(i) Atnaik, Srikanta, "Robot Cognition and Navigation: An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.

(ii) Spyros G. Tzafestas, "Introduction to Mobile Robot Control", Elsevier, 2021.

(iii) Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg, 2008.

Course Outcomes:

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

- Identify and design a suitable manufacturing process for micro robots.
- Understand the importance of visual perception and recognition for cybernetic view.
- Program a robot for wandering and teleoperation.

Experiment based upon the theory subject.

Unit 1: Fundamentals of Data Analytics, Descriptive, Predictive, and Prescriptive Analytics, Data Types, Analytics Types, Data Analytics Steps: Data Pre-Processing, Data Cleaning, Data Transformation, and Data Visualization.

Unit 2: Data Analytics Tools

Data Analytics using Python, Statistical Procedures, NumPy, Pandas, SciPy, Matplotlib.

Unit 3: Data Pre-Processing

Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python, Turning categorical variables into quantitative variables in Python, Accessing Databases with Python.

Unit 4: Data Visualization

Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single variable: Dot plot, Jitter plot, Error bar plot, Box-and whisker plot, Histogram, Twovariable: Bar chart, Scatter plot, Line plot, Log-log plot, More than two variables: Stacked plots, Parallel coordinate plot.

Unit 5: Descriptive and Inferential Statistics

Probability distributions, Hypothesis testing, ANOVA, Regression.

Unit 6: Machine Learning Concepts

Classification and Clustering, Bayes" classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system.

Suggested Text books:

- (i) Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014.
- (ii) James R. Evans, "Business Analytics: Methods, Models, and Decisions", Pearson 2012.
- (iii) Song, Peter X. K, "Correlated Data Analysis: Modeling, Analytics, and Applications", Springer-Verlag New York 2007.

Suggested Reference Books:

- (i) Glenn J. Myatt, Wayne P. Johnson, "Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining", Wiley 2009.
- (ii) Thomas H. Davenport, Jeanne G. Harris and Robert Morison, "Analytics at Work: Smarter Decisions, Better Results", Harvard Business Press, 2010.
- (iii) Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'REILLY, 2006. Shamanth Kumar Fred Morstatter Huan Liu "Twitter Data Analytics", Springer-Verlag, 2014.

Course Outcomes:

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

- Examine and compare various datasets and features.
- Analyze the business issues that analytics can address and resolve.
- Apply the basic concepts and algorithms of data analytics.
- Interpret, implement, analyze and validate data using popular data analytics tools.

List of Experiments:

1. Setting up Hadoop on standalone machine.
2. Wordcount Map Reduce program using standalone Hadoop.
3. Adding the combiner step to the Wordcount Map Reduce program.
4. Setting up HDFS.
5. Using HDFS monitoring UI
6. HDFS basic command-line file operations.
7. Setting Hadoop in a distributed cluster environment.
8. Running the Word Count program in a distributed cluster environment.
9. Using Map Reduce monitoring UI

Text Books:

Hadoop Map Reduce Cookbook, Srinath Perera & Thilina Gunarathne, 2013, PACKT PUBLISHING.

BTRA 615-22

Intelligent Manufacturing

3L:0T:0P 3 credits

Unit 1:

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM.

Unit 2:

Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Unit 3:

Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Inference Engine, Knowledge Acquisition. Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KBSES.

Unit 4:

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSC IT) — Data Base, Knowledge Base, Clustering Algorithm.

Suggested Text Books:

- (i) Andrew Kusiak, “Intelligent Manufacturing Systems”, Prentice Hall, 1990.
- (ii) Pat Langley, “Computational Intelligence and Intelligent Systems”, 2006.

Suggested Reference Books:

- (i) Mohammad Jamshidi, “Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks to Fuzzy Logic”, 1st Edition, 1995.
- (ii) Lucia Knapčíková, Michal Balog, “Industry 4.0: Trends in Management of Intelligent Manufacturing Systems”, Springer, 2019.

Course Outcomes:

After completion of the course, the students will be able to:

- Summarize the concepts of computer integrated manufacturing systems and manufacturing communication systems.
- Identify various components of knowledge based systems.
- Demonstrate the concepts of artificial intelligence and automated process planning.
- Select the manufacturing equipment using knowledge based system for equipment selection.
- Apply various methods to solve group technology problems and demonstrate the structure for knowledge based system for group technology.

BTRA 616-22

Intelligent Manufacturing Lab

0L:0T:2P 1 credits

Experiment based upon the theory subject.

B.Tech. Robotics and AI (Batch 2022)

7th Semester

Course Code	Type of Course	Course Title	Hours per Week			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCS70 1-18	Professional Core Courses	Network Security and Cryptography	3	0	0	40	60	100	3
BTCS70 2-18	Professional Core Courses	Data Mining and Data Warehousing	3	0	0	40	60	100	3
BTRA-XXX-22	Professional Elective Courses	Elective-IV	3	0	0	40	60	100	3
BTRA-XXX-22	Professional Elective Courses	Elective-V	3	0	0	40	60	100	3
BTOE-XXX-22	Open Elective Courses	Open Elective-II	3	0	0	40	60	100	3
BTRA 713-22	Project	Project-II	0	0	12	120	80	200	6
BTRA-XXX-22	Professional Elective Courses	Elective-IV Lab	0	0	2	30	20	50	1
BTRA-XXX-22	Professional Elective Courses	Elective-V Lab	0	0	2	30	20	50	1
Total			15	0	16	380	420	800	23

Elective IV:

BTRA 701-22 Cognitive Computing
BTRA 702-22 Cognitive Computing Lab
BTRA 703-22 Robot System Design
BTRA 704-22 Robot System Design Lab
BTRA 705-22 Knowledge Engineering and Expert System
BTRA 706-22 Knowledge Engineering and Expert System Lab

Elective V:

BTRA 707-22 AI and Healthcare Robotics/Ethics in AI and Robotics
BTRA 708-22 AI and Healthcare Robotics/Ethics in AI and Robotics Lab
BTRA 709-22 Internet of Robotic Things (RIoT)
BTRA 710-22 Internet of Robotic Things (RIoT) Lab
BTRA 711-22 Reinforcement Learning
BTRA 712-22 Reinforcement Learning Lab

B.Tech. Robotics and AI (Batch 2022)

7th Semester/8th Semester

Course Code	Course Title	Marks Distribution		Total Marks	Credits
		Internal	External		
BTRA-801-22	Semester Training	300	200	500	16

Course Code: BTCS 701-18	Network Security and Cryptography	3L:0T:0P	3Credits
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UNIT 1: Introduction

Introduction to Cryptography, Security Threats, Vulnerability, Active and Passive attacks, Security services and mechanism, Conventional Encryption Model, CIA model

UNIT 2: Math Background

Modular Arithmetic, Euclidean and Extended Euclidean algorithm, Prime numbers, Fermat and Euler's Theorem

UNIT 3: Cryptography

Dimensions of Cryptography, Classical Cryptographic Techniques Block Ciphers (DES, AES) Feistel Cipher Structure, Simplified DES, DES, Double and Triple DES, Block Cipher design Principles, AES, Modes of Operations Public-Key Cryptography : Principles Of Public-Key Cryptography, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Elgamal Algorithm, Elliptic Curve Cryptography

UNIT 4 Hash and MAC Algorithms

Authentication Requirement, Functions, Message Authentication Code, Hash Functions, Security of Hash Functions and Macs, MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signatures, Key Management: Key Distribution Techniques, Kerberos

UNIT 5 Security in Networks

Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME

Course Outcomes:

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

CO1: Understand the fundamental principles of access control models and techniques, authentication and secure system design

CO2: Have a strong understanding of different cryptographic protocols and techniques and be able to use them.

CO3: Apply methods for authentication, access control, intrusion detection and prevention. CO4: Identify and mitigate software security vulnerabilities in existing systems.

Suggested Readings/ Books:

1. Cryptography And Network Security Principles And Practice Fourth Edition, William Stallings, Pearson Education
2. Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall PTR
3. Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall
4. Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

Course Code: BTCS-702-18

Data Mining and data ware housing

3L: 0T: 0P: 3C

UNIT 1:

Data Warehousing Introduction: design guidelines for data warehouse implementation, Multidimensional Models; OLAP- introduction, Characteristics, Architecture, Multidimensional view Efficient processing of OLAP Queries, OLAP server Architecture ROLAP versus MOLAP Versus HOLAP and data cube, Data cube operations, data cube computation.

Data mining: What is data mining, Challenges, Data Mining Tasks, Data: Types of Data, Data Quality, Data Pre-processing, Measures of Similarity and Dissimilarity.

UNIT 2:

Data mining: Introduction, association rules mining, Naive algorithm, Apriori algorithm, direct hashing and pruning (DHP), Dynamic Item set counting (DIC), Mining frequent pattern without candidate generation (FP, growth), performance evaluation of algorithms

Classification: Introduction, decision tree, tree induction algorithms – split algorithm based on information theory, split algorithm based on Gini index; naïve Bayes method; estimating predictive accuracy of classification method

UNIT 3:

Cluster analysis: Introduction, partition methods, hierarchical methods, density-based methods, dealing with large databases, cluster software, Search engines: Characteristics of Search engines, Search Engine Functionality, Search Engine Architecture, Ranking of web pages, The search engine history, Enterprise Search, Enterprise Search Engine Software.

UNIT 4:

Web data mining: Web Terminology and Characteristics, Locality and Hierarchy in the web, Web Content Mining, Web Usage Mining, Web Structure Mining, Web mining Software.

Suggested Readings / Books:

1. Carlo Verrellis, Business Intelligence: Data mining and Optimization for Decision Making, WILEY.
2. Han J., Kamber M. and Pei J. , b Data mining concepts and techniques, Morgan Kaufmann Publishers (2011) 3rd ed.
3. Pudi V., Krishana P.R., Data Mining, Oxford University press, (2009) 1st ed.
4. Adriaans P., Zantinge D., Data mining, Pearson education press (1996), 1st ed.
5. Pooniah P. , Data Warehousing Fundamentals, Willey interscience Publication, (2001), 1st ed.

Course Code: BTRA 701-22

Cognitive Computing

3L,0T,0P,3C

Course Objectives

- To introduce the fundamentals of cognitive computing.
- To understand how machines can simulate human cognitive processes.
- To explore AI, machine learning, natural language processing, and deep learning in cognitive systems.
- To analyze real-life applications using IBM Watson, chatbots, and smart assistants.

UNIT I: Introduction to Cognitive Computing, Definition and scope of cognitive computing, Difference between AI and Cognitive Computing, Cognitive Science basics: brain-inspired computing, Components of cognitive systems: perception, reasoning, learning, and language understanding, Applications and use-cases in various domains

UNIT II: Machine Learning in Cognitive Computing, Overview of supervised, unsupervised, and reinforcement learning, Feature engineering and model selection, Learning models: Decision Trees, SVMs, Neural Networks, Introduction to deep learning in cognition, Role of data and big data analytics

UNIT III: Natural Language Processing (NLP): NLP basics: syntax, semantics, and pragmatics, Speech recognition and synthesis, Sentiment analysis, question answering, and language modelling, Chatbot architecture, Tools: NLTK, spaCy, IBM Watson NLP tools

UNIT IV: Cognitive Systems and Architectures: Cognitive system architecture: sensors, perception, memory, reasoning, IBM Watson platform: architecture, services, and APIs, Cognitive agent modelling and frameworks, Knowledge representation and ontologies, Human-computer interaction in cognitive systems

UNIT V: Applications and Case Studies: Cognitive computing in healthcare, finance, and education Smart assistants (e.g., Siri, Alexa), Use of cognitive systems in robotics, Building a simple cognitive chatbot using Watson Ethical issues and future of cognitive computing

Textbooks:

1. Judith Hurwitz et al., "Cognitive Computing and Big Data Analytics", Wiley, 2015.
2. Rajendra Akerkar, "Cognitive Computing and Artificial Intelligence: Theory and Applications", Springer, 2019.

Reference Books:

1. IBM Watson Documentation and Developer Tools
2. Dan Jurafsky and James H. Martin, "Speech and Language Processing", Pearson
3. Tom Mitchell, "Machine Learning", McGraw Hill

Course Outcomes

- After successful completion of the course, students will be able to:
- Understand the concepts and technologies behind cognitive computing.
- Apply machine learning and NLP techniques in building cognitive systems.

- Use cognitive platforms like IBM Watson to develop intelligent applications.
- Analyze and design real-world solutions using cognitive computing.
- Evaluate ethical and societal impacts of cognitive systems.

List of Experiments:

- Introduction to Cognitive Computing Tools: Setup and configuration of IBM Watson, Google AI, or Microsoft Azure.
- Exploring basic APIs and SDKs.
- Text Analysis using Natural Language Understanding: Sentiment analysis, emotion detection, and keyword extraction.
- Named Entity Recognition (NER) using Watson NLU or spaCy.
- Speech-to-Text Conversion: Implementing a voice-to-text converter using Watson Speech to Text or Google Cloud Speech API.
- Text-to-Speech Application: Creating an application to convert input text into speech using IBM or Google TTS APIs.
- Chatbot Development: Designing and deploying a basic chatbot using Watson Assistant or Dialogflow.
- Image Classification: Using IBM Watson Visual Recognition / Google Vision AI for object detection or image labeling.
- Language Translator: Building a translation tool using Watson Language Translator or Google Translate API.
- Building a Recommendation System: Content-based or collaborative filtering system using scikit-learn or TensorFlow.
- Knowledge Graph Creation: Extracting entities and relationships from text to build a simple knowledge graph.
- Cognitive Search Application: Implementing a cognitive search using indexing and semantic search capabilities.

Suggested Tools & Platforms:

- IBM Watson Studio / Cloud
- Google Cloud AI / Dialogflow
- Microsoft Azure AI Services
- Python Libraries: NLTK, spaCy, OpenCV, TensorFlow, Keras

Course Outcomes:

- Understand the features and uses of Robotic Operating System (ROS) and allied software tools.
- Generate a robot manipulator and its working environment using simulation tools.
- Implement robot navigation and object manipulation for a given application.
- Incorporate and use robot vision for real-world applications.

Module 1: Introduction:

Industrial Applications of Robots, Industrial Environments and Constraints, Free Open Source Software for Robot Simulation, Robotic Operating System (ROS), Gazebo, MoveIt, Ubuntu, Python, Installing and Configuring Simulation Softwares.

Module 2: Robotic Operating System:

Robotic Operating System (ROS) Fundamentals, Building a ROS Application, ROS Services, ROS Actions, Unified Robot Description Format (URDF).

Module 3: Robot Navigation:

Slam: Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts, Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping, Mapping an environment with the Occupancy Grid Mapping algorithm, Grid-based FastSLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm, Self-Localisation, Path Planning and Obstacle Avoidance, Map-Building and Map Interpretation, Simultaneous Localization and Mapping, Navigation using Software Tools.

Module 4: Manipulation:

Object Manipulation, Manipulation Planning Algorithms, Prehension, Manipulation using Software Tools.

Module 5: Robot Vision:

Object Detection, Pose Estimation, Logical Camera, ROS Tools for Vision.

Text Books:

1. Anis Koubaa, “Robot Operating System”, Springer link, 2016.
2. Anil Mahtani, “Effective Robotics Programming with ROS”, Packt Publishing, 2016.
3. Ramkumar Gandhinathan , Lentin Joseph , “ ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality”, Packt Publishing Limited, December 2019.
4. SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslambblas_repo.pdf
5. ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim; <https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/51>

Course Code: BTRA 704-22

Robot System Design Lab

L:0, T: 0, P: 2, C:1

Detailed Content:

- To install ROS and set-up a ROS workspace on a computer.
- To write ROS talker-listener code in python.
- To create a mobile robot base URDF model.
- To create a 3-DOF robot arm URDF model.
- To simulate a mobile robot base in Gazebo.
- To attach the robot arm to base and simulate the complete mobile robot in Gazebo.
- To create an environment in Gazebo for simulating a mobile robot for an industrial application.
- To implement SLAM for industrial application using ROS open-source packages.
- To configure and interface a webcam with ROS.
- To use OpenCV with ROS for a vision application.

Course Code: BTCS 705-22
L:3, T: 0, P: 0, C:3

Knowledge Engineering and Expert System

Course Outcomes:

- Explain and describe the concepts central to the creation of knowledge bases and expert systems.
- Use the tools and the processes for the creation of an expert system.
- Conduct an in-depth examination of an existing expert system with an emphasis on basic methods of creating a knowledge base.
- Examine properties of existing systems in a case-study manner, comparing differing Approaches.
- Demonstrate proficiency developing applications in expert system shell.

Module 1:

Introduction, the history of knowledge-based expert systems, Characteristics of current expert systems, Basic concepts for building expert systems.

Module 2:

Building and Expert System, the architecture of expert systems, constructing an expert system, including computer inference and knowledge acquisition.

Module 3:

Knowledge representation schemes; conceptual data analysis; plausible reasoning techniques, Tools for building expert systems.

Module 4:

Evaluating an Expert System, Reasoning about reasoning, validation and measurement methods.

Module 5:

Production-rule programming, Issues and case studies, Language and Tools for Knowledge Engineering.

Text Books:

1. Davis, R. & Lenat, D. B., "Knowledge-Based Systems in Artificial Intelligence", McGraw-Hill, 1989.
2. Hayes-Roth, F., Waterman, D. A. & Lenat, D. B. (eds) Building Expert Systems. Addison-Wesley Publishing Company, Inc., 1984.
3. Buchanan, B. B. & Shortliffe, E. H., "Building Expert Systems with Production Rules: The Mycin Experiments", Wesley Publishing Company, 1983.
4. Torsun, I. S. Expert Systems: State of the Art, Addison-Wesley Publishing Company, 1983.

Course Code: BTCS 706-22 Knowledge Engineering and Expert System Lab

L:0, T: 0, P: 2, C:1

List of Experiments

- Introduction to CLIPS / Jess / Prolog environments
- Creating basic rule-based expert systems using CLIPS
- Developing an expert system for medical diagnosis
- Implementing Forward and Backward chaining algorithms
- Designing a fuzzy logic-based inference system
- Building an expert system for agriculture or business domain
- Knowledge acquisition from a domain expert and encoding in ontological format
- Case-based reasoning system prototype
- Developing an intelligent agent-based simulation
- Final mini-project: Complete expert system from design to implementation

Course Objectives:

- To understand the role and applications of Artificial Intelligence in the healthcare domain.
- To explore AI techniques for medical imaging, diagnostics, prediction, and healthcare operations.
- To study the challenges and ethical considerations of deploying AI in clinical settings.

UNIT I: Introduction to AI in Healthcare, Overview of AI and ML in healthcare, Types of AI technologies: Machine Learning, Deep Learning, NLP, Robotics, Healthcare data types: EHR, clinical notes, sensor data, imaging data, Challenges in AI for healthcare: data privacy, bias, regulation

UNIT II: Machine Learning for Medical Diagnosis, Supervised and unsupervised learning for disease prediction, AI for chronic disease management (e.g., diabetes, cancer, cardiovascular diseases), Feature selection and model evaluation in healthcare

UNIT III: Deep Learning in Medical Imaging, Medical image processing using CNNs ,AI in radiology: X-rays, MRIs, CT scans, Segmentation, classification, detection tasks

UNIT IV: Natural Language Processing for Clinical Text, Clinical text mining: EHRs, discharge summaries, clinical notes, Named entity recognition (NER), de-identification, summarization, Conversational AI in healthcare (chatbots, virtual assistants) Lab: Extracting clinical concepts from EHR text using spaCy/NLP tools

UNIT V: AI in Healthcare Operations & Ethics, AI for hospital workflow optimization and resource allocation, Remote patient monitoring using wearable data, Ethical, legal, and regulatory considerations (HIPAA, GDPR, FDA guidelines), Explainable AI (XAI) in medical decision-making

Textbooks & References:

1. "Artificial Intelligence in Healthcare" by Adam Bohr and Kaveh Memarzadeh (Elsevier, 2020)
2. "Deep Medicine" by Eric Topol
3. Online datasets: MIMIC-III, NIH ChestX-ray14, PhysioNet

List of Experiments

- Introduction to Healthcare Datasets: Overview of public datasets: MIMIC-III, NIH ChestX-ray14, Diabetes, Heart Disease UCI
- Data cleaning and preprocessing using Pandas and Scikit-learn
- Disease Prediction using Machine Learning
- Implement Logistic Regression / Decision Tree / Random Forest: Apply on Heart Disease or Diabetes prediction dataset
- Classification of Breast Cancer Data: Use Support Vector Machines (SVM) and evaluate model metrics (Accuracy, Precision, Recall, F1-Score)
- CNN for Chest X-Ray Image Classification
- Build and train a Convolutional Neural Network
- Use sample dataset to detect pneumonia or tuberculosis
- Lung Cancer Detection with Image Segmentation
- Apply U-Net or other segmentation models
- Preprocessing of CT scan images using OpenCV
- Clinical Named Entity Recognition (NER)
- Use NLP tools (spaCy, SciSpacy) to extract diseases, symptoms, medications from sample EHR text
- Symptom Checker Chatbot using NLP
- Create a simple rule-based or ML-based chatbot
- Input symptoms and provide preliminary advice
- Time-Series Analysis for Patient Monitoring
- Analyze ECG or blood pressure data
- Use RNNs or traditional statistical models
- Explainable AI in Healthcare

Software & Tools Required:

- Python (Jupyter Notebook/Google Colab)
- TensorFlow/Keras or PyTorch
- Scikit-learn, Pandas, NumPy, OpenCV
- NLP Libraries: spaCy, NLTK, SciSpacy
- Visualization: Matplotlib, Seaborn

Course Code: BTRA 709-22

Internet of Robotic Things L:3, T: 0, P: 0,C:3

Course Outcomes:

- Understand the drivers and enablers of Industry 4.0.
- Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services.
- Able to outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world.
- Appreciate the power of Cloud Computing in a networked economy.
- Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.

Module 1: IoT Foundations:

Introduction to Internet of Things, An Overview Introduction – Definition and characteristics of IoT, Physical design of IoT- Things in IoT, IoT protocol, Logical design of IoT – IoT functional blocks, IoT Communication Models, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud, Fog Computing, Examples of IoT based Systems: Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT.

Module 2: IoT Architecture and its Protocols:

Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.

Module 3: Sensors for IoT:

Sensing and actuation, types of sensors, Occupancy Sensors, Motion sensor, velocity, temperature, pressure, chemical, Gyroscopic sensor, Optical sensors, Humidity, Water Quality sensors, Sensor applications.

Module 4: Actuator for IoT:

Actuator types, working principle of actuators, integration of sensors and actuators with arduino, formation of actuators, selection criteria for right actuator, maintenance of actuators, smart material actuators.

Module 5: Applications of IoT in Robotics:

Future farming with the Internet of things, drones for surveillance, Soft low-power robotics, Tracking sensors for underwater robotics, Disaster response, Medical services, Smart restaurant, Analysis of IoT applications and Sensors, Space robotics for science and space exploration, Satellite based Internetworking, Tele operators, Space component systems like rover mobility, locomotion and guidance.

Text Books:

1. Lewin A.R.W. Edwards, "Open-source robotics and process control cookbook", Elsevier Publications, 2005.
2. Francis DaCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, 1st Edition, Apress Publications, 2013.
3. Wimer Hazenberg, Menno Huisman and Sara Cordoba Rubino, Meta Products: Building the Internet of Things, BIS publishers, 2012.
4. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
5. Arshdeep Bahga and Vijay Madisetti Internet of Things: A Hands-on Approach",Universities Press, 2014.

List of Experiments:

- Introduction to IoRT Lab Setup: Overview of hardware and software tools (Arduino, Raspberry Pi, ESP32, sensors, actuators).
- Sensor and Actuator Interfacing: Reading data from sensors and controlling actuators using microcontrollers.
- IoT Communication Protocols: Implementing MQTT/HTTP-based communication between devices.
- Controlling Robot with IoT: Remote control of robot movement using mobile/web interface.
- Object Detection and Obstacle Avoidance: Using ultrasonic, IR, or vision-based sensors.
- Data Logging and Visualization: Sending robot sensor data to cloud platforms like ThingSpeak or Firebase.
- Voice-Controlled Robot using IoT Services: Integrating voice recognition APIs (e.g., Google Assistant) with robotics.
- Surveillance Robot with Live Camera Feed: Streaming live video from robot to a remote server or mobile app.
- IoRT-based Smart Home Simulation: Automating devices using robots and sensors in a simulated smart environment.

Lab Tools and Platforms:

- Arduino, Raspberry Pi, ESP32
- NodeMCU, Wi-Fi/Bluetooth Modules
- Sensors (temperature, IR, ultrasonic, motion, gas, etc.)
- Actuators (motors, servos, relays)
- Cloud Platforms: ThingSpeak, Blynk, Firebase, IFTTT
- Languages: Python, C/C++, JavaScript

Course Code: BTRA 711-22

Reinforcement Learning

L:3 T:0 P:0 C:3

Course Outcomes: At the end of the course, a student will be able to:

CO1: Demonstrate various Components of Reinforcement Learning.

CO2: Make use of various exploration and exploitation strategies.

CO3: Apply Model based and Model Free Prediction techniques.

CO4: Make use of different value-based Reinforcement Learning Algorithms

CO5: Demonstrate various Policy based Reinforcement Learning Algorithms

UNIT-I:

Introduction: Deep Reinforcement Learning, Suitability of RL, Components of Reinforcement Learning Agent, Environment, Observations, Actions, Example-The Bandit Walk Environment, Agent-Environment interaction cycle, MDP (Markov Decision Process): The engine of the Environment-States, Actions, Transition Function, Reward Signal.

UNIT-II:

Planning: Objective of a decision-making agent-environment, Plan, Optimal policy, Comparison of Policies, Bellman Equation/State-Value Function, Action-Value Function, Action-Advantage Function, Optimality. Exploitation and Exploration of Reinforcement Learning: Bandits- Single-state decision problem (Multi-Armed Bandit (MAB) problem), The cost of exploration, Approaches to solve MAB environments, Greedy Strategy, Random Strategy, Epsilon-Greedy Strategy, Decaying Epsilon-Greedy Strategy, Optimistic Initialization strategy, Strategic exploration, Softmax exploration strategy, Upper confidence bound (UCB) equation strategy, Thompson sampling strategy.

UNIT-III:

Model Free Reinforcement Learning: Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to estimate from multiple steps, N-step TD learning, Forward-view TD(λ), Backward-view TD(λ), Generalized policy iteration (GPI), Monte Carlo control, SARSA: On-Policy TD control, Q-learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). Model Based Reinforcement Learning: Dyna-Q, Trajectory sampling.

UNIT-IV:

Value Based Reinforcement Learning: Deep reinforcement learning agents with sequential feedback, evaluative feedback, sampled feedback, Function Approximation for Reinforcement

Learning- high-dimensional state and action spaces, continuous state and action spaces, state-value function and action-value function with and without function approximation, Neural Fitted Q (NFQ), Deep Q-Network (DQN), Double Deep-Q Networks (DDQN), Dueling DDQN, Prioritized Experience Replay (PER).

UNIT-V:

Policy Based Reinforcement Learning: Policy Gradient and Actor-Critic Methods—REINFORCE Algorithm and Stochastic Policy Search, Vanilla Policy Gradient (VPG), Asynchronous Advantage Actor-Critic (A3C), Generalized Advantage Estimation (GAE), Advantage Actor-Critic(A2C), Deep Deterministic Policy Gradient (DDPG), Twin-Delayed DDPG (TD3), Soft Actor-Critic (SAC), proximal policy optimization (PPO).

TEXT BOOKS:

1. Miguel Morales, Grokking Deep Reinforcement Learning, Manning Publications, 2020.

REFERENCE BOOKS:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An Introduction, Second Edition, MIT Press, 2019.
2. Marco Wiering, Martijn van Otterlo(Ed), Reinforcement Learning, State-of-the-Art, Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.
3. Keng, Wah Loon, Graesser, Laura, Foundations of Deep Reinforcement Learning: Theory and Practice in Python, Addison Wesley Data & Analytics Series, 2020.
4. Francois Chollet, Deep Learning with Python, Manning Publications, 2018.

WEB REFERENCES:

1. http://cse.iitkgp.ac.in/~adas/courses/rl_aut2021/syllabus.html

List of Experiments / Lab Activities

- Introduction to Reinforcement Learning and OpenAI Gym
- Implementing Gridworld using Dynamic Programming (DP)
- Value Iteration and Policy Iteration on small MDPs
- Monte Carlo Prediction and Control Algorithms
- Temporal Difference Learning (TD(0))
- Q-learning and SARSA Implementation
- Deep Q Networks (DQN) with TensorFlow or PyTorch
- Policy Gradient Methods: REINFORCE Algorithm
- Actor-Critic Algorithms

Lab Tools and Platforms:

- Python Programming Language
- OpenAI Gym, PyBullet, Unity ML-Agents
- TensorFlow, Keras, or PyTorch
- Jupyter Notebooks
- Colab for cloud-based training