Course Curriculum and Syllabi of
Bachelor of Technology (B.Tech)
Branch/Programme: Computer Science and Engineering
with Specialization in Artificial Intelligence & Data Science
(2023 Regulations)

(Approved by the 7th and 8th Senate Meeting held on 23rd August 2023 & 12th April 2024 respectively)

भारतीय सूचना प्रौद्योगिकी संस्थान सेनापति, मणिपुर

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY SENAPATI, MANIPUR

(An Institute of National Importance by Act of Parliament, Government of India)

Mantripukhri, Imphal – 795002, Manipur, India.

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COURSE CURRICULUM

SEMESTER-I

1st Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
I	CS1011	Computer Programming	3	0	0	3
I	EC1011	Digital Design	3	0	0	3
I	EC1012	Electrical Circuit Analysis	3	1	0	4
I	MA1011	Mathematics I	3	1	0	4
I	PH1011	Physics I	3	0	0	3
I	EC1111	Digital Design Lab	0	0	2	1
I	CS1111	Computer Programming Lab	0	0	2	1
I	EN1011	English Language Skills I	3	0	0	3
	JA1011	Japanese Language Skills I				
	KO1011	Korean Language Skills I				
I	GE1091	Yoga for Holistic Health	0	0	2	1
I	GE1092	Induction Programme	0	0	2	1
		Total	**18**	**2**	**8**	**24**
		Contact Hours / Week	**28**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	5	7	8	4	0	0	0

SEMESTER-II

2nd Semester						
Sem.	**Course code**	**Course Name**	**L**	**T**	**P**	**C**
II	EC1013	Basic Electronic Circuits	3	0	0	3
II	CS1012	Data Structures	3	0	0	3
II	HS1091	HSS-I (Introduction to Entrepreneurship)	3	0	0	3
II	MA1012	Mathematics II	3	1	0	4
II	PH1012	Physics II	3	0	0	3
II	EC1112	Basic Electronics Lab	0	0	2	1
II	CS1112	Data Structures Lab	0	0	2	1
II	EN1012	English Language Skills II	3	0	0	3
	JA1012	Japanese Language Skills II				
	KO1012	Korean Language Skills II				
		Total	**18**	**1**	**4**	**21**
		Contact Hours / Week	**23**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	6	7	4	4	0	0	0

SEMESTER-III

3rd Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
III	CS2014	Design and Analysis of Algorithms	3	0	0	3
III	ECXXXX	Microcontroller and Microprocessor	3	0	0	3
III	CS2013	Object Oriented Programming	3	1	0	4
III	MA2013	Probability and Random Processes	3	1	0	4
III	EC2031	Signals and Systems	3	0	0	3
III	CS2015	Web Technology	2	0	2	3
III	CS2113	Object Oriented Programming Lab	0	0	2	1
III	EC2131	Signals and Systems Lab	0	0	2	1
		Total	**17**	**2**	**6**	**22**
		Contact Hours / Week			**25**	

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	4	7	11	0	0	0

SEMESTER-IV

4th Semester						
Sem.	**Course code**	**Course Name**	**L**	**T**	**P**	**C**
IV	CS3051	Artificial Intelligence	3	0	0	3
IV	CS2043	Database Management Systems	3	0	0	3
IV	CS2021	Discrete Mathematics	3	0	0	3
IV	CS2041	Operating Systems	3	0	0	3
IV	CS2042	Software Engineering	3	1	0	4
IV	CS2022	Theory of Computing	3	0	0	3
IV	CS2143	Database Management Systems Lab	0	0	2	1
IV	CS2141	Operating Systems Lab	0	0	2	1
		Total	**18**	**1**	**4**	**21**
		Contact Hours / Week			**23**	

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	3	18	0	0	0

SEMESTER-V

5th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
V	CS3044	Compiler Design	3	1	0	4
V	CS3081	Data Science - I	3	0	0	3
V	CS1061	Computer Organization and Architecture	3	0	0	3
V	CS2031	Computer Networks	3	1	0	4
V	HS30XX	HSS Elective – II	3	0	0	3
V	PE30XX	Professional Elective – I	3	0	0	3
V	CSXXXX	Computer Networks Lab	0	0	2	1
V	CSXXXX	Compiler Design Lab	0	0	2	1
		Total	**18**	**2**	**4**	**22**
		Contact Hours / Week	**24**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	3	0	3	13	3	0	0

SEMESTER-VI

6th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
VI	CS3071	Computer Graphics	3	0	0	3
VI	CS4082	Data Science – II	3	0	0	3
VI	CS3052	Machine Learning - I	3	0	0	3
V	CS3023	Optimization Techniques	3	0	0	3
VI	PE30XX	Professional Elective – II	3	0	0	3
VI	OE30XX	Open Elective - I	3	0	0	3
VI	CSXXXX	Computer Graphics Lab	0	0	2	1
VI	CS3201	Project - I	0	1	4	3
		Total	**18**	**1**	**6**	**22**
		Contact Hours / Week	**25**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	3	10	3	3	3

SEMESTER-VII

7th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
VII	CS4035	Computer and Network Security	3	1	0	4
VII	CS4054	Machine Learning - II	3	0	0	3
VII	PE30XX	Professional Elective - III	3	0	0	3
VII	OE30XX	Open Elective - II	3	0	0	3
VII	CSXXXX	Project – III	0	1	4	3
VII	CS4204	Internship	0	1	2	2
		Total	**12**	**2**	**6**	**18**
		Contact Hours / Week	**20**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	0	6	3	3	5

SEMESTER-VIII

8th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
VIII	CS4205	Industry/ Research Internship	0	1	22	12
		Total	**0**	**1**	**22**	**12**
		Contact Hours / Week	**23**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	0	0	0	0	12

Total distribution:

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	14	18	28	67	9	6	20

Professional Elective-I (PE-I)

Code	Course Title	Hours per week			Credits
		L	T	P	
PEXXXX	Distributed Systems	3	0	0	3
PEXXXX	Advanced Data Structure and Algorithm	3	0	0	3
PEXXXX	Principle of Programming Language	3	0	0	3
PEXXXX	HCI	3	0	0	3
PEXXXX	Advance Web Technology	3	0	0	3

Professional Elective-II (PE-II)

Code	Course Title	Hours per week			Credits
		L	T	P	
PEXXXX	Software Testing	3	0	0	3
PEXXXX	High Performance Computing	3	0	0	3
PEXXXX	Data Mining and Warehousing	3	0	0	3
PEXXXX	Cyber Security	3	0	0	3

Professional Elective-III (PE-III)

Code	Course Title	Hours per week			Credits
		L	T	P	
PEXXXX	Introduction to Intelligent System	3	0	0	3
PEXXXX	Dependable Artificial Intelligence	3	0	0	3
PEXXXX	Advanced Artificial Intelligence	3	0	0	3

Open Elective-I (OE-I)

Code	Course Title	Hours per week			Credits
		L	T	P	
OEXXXX	Deep Learning	3	0	0	3
OEXXXX	Computer Vision	3	0	0	3
OEXXXX	Audio and Speech Processing	3	0	0	3

Open Elective-II (OE-II)

Code	Course Title	Hours per week			Credits
		L	**T**	**P**	
OEXXXX	Image Processing	3	0	0	3
OEXXXX	Quantum Computing	3	0	0	3
OEXXXX	Block chain Technologies	3	0	0	3
OEXXXX	Soft Computing	3	0	0	3
OEXXXX	Pattern Classification	3	0	0	3
OEXXXX	IOT	3	0	0	3

HSS Elective

Course Code	Course Title	Hours per week			Credits
		L	T	P	
HSXXXX	Introduction to Linguistics	2	0	2	3
HSXXXX	Environmental Sciences	3	0	0	3
HSXXXX	Professional Ethics for Engineers/ Ethics and Human Values	3	0	0	3
HSXXXX	Principles of Management	3	0	0	3
HSXXXX	Entrepreneurship and Management Functions	3	0	0	3
HSXXXX	Organizational Behaviour	3	0	0	3
HSXXXX	Computational Linguistics	3	0	0	3
HSXXXX	Introduction of IPR	3	0	0	3
HSXXXX	Sustainable Development Goals	3	0	0	3
HSXXXX	Supply Chain and Logistic Management	3	0	0	3
HSXXXX	Consumer Behaviour and Welfare Economics	3	0	0	3
HSXXXX	Understanding Democracy and Governance in India	3	0	0	3
HSXXXX	Language, Cognition and Culture	3	0	0	3

DETAILED SYLLABI

SEMESTER-I

1st Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
I	CS1011	Computer Programming	3	0	0	3
I	EC1011	Digital Design	3	0	0	3
I	EC1012	Electrical Circuit Analysis	3	1	0	4
I	MA1011	Mathematics I	3	1	0	4
I	PH1011	Physics I	3	0	0	3
I	EC1111	Digital Design Lab	0	0	2	1
I	CS1111	Computer Programming Lab	0	0	2	1
I	EN1011	English Language Skills I	3	0	0	3
	JA1011	Japanese Language Skills I				
	KO1011	Korean Language Skills I				
I	GE1091	Yoga for Holistic Health	0	0	2	1
I	GE1092	Induction Programme	0	0	2	1
		Total	**18**	**2**	**8**	**24**
		Contact Hours / Week	**28**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	5	7	8	4	0	0	0

CS1011	Computer Programming	3-0-0-3

Syllabus:

Need to study programming languages, Characteristics of Programming Languages, Programming language paradigms: Imperative, Object Oriented, Functional, Logic, Event Driven and Concurrent Programming, Language design issues, Language Translation issues, Data Types: properties of Types and objects, Elementary data types, structured data types, Type conversion, Binding and binding times.

Procedural programming through Language 'C': Basic Syntax and Semantics, Variables, Types, Expressions, Assignment statements, Scope of variables, Conditional and Iterative Control Structures, I/O, Functions and parameter passing, Strings and string processing, Pointers and References, Structures, Recursion.

Algorithm development: Techniques of problem solving, Stepwise Refinement, example of algorithm writing systems as a solution to mathematical problems (at least ten), algorithms for searching and sorting, merging order lists, Flow-chart for the above algorithms.

Texts:

1. Bryon Gottfried, Programming with C, McGraw Hill, Third edition (ISBN: 9780070145900).

References:

1. Horowitz, Sahni, and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press, Second edition (ISBN: 9788173716058).

2. Kernighan and Ritchie, The C Programming Language, PHI, Second edition, (ISBN:9788120305960).
3. Roosta Seyed, Foundations of Programming Languages Design & Implementation, 3rd Edition, Cenage learning.

EC1011	Digital Design	3-0-0-3

Syllabus:

Number System: Introduction to number systems, binary, Integer and floating-point- numbers, octal, hexadecimal and decimal number system and their conversion.

Arithmetic Operations: Binary addition & subtraction; 1's and 2's complement, subtraction using 2's complement; binary codes, addition and subtraction operations on binary-coded numbers; Algorithms for performing multiplication and division.

Combinational Circuits: Basic Logic Operations, AND, OR, NOR, NAND, EX-OR, EX-NOR Gates, Boolean expressions and their minimization using algebraic identities; Karnaugh map representation and minimization of Boolean functions using K-map; Don't care conditions, NAND and NOR logic implementations, two-level realizations using gates -- AND-OR, OR-AND, NAND-NAND and NOR-NOR structures.

Combinational Circuits using MSI Modules: Adders, subtractors, BCD arithmetic, serial adder, carry look-ahead adder, multi-bit adder, Multiplexers, De-multiplexers, Decoders, Multiplexer-based realization of K-maps; Combinational circuit design using multiplexers and gates. Programmable Logic Devices: ROM, PLA, PAL.

Sequential Circuits: Latches and Flip-flops; Ripple counters using T flip-flops; Synchronous counters; Shift Registers; Ring and MLS counters; Sequence generator using J-K / D flip-flops, Finite state machines, propagation delay, setup and hold time, critical path delay, Static RAM, Dynamic RAM.

Texts:

1. M. Morris Mano, Digital Logic and Computer Design, 11th Edition, Pearson Education, 2009.

References:

1. Ronald J Tocci, Neal S Wisdmer and Gregory L. Moss, Digital Systems: Principle and Applications, 10th Edition, Pearson Education, 2011.
2. Albert Paul Malvino, Donald P Leach and Gautam Saha, Digital Principles and Applications 7th Edition, Tata McGraw - Hill Education, 2011.

EC1012	Electrical Circuit Analysis	3-1-0-4

Syllabus:

Basic components and circuit analysis: Charge, current, voltage and power, voltage and current sources, Ohm's law; Voltage and current laws: nodes, paths, loops and branches, Kirchhoff's current law, Kirchhoff's voltage law, independent sources, voltage and current division; Basic nodal and mesh analysis: nodal analysis, super-node, mesh analysis, super-mesh; Network theorems: linearity and superposition, source transformations, Thevenin's theorem, Norton's theorem, reciprocity, maximum power transfer;

Magnetically coupled circuits: mutual inductance, energy considerations, linear transformer, ideal transformer;

Poly-phase circuits: Poly-phase systems, single-phase three-wire systems, three-phase Y-Y connection, wye-delta transformation, power measurement in three-phase systems;

Time and frequency domain analysis of linear circuits: Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Sinusoidal steady-state analysis: Forced response to sinusoidal functions, complex forcing function, phasor, phasor relationship for R, L and C, impedance, admittance, phasor diagrams, instantaneous power, average power, apparent power and power factor, complex power;

Two-port networks: one-port networks, linear 2-port network parameters, admittance parameters, impedance parameters, hybrid parameters, transmission parameters.

Texts:

1. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata-McGraw-Hill Publishing Company Limited, 7th / 8th Edition, 2010/ 2012.

References:

1. Bruce Carlson, Circuits: Engineering Concepts and Analysis of Linear Electric Circuits, 2nd Reprint, Thomson Asia Pvt. Ltd., 2006.
2. R. A. De Carlo and P. M. Lin, Linear Circuit Analysis, 2nd Edition, Oxford University Press, 2001.

MA1011 MATHEMATICS I 3-1-0-4

Syllabus:

Linear Algebra: Systems of linear equations and their solutions; vector space Rn and its subspaces; spanning set and linear independence; matrices, inverse and determinant; range space and rank, null space and nullity, eigenvalues and eigenvectors; diagonalization of matrices; similarity; inner product, Gram-Schmidt process; vector spaces (over the field of real and complex numbers), linear transformations.

Single Variable Calculus: Convergence of sequences and series of real numbers; continuity of functions; differentiability, Rolle's theorem, mean value theorem, Taylor's theorem; power series; Riemann integration, fundamental theorem of calculus, improper integrals; application to length, area, volume and surface area of revolution.

Texts:

1. G. Strang, *Linear Algebra and Its Applications*, 4th Edition (South Asian Edition), Wellesley- Cambridge Press, 2009(ISBN: 9788175968110).
2. S. R. Ghorpade and B. V. Limaye, *An Introduction to Calculus and Real Analysis*, Springer India, 2006 (ISBN: 9788181284853).

References:

1. D. Poole, *Linear Algebra: A Modern Introduction*, 2nd Edition, Brooks/Cole, 2005.
2. K. Hoffman and R. Kunze, *Linear Algebra*, 2nd Edition, Prentice Hall India, 2009.
3. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Edition, Wiley India, 2007.

PH1011	Physics I	3-0-0-3

Syllabus:

Special Theory of Relativity: Michelson-Morley experiment, Postulates of STR. Galilean transformation. Lorentz transformation. Simultaneity. Length Contraction. Time dilation. Relativistic addition of velocities. Energy momentum relationships.

Quantum Mechanics: Two-slit experiment. De Broglie's hypothesis. Uncertainty Principle, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization. Expectation values. Eigenvalues and eigen functions. particle in a box, potential barrier, harmonic oscillator

Solid State Physics: Crystal lattices and symmetry groups, reciprocal lattice, Brillouin zone, Miller indices, crystal structure by X-ray diffraction; free electron theory, electrons in a periodic potential, Bloch's theorem, Kronig-Penny model, formation of bands, effective mass, holes, classification of metal, insulator and semiconductor, intrinsic and extrinsic semiconductors, law of mass action, Hall effect; Curie law, concepts of ferro, ferri, and anti-ferro magnetism

Texts:

1. Kenneth S. Krane, Modern Physics, John Wiley &Sons, Inc, 3rd Edition, 2012
2. C. Kittel, Introduction to Solid State Physics, John Wiley & Sons, 2005.

References:

1. Beiser, Concepts of Modern Physics, Tata McGraw-Hill, New Delhi, 1995.
2. A.J. Dekker, Solid State Physics, Mcmillan, 1986.

EC1111	Digital Design Lab	0-0-2-1

Familiarization with digital IC family 74LS00 and 74HS00. Familiarization with laboratory equipment – voltage generator, function generator, oscilloscope. Study of digital IC characteristics – input voltage, input current, output voltage, output current, fan out, noise margin and propagation delay. Combinational logic circuits: Implementation of Boolean functions using logic gates; Arithmetic operations using logic gates; Implementation of Multiplexers, De-multiplexers, Encoders, Decoders; Implementation of Boolean functions using Multiplexers/Decoders Study of sequential logic circuits: Implementation of flip flops, Implementation of counters, Implementation of sequence generators

CS1111	Computer Programming Lab	0-0-2-1

Introduction to Linux OS, Free & Open source software, Basic tools & commands, Compiling and debugging C program with GCC & GDB.

Basic Assignment Statement, Conditional and Iterative Control Structures, Some Numerical Examples, Functions and parameter passing, Array and String, Pointer, Structure, Recursion, Dynamic Memory Allocation, File Handling, Command Line Arguments.

Implementation of the following problem statements using C programming language along with algorithm and

flowchart are mandatory.

1. Solution to basic mathematical problems such as, largest of 2,3,..n numbers, factorial of a given number, Armstrong number, palindrome, LCM, GCD, sum digits, sum of series (arithmetic, geometric, alternating), printing octal, or hexadecimal equivalent of a given number or vice versa, solving quadratic equation, number pyramid, printing 1st 500 hundred prime numbers, swapping of numbers using pointers and without using third variable, Operations on matrix)
1. Arrange a list of numbers into a specific order (ascending, descending).
2. Arrange a list of strings into a specific order (ascending, descending, based on number of characters in the string etc., the order will be provided as command line argument.
3. Reverse a string using recursion and check whether the string is palindrome or not.
4. Count frequency of a specific character from a given paragraph
5. Generate character bigrams from a given paragraph
6. Remove all characters in a string other than alphabet
7. Count the frequency of digits after decimal and find maximum occurring digit in the PI value upto first 100 decimals (3.1415 92653 58979 32384 62643 38327 95028 84197 1 6939 93751 05820 97494 45923 07816 40628 62089 98628 03482 53421 17067)
8. Display the content of a file in reverse direction (similar to $cat and $tac commands)
9. Store student record such as height, weight, date of birth etc. of the batch using structure and display the stored details including average height and average weight.

Reference Book:

1. Bryon Gottfried, Programming with C, McGraw Hill
2. Horowitz, Sahni, and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press, Second edition.
3. GDB https://www.eecs.umich.edu/courses/eecs373/readings/Debugger.pdf, https://ftp.gnu.org/old-gnu/Manuals/gdb/html_node/gdb_toc.html, https://www.sourceware.org/gdb/documentation/,
4. GCC https://www.cse.iitb.ac.in/grc/intdocs/gcc-basic-info.html, https://gcc.gnu.org/onlinedocs

EN1011	English Language Skills I	3-0-0-3

Syllabus:

Basic Grammar: articles, quantifiers, punctuation, use of tenses, gerunds and infinitives, present participles, subject verb concord, adverbs, nouns, pronouns, prepositions, use of connectives, use of adjectives and adverbs; common errors; Lexicon- Enriching vocabulary through one-word substitutes, synonyms, antonyms, etc.

Spoken English: importance for effective communication; linguistic aspects of mishearing; fluency; speaking to multicultural/multidisciplinary audience; standard varieties of spoken English; understanding vowels, consonants and syllable in English; tempo of speech & phrasal pause in English; English rhythm; stress on simple and derived words in English; practice and learning to improve pronunciation of numbers, units of weights, distance, etc.

Aspects of Theatre in Spoken Communication: grooming, eye contact, body language, amplitude.

Preparing a Presentation: charts, graphs, drawings, maps, diagrams, tables, etc.; using power point slides and other presentation aids; making presentations and self-evaluation.

Texts:

1. Shreesh Chaudhary. *Better Spoken English*, New Delhi: Vikas Publishing. (1992/2004)
2. J. D. O'Connor. *Better English Pronunciation, Cambridge* University Press. (1980)
3. F.T. Wood. *A Remedial English Grammar for Foreign Students*. New Delhi: Macmillan. (1965)

References:

1. Marilyn Anderson, Pramod K. Nayar, and Madhucchanda Sen. *Critical Reasoning, Academic Writing and Presentation Skills*. Rev. ed. New Delhi: Longman-Pearson. (2010)
2. Oxford Advanced Learner's Dictionary of English, Ninth Edition. (2016)
3. Michael Swan and Catherine Walter. *Oxford English Grammar Course: Advanced*. Oxford: OUP. (2011)
4. Allan Pease and Barbara Pease. *The Definitive Book of Body Language*. New Delhi: Manjul Publishing House. (2005)

JA1011	**Japanese Language Skills I**	**3-0-0-3**
Module I:	Introduction to Japanese language and scripts: Hiragana,Katakana, and Kanji. Introduction to Japanese pronunciation Culture Input: Useful everyday Japanese greetings and expressions with classroom vocabularies. Introduction to Japanese numerals.	
Module II:	Learning self Introduction and how to connect with people. Talk about things using Japanese demonstratives.	
Module III:	Learning how to tell time, and also to invite and accept invitation. Be able to perform basic actions in daily life.	
Module IV:	Learning how to express likes and dislikes, simple thoughts and impressions about past events and experiences. Be able to express the existence of people and things.	

Texts:

1. Minna No Nihongo Main Textbook Elementary1-2 (Goyal Publications)
2. Minna No Nihongo Translation and Grammatical Notes in English Elementary 1-2 (Goyal Publications)
3. Minna no Nihongo *Shokyū 1 Kanji Eigo Ban* (3A corporation)
4. Minna no Nihongo *Shokyū 1 Hyōjun Mondai Shū* (3A corporation)
5. Listening materials (3A corporation website)

KO1011	Korean Language Skills I	3-0-0-3
Module I:	Preliminaries I: Introduction to Korean language / Consonants & vowels / combining consonants & vowels. Preliminaries II : Final consonants / Reading practice / Basic expressions for the class	
Module II:	Greeting and introducing yourself. Asking and answering questions about daily life	
Module III:	Talking about where things are Buying things1 / Reading Sino-Korean numbers / Making requests	
Module IV:	Buying Things2 / Reading Pure Korean numbers /Quantifiers	
Texts: **1. Sejong Korean 1(**King Sejong Institute Foundation, Seoul) **& Workbook**		

GE1091	Yoga for Holistic Health	0-0-2-1
Module I:	**Inauguration:** Introduction to the Course, Benefits of the Course, Ice-Breaking, Goal Setting, Team Building, The Power of Knowledge, The Power of Yoga & Meditation, Mental Relaxation Techniques. **Capacity Building:** Listening and Learning Enhancement, Questioning Skills, Communication Skills, The Latest Ipod (Inner Peace, Outer Dynamism) **Introduction to Yoga:** What's Yoga?, Benefits of Yoga, Limbs of Yoga, Obstacles to Yoga, Practicals (Yoga Asanas).	
Module II:	**Yoga & Personality Development:** Life Skills (Vastness of Life and Layers of Existence), Energy Management (Sources of Energy), Mind & Emotion Management, The Power of a Focussed Mind (Present Moment), Body - Breath - Mind Connection (Importance of Breath), Introduction to Breathing Techniques, Practicals (Pranayams + Sudarshan Kriya). **Mechanics of Happiness:** Secret of Happiness, Stress Management (Sources of Stress, Physiology and Psychology of Stress), Handling Opposite Situations, Responsibility and Happiness Index, The Power of Responsibility, Living with Awareness (100%), Adaptability & Acceptance, Understanding Changing Nature of Life, Improving memory, concentration & focus, Concentration Pranayama, Practicals.	
Module III:	**Emotional Intelligence:** Dealing with Worry/ Regret / Love/ Hate/ Fear/Regret/ Aversion, Anger Management, Time Management & Prioritization, Overcoming negative mental habits (i.e. complaining, gossiping, procrastination), Dealing with counterproductive habits, Lifestyle & Environment Awareness, Life Choices and their global consequences, Practicals. **Self Confidence, Peer Pressure & Optimal Performance:** Anxiety Management and Confidence, Personal and interpersonal relationship, Coping with	

	Parental and Peer Pressure, Opinions, Inhibitions and their Impact on Life, Going Beyond Ego, The Ego-Handling Technique, Practicals.
Module IV:	**Leadership:** The Qualities of a Leader, The Role of Enthusiasm, Power of a Team, The Power of Intention, Intention, Attention, Manifestation, Commitment, Practicals. **Ethics, Morality and Integrity:** Importance of ethics, morals and integrity, Human Values, Social Code of Conduct, Role Models of Integrity, Role of youth in nation building, Practicals. **A Vision for A Stress-free, Violence-free World:** Spreading Happiness, Happiness Survey, The Concept of Social work, Brainstorming for Team Service Projects, Anti-Drug Awareness Campaign, Break into Service, Practical.
TEXT BOOK:	**1. Commentary on the Patanjali Yoga Sutras** **2. Wisdom for Life**

GE1092	Induction Programme (Audit)	0-0-2-1

- Physical activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to local Areas
- Familiarization to Dept./Branch & Innovations

Semester-II

2nd Semester						
Sem.	**Course code**	**Course Name**	**L**	**T**	**P**	**C**
II	EC1013	Basic Electronic Circuits	3	0	0	3
II	CS1012	Data Structures	3	0	0	3
II	HS1091	HSS-I (Introduction to Entrepreneurship)	3	0	0	3
II	MA1012	Mathematics II	3	1	0	4
II	PH1012	Physics II	3	0	0	3
II	EC1112	Basic Electronics Lab	0	0	2	1
II	CS1112	Data Structures Lab	0	0	2	1
II	EN1012	English Language Skills II	3	0	0	3
	JA1012	Japanese Language Skills II				
	KO1012	Korean Language Skills II				
		Total	**18**	**1**	**4**	**21**
		Contact Hours / Week	**23**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	6	7	4	4	0	0	0

EC1013	Basic Electronic Circuits	3-0-0-3

Syllabus:

Course Topics - Examples of Electronic Systems: Music System, Radio, Television

Diodes and Applications: Semiconductor diode - ideal versus practical, resistance levels, diode equivalent circuits, load line analysis; diode as a switch, diode as a rectifier, half wave and full wave rectifiers with and without filters; clipping circuits, clamper circuits, breakdown mechanisms, Zener diode – operation and applications; regulated d-c power supply.

Transistor Characteristics: Bipolar junction transistor (BJT) – construction, operation, amplifying action, common base, common emitter and common collector configurations, operating point, voltage divider bias configuration; Differential Amplifier.

Operational Amplifiers and Applications: Introduction to op-amp, characteristics of ideal op-amp, controlled source models, classification, the operational amplifier (op-amp) as a linear active device, the VCVS model of an op-amp, different amplifier configurations using op-amp, concept of virtual ground; op-amp operations, integrator and differentiator, frequency response of op-amp and op-amp based amplifiers. CMRR, PSRR, slew rate; pin configuration of 741 op-amp

Filters: Concepts of low-pass, high-pass and band-pass filters, ideal (brick-wall) filter response, frequency response of simple RC filters, active RC filters using Op-amp.

Oscillators: Effects of negative and positive feedback of an amplifier, condition of harmonic oscillation, RC and LC oscillator circuits.

Comparator: Op-amp as a comparator, digital inverters (TTL/CMOS) as comparators, comparator with hysteresis, Schmitt trigger using Op-amp, 555 timer as a two dimensional comparator. Waveform generators: Concept of bistable, monostable and astable circuits, timer and relaxation oscillator based on comparator and RC timing circuit, square wave generator using 555 timer, crystal clock generator.

Data Converters: Sample and hold circuits, Digital to Analog Converter (DAC) using binary resistor scheme, R-2R ladder DAC, DAC using switched current resources, Analog to Digital converter (ADC) using capacitor charge/discharge: single-slope and dual-slope ADCs, ADC using counter and DAC, ADC using successive approximation.

Texts:

1. Albert Malvino and David Bates, Electronic Principles, McGraw Hill Education; 2015.

References:

1. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, 2013.

2. Jacob Millman, Christos Halkias, Chetan Parikh, Millman's Integrated Electronics - Analog and Digital Circuit and Systems, McGraw Hill Education; 2017

3. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits, International Version 6th Edition, 2013, Oxford University Press India

CS1012	Data Structures	3-0-0-3

Syllabus:

Performance of algorithms: space and time complexity, asymptotic;

Basic data structure: Linked list (singly, doubly, circular), stacks, queue (circular, priority, dqueue)

Sorting & searching: Insertion sort, selection sort, bubble sort, quicksort, mergesort, heapsort, shellsort, linear search;

Nonlinear data structure: Tree (Representation, binary tree (full, complete, balance), binary search tree), tree traversals (post, in, pre), red-black tree, AVL tree

Advanced structure: Heap (max, min, binomial, fibonacci), hash (Chaining, Linear probing, Quadratic probing, Hash tree);

Graphs: Representations (Adjacency Matrix, Adjacency list), Depth first search, Breadth first search;

Text:

1. A H Aho, J E Hopcroft and J Ullman, Data Structures and Algorithms, Addison-Wesley, 1987.

References:

1. M A Weiss, Data Structures and Problem-Solving Using Java, Addison-Wesley, 1997.
2. A M Tannenbaum, Y Langsam and M J Augenstein, Data Structures Using C++, Prentice Hall India, 1996.
3. Robert Sedgewick, Algorithms in C++ Parts 1-5, Pearson Education, Third Edition, 1998.
4. Seymour Lipschutz, Data Structures with C, SCHAUM SERIES, Tata McGraw-Hill, 1st edition, 2010.
5. Horowitz, Sahni, and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press

HS1091	HSS-I (Introduction to Entrepreneurship)	3-0-0-3

Syllabus:

Meaning and Importance, Evolution, influencing factors (Psychological, Social, Economic, Environmental), Characteristics, Types of entrepreneur (based business, technology, motivation, growth, stages), Myths & Barriers.

Meaning and concept of E-cells, advantages to join E-cell, significance of E-cell, various activities conducted by E-cell, case studies (including success and failure stories) and comparative analysis, Rules And Legislation (Applicability of Legislation; Industries Development (Regulations) Act, 1951; Factories Act, 1948; The Industrial Employment (Standing Orders) Act, 1946; Suspension; Stoppage of work; Termination of employment; Environment (Protection) Act, 1986; The sale of Goods Act, 1950; Industrial Dispute Act 1947; GST; Central Excises Act, 1944

Why to become entrepreneur, the skills/ traits required to be an entrepreneur, Creative and Design; Thinking, the entrepreneurial decision process, skill gap analysis, and role models, mentors and support; system,Introduction to various form of business organization (sole proprietorship, partnership; corporations, Limited Liability company), mission, vision and strategy formulation.

Assistance to an entrepreneur: Industrial Park (Meaning, features, & examples), Special Economic Zone (Meaning, features & examples), Financial assistance by different agencies, MSME Act Small Scale Industries, Carry on Business (COB) license, Environmental Clearance, National Small Industries Corporation (NSIC), Government Stores Purchase scheme (e-tender process), Excise exemptions and concession, Exemption from income tax, Quality Standards with special reference to ISO, Small Industries Development Bank of India (SIDBI), State Small Industries Development Corporation (SSIDC), Directorate General of Supplies and Disposals, Khadi and Village Industries Commission (KVIC)

Importance of communication, barriers and gateways to communication, listening to people, the power of talk, personal selling, risk taking \& resilience, negotiation.

Text:

1. Introduction to Entrepreneurship, Commonwealth of Learning; http://oasis.col.org/bitstream/handle/11599/2465/2011_VUSSC_Intro-to-Entrepreneurship.pdf?sequence=1&isAllowed=y

References:

1. Entrepreneurship, Michael Laverty & Chris Littel, https://openstax.org/books/entrepreneurship/pages/preface
2. Introduction to Entrepreneurship; Katherine Carpenter, University of Victoria; https://open.umn.edu/opentextbooks/textbooks/introduction-to-entrepreneurship

MA1012	Mathematics II	3-1-0-4

Syllabus:

Multivariable Calculus: Vector functions of one variable – continuity, differentiation and integration; functions of several variables - continuity, partial derivatives, directional derivatives, gradient, differentiability, chain rule; tangent planes and normals, maxima and minima, Lagrange multiplier method; repeated and multiple integrals with applications to volume, surface area, moments of inertia, change of variables; vector fields, line and surface integrals; Green's, Gauss's and Stokes' theorems and their applications.

Ordinary Differential Equation: First order differential equations - exact differential equations, integrating factors, Bernoulli equations, existence and uniqueness theorem, applications; higher-order linear differential equations - solutions of homogeneous and non-homogeneous equations, method of variation of parameters; Laplace and inverse Laplace transforms; properties, convolutions; solution of ODE by Laplace transform. Systems of first-order equations, two-dimensional linear autonomous system, phase plane, critical points, stability.

Texts:

1. G. B. Thomas, Jr. and R. L. Finney, *Calculus and Analytic Geometry*, 9th Edition, Pearson Education India, 1996.
2. S. L. Ross, *Differential Equations*, 3rd Edition, Wiley India, 1984.

References:

1. H. Anton, I. C. Bivens and S. Davis, *Calculus*, 10th Edition, Wiley, 2011.
2. T. M. Apostol, *Calculus*, Volume 2, 2nd Edition, Wiley India, 2003.
3. W. E. Boyce and R. C. Di Prima, *Elementary Differential Equations and Boundary Value Problems*, 9th Edition, Wiley India, 2009.
4. E. A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice Hall India, 1995.

PH1012	**Physics II**	**3-0-0-3**

Syllabus:

Vector Calculus: Gradient, Divergence and Curl, Line, Surface, and Volume integrals, Gauss's divergence theorem and Stokes' theorem in Cartesian, Spherical polar and cylindrical polar coordinates, Dirac Delta function.

Electrostatics: Gauss's law and its applications, Divergence and Curl of Electrostatic fields, Electrostatic Potential, Boundary conditions, Work and Energy, Conductors, Capacitors, Laplace's equation, Method of images, Boundary value problems in Cartesian Coordinate Systems, Dielectrics, Polarization, Bound Charges, Electric displacement, Boundary conditions in dielectrics, Energy in dielectrics, Forces on dielectrics.

Magnetostatics: Lorentz force, Biot---Savart and Ampere's laws and their applications, Divergence and Curl of Magnetostatic fields, Magnetic vector Potential, Force and torque on a magnetic dipole, Magnetic materials, Magnetization, Bound currents, Boundary conditions.

Electrodynamics: Ohm's law, Motional EMF, Faraday's law, Lenz's law, Self and Mutual inductance, Energy stored in magnetic field, Maxwell's equations, Continuity Equation, Poynting Theorem, Wave solution of Maxwell Equations.

Electromagnetic waves: Polarization, reflection & transmission at oblique incidences.

Texts:

1. Introduction to Electrodynamics by D. J. Griffiths, 3rd Ed., Prentice Hall of India, 2005.
2. Elements of Electromagnetics by M. N. O. Sadiku, Oxford, 2006.

References:

1. C. A. Balanis, Advanced Engineering Electromagnetics, 2nd Edition, John Wiley, 2012.
2. The Feynman Lectures on Physics, Vol.II by R. P. Feynman, R. B. Leighton and M. Sands, Narosa Publishing House, 1998.

EC1112	Basic Electronics Lab	0-0-2-1

Experiments using diodes: Diode characteristics, design and analysis of half-wave and full-wave rectifier circuits without and with filter, clipping circuits, clamper circuits,

Experiments using operational amplifier: Inverting amplifier, non-inverting amplifier, voltage follower, integrator, differentiator, comparators, Multivibrators, Wien's Bridge Oscillator, first-order filters, D/A and A/D converters.

CS1112	Data Structures Lab	0-0-2-1

Implementation of the following algorithms with operations are mandatory using C/C++ programming language (preferably using functions to make it modular). Instructor may take help of application-specific mini-projects (a set of input will be transformed to output) to explain the concept of these data structures.

Basic data structure: Linked list (singly, doubly, circular), stacks, queue (circular, priority, dqueue)

Sorting & searching: Insertion sort, selection sort, bubble sort, quicksort, mergesort, heapsort, shellsort, linear search;

Nonlinear data structure: Tree (Representation, binary tree (full, complete, balance), binary search tree), tree traversals (post, in, pre), red-black tree, AVL tree

Advanced structure: Heap (max, min, binomial, fibonacci), hash (Chaining, Linear probing, Quadratic probing, Hash tree);

Graphs: Representations (Adjacency Matrix, Adjacency list), Depth first search, Breadth first search;

References:

1. A H Aho, J E Hopcroft and J Ullman, Data Structures and Algorithms, Addison-Wesley
2. Horowitz, Sahni, and Anderson-Freed, Fundamentals of Data Structures in C, Universities Press
3. Seymour Lipschutz, Data Structures with C, SCHAUM SERIES, Tata McGraw-Hill
4. M A Weiss, Data Structures and Problem-Solving Using Java, Addison-Wesley
5. Robert Sedgewick, Algorithms in C++ Parts 1-5, Pearson Education, Third Edition

EN1012	English Language Skills II	3-0-0-3

Syllabus:

Introduction to Communication: need for effective communication; the process of communication; significance of technical communication; barriers to communication.

Listening Skills: listening as an active skill; listening for specific information; developing effective listening skills; barriers to effective listening skills.

Reading Skills: skimming; scanning; understanding the gist of an argument; identifying the topic sentence; inferring lexical and contextual meaning.

Writing Skills: sentence formation; use of appropriate diction; paragraph and essay writing; coherence and cohesion; technical writing; letter writing; job application; report writing.

Speaking Skills: non-verbal communication; group discussion; presentation skills; technology-based communication.

Texts:

1. V.N. Arora and Lakshmi Chandra. *Improve Your Writing*. New Delhi: OUP, 1981.
2. Marilyn Anderson, Pramod K. Nayar, and Madhucchanda Sen. *Critical Reasoning, Academic Writing and Presentation Skills*. Rev. ed. New Delhi: Longman-Pearson, 2010.
3. Allan Pease and Barbara Pease. The Definitive Book of Body Language. New Delhi: Manjul Publishing House, 2005.

References:

1. F.T. Wood. A Remedial English Grammar for Foreign Students. New Delhi: Macmillan, 1965.
2. Nitin Bhatnagar and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson.
3. N. Krishnaswami and T. Sriraman. Current English for Colleges. Chennai: Macmillan, 1990.
4. N. Krishnaswami and T. Sriraman. Creative English for Communication. 2nded. New Delhi: Macmillan, 2009.
5. Michael Swan. Practical English Usage. 3rd ed. Oxford: OUP, 2005.
6. Michael Swan and Catherine Walter. Oxford English Grammar Course: Advanced. Oxford: OUP, 2011.

JA1012	**Japanese Language Skills II**	**3-0-0-3**
Module I:	Be able to express one's wants and desires, also be able to give simple requests, instructions and recommendations. Be able to understand prohibitions and rules, and also to be able to describe people, things, places, etc.	
Module II:	Be able to talk easily about potential and hobbies. Also be able to express the transformation of things and people.	
Module III:	Be able to understand the difference between polite and informal sentences, as well as to be able to use casual sentences and the context. Be able to use indirect sentences	
Module IV:	Be able to explain what action to perform at what time.Deeper understanding of the usage of respected forms of Japanese .Be able to use conditional forms.	

Texts:

1. Minna No Nihongo Main Textbook Elementary1-2 (Goyal Publications)
2. Minna No Nihongo Translation and Grammatical Notes in English Elementary 1-2 (Goyal Publications)
3. Minna no Nihongo *Shokyū 1 Kanji Eigo Ban* (3A corporation)
4. Minna no Nihongo *Shokyū 1 Hyōjun Mondai Shū* (3A corporation)
5. Listening materials (3A corporation website)

KO1012	**Korean Language Skills II**	**3-0-0-3**
Module I:	Talking about the past Talking about Seasons and Weather / Negating	
Module II:	Asking and telling the date, day, and time Making suggestions/promises	
Module III:	Asking and answering about weekend activities Talking about studying Korean	
Module IV:	Talking about future plans	
Texts: **1. Sejong Korean 1(**King Sejong Institute Foundation, Seoul) **& Workbook**		

Semester-III

3rd Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
III	CS2014	Design and Analysis of Algorithms	3	0	0	3
III	ECXXXX	Microcontroller and Microprocessor	3	0	0	3
III	CS2013	Object Oriented Programming	3	1	0	4
III	MA2013	Probability and Random Processes	3	1	0	4
III	EC2031	Signals and Systems	3	0	0	3
III	CS2015	Web Technology	2	0	2	3
III	CS2113	Object Oriented Programming Lab	0	0	2	1
III	EC2131	Signals and Systems Lab	0	0	2	1
		Total	**17**	**2**	**6**	**22**
		Contact Hours / Week			**25**	

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	4	7	11	0	0	0

CS2014	Design and Analysis of Algorithms	3-0-0-3

Syllabus:

Models of Computation: space and time complexity measures, lower and upper bounds; Design techniques: the greedy method, divide-and-conquer, dynamic programming, backtracking, branch and bound; Lower bound for sorting; Selection; Graph Algorithms: connectivity, topological sort, shortest paths, minimum spanning trees, network flow; The disjoint set union problem; String matching; NP-completeness; Introduction to approximate algorithms and Randomized algorithms.

Texts:

1. T H Cormen, C E Leiserson, R L Rivest and C Stein, Introduction to Algorithms, MIT Press, 2001.

References:

1. Jon Kleinberg and Eva Tardos, Algorithm Design, Addison Wesley, 2005
2. A Aho, J E Hopcroft and J D Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley, 1974.
3. S Sahni, Data Structures, Algorithms and Applications in C++, McGraw-Hill, 2001.
4. M T Goodrich and R Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, John Wiley & Sons, 2001.

EC2071	MICROCONTROLLER AND MICROPROCESSOR	3-0-0-3

Microprocessors: Evolution of Microprocessors, Basic functional blocks of a microprocessor, microprocessor-based systems, concept of multiplexing in microprocessor.

Architecture of 8-bit Microprocessor: Intel 8085/8086 microprocessor, pin description and internal architecture, comparison with 8-bit processor.

Instruction Set of x86: Assembly language fundamentals, Machine cycles, instruction format, addressing modes, instruction set, classification, Data Transfers instructions, arithmetic and logical instructions, String manipulating instructions, control transfer instructions, processor control instructions, flags, assembly language programming using 8086.

Peripheral Devices and Interfacing: Memory and I/O interfacing, 8255 Interfacing examples, interfacing of DC and stepper motors, interfacing of key board, display, USART.

Lab Assignments:

Software experiments using an 8085/8086 Kit to learn its instruction set. Hardware experiments for the use of peripherals like 8251 (USART). Experiments to learn Port IO, control of on chip peripherals such as timers, interfacing with off chip peripherals such as LCD displays, Key boards, Stepper motors and ADC chips. Experiments for the use of other microcontrollers such as PIC using development boards.

Text:

1. R.S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Penram International Publishing, Fifth Edition, 2011.

References:

1. Nagoor Kani, Microprocessors and Microcontrollers, The McGraw-Hill Companies, 2nd Edition
2. J.H. Hennessy, and D.A. Patterson, Computer Architecture: A Quantitative Approch, Morgan Kaufmann Publishers, Fourth Edition, 2006.
3. Kenneth J. Ayala, The 8051 Microcontroller, Architecture, Programming and Applications, Penram International Publishing, 1996.
4. Hall D. V., "Microprocessor and Interfacing-Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008

CS2013	Object Oriented Programming	3-1-0-4

Syllabus:

Review of programming practices and code-reuse; Object model and object-oriented concepts: Data Abstraction: Class, object, constructors, destructors, memory allocations for objects, member functions, friend functions, templates. Inheritance: Single & multiple inheritance, virtual base class. Polymorphism: Compile time polymorphism: operator overloading, function overloading, static binding. Run-time polymorphism: Virtual function, pure virtual function, abstract class, dynamic binding. Exception handling. Object-oriented programming languages and implementation. File handling.

Texts:

1. E Balaguruswamy: Object Oriented Programming with C++, McGraw Hill
2. Grady Booch: Object Oriented Analysis and Design, Pearson Education.

References:

1. Herbert Schild: The Complete Reference to C++, Osborne Mc Graw Hill.
2. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall.
3. Bjarne Stroustrup: The C++ Programming Language, Addison Wesley
4. Rambaughet al.: Object Oriented Modeling and Design, PHI(EEE).

MA2013	Probability and Random Processes	3-1-0-4

Syllabus:

Introduction to probability: mathematical background - sets, set operations, sigma and Borel fields; classical, relative-frequency and axiomatic definitions of probability; conditional probability, independence, total probability, Bayes rule; repeated trials;

Random variables: Cumulative distribution function, continuous, discrete and mixed random variables, probability mass function, probability density functions; functions of a random variable; expectation - mean, variance and moments; characteristic and moment-generating functions; Chebyshev, Markov and Chernoff bounds; special random variables-Bernoulli, binomial, Poisson, uniform, Gaussian and Rayleigh; joint distribution and density functions; Bayes rule for continuous and mixed random variables; joint moments, conditional expectation; covariance and correlation- independent, uncorrelated and orthogonal random variables; function of two random variables; sum of two independent random variables; random vector- mean vector and covariance matrix, multivariate Gaussian distribution; Vector-space representation of Random variables, laws of large numbers, central limit theorem;

Random process: discrete and continuous time processes; probabilistic structure of a random process; mean, autocorrelation and autocovariance functions; stationarity- strict-sense stationary and wide-sense stationary (WSS) processes: autocorrelation and cross-correlation functions; time averages and ergodicity; spectral representation of a real WSS process-power spectral density, cross-power spectral density, Wiener Khinchin theorem, linear time-invariant systems with WSS process as an input time and frequency domain analyses; spectral factorization theorem;

Examples of random processes: white noise, Gaussian, Poisson and Markov processes, Basics of Queuing Theory, Characteristics of queuing systems.

Texts:

1. Papoulis and S.U. Pillai, Probability Random Variables and Stochastic Processes, 4/e, McGraw-Hill, 2002.
2. A. Leon Garcia, Probability and Random Processes for Electrical Engineering, 2/e, Addison-Wesley, 1993.

References:

1. H. Stark and J.W. Woods, Probability and Random Processes with Applications to Signal Processing, 3/e, Prentice Hall, 2002.
2. John J. Shynk, Probability, Random Variables, and Random Processes: Theory and Signal Processing Applications, 1/e, Wiley publications, 2012.

EC2031	Signals and Systems	3-0-0-3

Syllabus:

Signals: Signal Basics, Elementary signals, classification of signals; signal operations: scaling, shifting and inversion; signal properties: symmetry, periodicity and absolute integrability; Sampling and Reconstruction, Sampling and Nyquist theorem, aliasing, signal reconstruction: ideal interpolator, zero-order hold, first-order hold; Sinc function,

Practical reconstruction, group delay, phase delay.

Systems: classification of systems; Time-Domain Analysis of Continuous-Time Systems; system properties: linearity, time/shift-invariance, causality, stability; continuous-time linear time invariant (LTI) and discrete-time linear shift invariant (LSI) systems: impulse response and step response; response to an arbitrary input: convolution; circular convolution; system representation using differential equations; Eigen functions of LTI/ LSI systems, frequency response and its relation to the impulse response; correlation and cross correlation of two sequences.

Signal representation: signal space and orthogonal basis; continuous-time Fourier series and its properties; continuous-time Fourier transform and its properties; Parseval's relation, time-bandwidth product; discrete time Fourier series; discrete-time Fourier transform and its properties; relations among various Fourier representations. Linear Convolution using DFT. Fast Fourier Transform (FFT);

Laplace transform and properties, Inverse Laplace Transform by Partial Fraction and Z-transform: definition, region of convergence, properties; transform-domain analysis of LTI/LSI systems, system function: poles and zeros; stability, inverse Z-Transform by Partial Fraction.

Text:

1. M. J. Roberts," Fundamentals of Signals and Systems", 1st Edition, Tata McGraw Hill, 2007.
2. A.V. Oppenheim, A.S. Willsky and H.S. Nawab," Signals and Systems", 2nd Edition Prentice Hall of India, 2006.

References:

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin," Signals and Systems - Continuous and Discrete", 4th Edition, Prentice Hall, 1998.
2. Simon Haykin, Barry van Veen," Signals and Systems", 2nd Edition, John Wiley and Sons, 1998.
3. TarunRawat, "Signals and Systems", Oxford University Press.

CS2015	Web Technology	2-0-2-3

HTML5, CSS3 and XML: Introduction to markup language, elements of Html5, controlling of Form elements, Dynamic graphics (canvas, SVG, etc.), controlling of audio and video elements; Introduction to CSS, type, elements and their attributes, layout, controlling of motion and colours; Introduction to XML, Defining XML tags, their attributes and values, Document type definition, XML Schema, Document Object model, XHTML, Parsing XML Data (DOM and SAX parser), UI framework: Bootstrap 4

Client Side Scripting: Introduction to JavaScript, declaring variables, scope of variables functions, event handlers (on click, on submit etc.), Document Object Model, Form validations. JavaScript Frameworks - ReactJS, AngularJS, VueJS, architures, Model-view-controller, virtual DOM

Server Side Scripting: Using stack: introduction to Node.JS, ExpressJS, MongoDB, Data Flow in MEAN and MERN stack, architures, example application; Using PHP: Introduction to PHP, Declaring variables, data types, arrays, strings, operations, expressions, control structures, functions, Reading data from web form controls like Text Boxes, radio buttons, lists etc., Handling File Uploads, Connecting to database (MySQL/MariaDB as reference), executing simple queries, handling results, Handling sessions and cookies; File operations like opening, closing, reading, writing, appending, deleting etc. on text and binary files, listing directories.

Lab: Unix network measurement and analysis tools, Wireshark, Socket interface and programming, RPC, RMI, HTML, HTTP, CGI, XML, Assignments using Network Simulators

Text:

1.Internet and World Wide Web – How to program, Dietel and Nieto, Pearson

2. Matthew MacDonald, ”Creating a Website - The Missing Manual”, 4th ed, 2015, O’Reilly.

3. Programming world wide web, R.W. Sebesta. Fourth Edition, Pearson

References:

1. Greg Lim, Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App

2. Cris Bates, Web Programming: Building Internet Applications, 3ed, Wiley

3. HTML5, CSS3, JavaScript, PHP Tutorials http://www.w3schools.com

4. jQuery Tutorial https://learn.jquery.com

5. MongoDB Tutorial and Certifications https://university.mongodb.com

6. Express https://expressjs.com/en/starter/installing.html

7. React Tutorialhttps://reactjs.org/tutorial/tutorial.html

8. Node https://nodeschool.io

CS2113	Object Oriented Programming Lab	0-0-2-1

Lab Assignment:

Implementation of class and Object creation, Constructors, Abstract classes and Abstract methods, Inheritance, overloading- operator & function, Exception Handling, Packages, File Handling, Multi-Threading, Graphic Classes

Reference Book:

1. Grady Booch: Object Oriented Analysis and Design, Pearson Education.
2. E Balaguruswamy : Object Oriented Programming with C++, McGraw Hill
3. Herbert Schild : The Complete Reference to C++, Osborne Mc Graw Hill.
4. Bjarne Stroustrup: The C++ Programming Language, Addison Wesley
5. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall.

EC2131	Signals and Systems Lab	0-0-2-1

Syllabus:

Introduction to computation platforms: GNU Octave, SciLab, MATLAB.

Signals: Generation of Continuous and Discrete time signals (Unit step, Impulse, Ramp, Exponential and Sinusoidal etc.); simulation of basic operations on signals (Folding, scaling, shifting, addition, subtraction, multiplication etc.); finding the even and odd parts of a signal; computing whether the given system is linear or not; computation of Sampling theorem;

Systems: Computation of output response of two sequences x(n) and h(n) using: a) Linear Convolution, b) Circular Convolution, c) Circular Convolution with zero padding; computation of Cross correlation of two sequences; Signal representation: Fourier Series Evaluation for Square Wave Function; Discrete Time Fourier Transform (DTFT); DFT and IDFT of the sequences x(n) and X(k); computation of L-transform transfer function for a given input; computations of Z-transform transfer function for a given input.

Reference:

1. V. K. Ingle and J. G. Proakis, “Digital Signal Processing with MATLAB”, Cengage, 2008.

SEMESTER-IV

4th Semester						
Sem.	**Course code**	**Course Name**	**L**	**T**	**P**	**C**
IV	CS3051	Artificial Intelligence	3	0	0	3
IV	CS2043	Database Management Systems	3	0	0	3
IV	CS2021	Discrete Mathematics	3	0	0	3
IV	CS2041	Operating Systems	3	0	0	3
IV	CS2042	Software Engineering	3	1	0	4
IV	CS2022	Theory of Computing	3	0	0	3
IV	CS2143	Database Management Systems Lab	0	0	2	1
IV	CS2141	Operating Systems Lab	0	0	2	1

						Total	**18**	**1**	**4**	**21**
						Contact Hours / Week		**23**		
Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**			
Credit	0	0	3	18	0	0	0			

CS3051	Artificial Intelligence	3-0-0-3

Intelligent Agents: Introduction to AI – Agents and Environments, Concept of rationality, Nature of environments, Structure of agents; Problem solving agents – search algorithms, uninformed search strategies.

Problem Solving: Heuristic search strategies – heuristic functions; Local search and optimization problems – local search in continuous space – search with nondeterministic actions – search in partially observable environments – online search agents and unknown environments.

Game Playing and Constraint Satisfaction Problems: Game theory – optimal decisions in games – alpha-betasearch – monte-carlo tree search – stochastic games – partially observable games; Constraint satisfaction problems (CSP) – constraint propagation – backtracking search for CSP – local search for CSP – structure of CSP

Logical Agents: Knowledge-based agents – propositional logic – propositional theorem proving – propositional model checking – agents based on propositional logic; First-order logic – syntax and semantics – knowledge representation and engineering – inferences in first-order logic – forward chaining – backward chaining – resolution.

Knowledge Representation And Planning: Ontological engineering – categories and objects – events – mental objects and modal logic – reasoning systems for categories – reasoning with default information; Classical planning – algorithms for classical planning – heuristics for planning – hierarchical planning – non-deterministic domains – time, schedule, and resources – analysis.

Text Books:

1. Stuart Russel and Peter Norvig, Artificial Intelligence: A Modern Approach, Fourth Edition, Pearson Education, 2020.
2. Kevin Night, Elaine Rich, and Shivashankar B. Nair, Artificial Intelligence, McGraw Hill Education, 3rd Ed, 2017.

Reference Books:

1. Deepak Khemani, Artificial Intelligence, Tata McGraw Hill Education, 2013.
2. Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases - by Dennis Rothman, 2018.

CS2043	Database Management Systems	3-0-0-3

Databases: Introduction, Introduction to the Relational Model, Introduction to SQL, Intermediate SQL, Advanced

SQL, Formal Relational Query Languages.

Database Design: ER Model, Functional Dependencies, Schema Design, Normal Forms. Data Storage and Querying: Storage and File Structure, Indexing and Hashing, Query Processing, Query Optimization. Transaction Management: Transactions, Concurrency Control, Recovery System. System Architecture: Database System Architecture, Parallel Databases, Distributed Databases. Advanced Topics: Data Warehousing and Mining, Information Retrieval, XML.

Lab: Using a relational DBMS: Writing SQL queries, accessing a DBMS from an external application. Implementing of parts of DBMS such as various file organizations, indexing methods (Tree/ Hash/ Bitmap), external sorting algorithms, and concurrency control schemes. Nonrelational DBMS; performance comparison of a non-relational DBMS with a relational DBMS for an application.

Text:

1. Database System Concepts - Silberschatz, Korth & Sudarshan, McGraw-Hill.
2. Fundamentals of Database Systems, Elmasri, Ramez; Navathe, Shamkant, Addison Wesley.

References:

1. An Introduction to Database Systems - CJ Date, Addison-Wesley.
2. Database Systems: The Complete Book - Gracia-Molina, Ullman, Widom, Pearson.
3. H. Garcia-Molina, J. Ullman, J. Widom, Database System Implementation, 2nd Edition, Pearson, 2002.
4. J. Groff and P. Weinberg, SQL Complete Reference, McGraw Hill, 3rd Edition, 2017.
5. P. Sadalage and M. Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesley, 2012.

CS2021	Discrete Mathematics	3-0-0-3

Syllabus:

Sets and Sequences: Data Models: Finite Sets, Power Set, Cardinality of finite sets, Cartesian Product, Properties of Sets, Vector Implementations of Sets. Introduction to Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. Infinite sets, well-ordering. Countable and Uncountable sets, Cantor's diagonalization. Mathematical Induction - weak and strong induction.

Relational Structures on Sets : Relations & Graphs : Relations and their properties, n-array relations and their applications, Equivalence of relations, partial ordering. Functions, Bijections. Binary relations and Graphs. Posets and Lattices, Lattice and algebra system, principles of duality, basic properties of algebraic systems defined by lattices, distributive and complimented lattices, Boolean lattice and Boolean algebra.

Sizes of Sets : Counting & Combinatorics : Counting, Sum and product rule, Principle of Inclusion Exclusion. Pigeon Hole Principle, Counting by Bijections. Double Counting. Linear Recurrence relations - methods of solutions. Generating functions, partitions of integers, exponential generating function. Permutations and counting.

Structured Sets : Algebraic Structures : Structured sets with respect to binary operations. Groups, Semigroups, Monoids. Rings, and Fields. Vector Spaces, Basis.

Graphs and Tree – Introduction, Isomorphism, Sub graphs, Walks, Paths, Circuits, Connectedness, Euler graphs, Hamiltonian paths and circuits, Trees, Properties of trees, Distance and centers in tree – Rooted and binary trees; Spanning trees, Fundamental circuits, Spanning trees in a weighted graph, cut sets, Properties of cut set, Fundamental circuits and cut sets; Connectivity and separability, Network flows, 1-Isomorphism, 2-Isomorphism, Combinational and geometric graphs, Planer graphs, Different representation of a planer graph.

Texts:

1. K. H. Rosen, Discrete Mathematics and its Applications, Tata McGraw-Hill, 2009
2. J. P. Tremblay and R. P. Manohar, Discrete Mathematical structures with Applications to Computer Science, Tata McGraw-Hill, 2001

References:

1. Ronald Graham, Donald Knuth, and Oren Patashnik, Concrete Mathematics, Pearson Education Publishers, 1996
2. J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010
3. R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999

CS2041	Operating Systems	3-0-0-3

Syllabus:

Process Management: process, thread, scheduling; Concurrency: mutual exclusion, synchronization, semaphores, deadlocks; Memory Management: allocation, protection, hardware support, paging, segmentation; Virtual Memory: demand paging, allocation, replacement, swapping, segmentation, TLBs; File Management: naming, file operations and their implementation; File Systems: allocation, free space management, directory management, mounting; I/O Management: device drivers, disk scheduling, Basics of Security.

Texts:

1. Silberschatz, A. and Galvin, P.B. Operating System Concepts, Wileys

References:

1. Stalling, W. Operating Systems: Internals and Design Principles, Pearson
2. Tanenbaum, A. S. Modern Operating System, Pearson
3. Dhamdhere, D.M. Operating Systems A Concept Based Approach, Mc Graw Hill

CS2042	Software Engineering	3-1-0-4

Software Engineering Principles: Overview of the software engineering discipline, Software lifecycle models, Agile development, The Unified Process(UP), Organizing development projects

Requirements Engineering: Documenting requirements, user stories, use cases and scenarios Introduction to UML: Review of object-oriented principles, UML use case, class, sequence, activity, state, component and deployment diagrams. UML models

The Analysis and Design Process: User story realisation, Object- oriented modelling, Incremental refinement, Design Principles: Software architecture, Separation of concerns, Design patterns, Object-Oriented design practices, Refactoring,

Testing: Unit Testing, Test-Driven Development, Functional Testing.

Text:

1. R. S Pressman, Software Engineering: A Practioner's Approach, McGraw-Hill

References:

1. Sommerville, Software Engineering, Addison-Wesley.

2. Jim Arlow, Ila Neustadt. UML and the Unified Process Addison Wesley.

3. Grady Booch, James Rumbaugh, Ivar Jacobson: The Unified Modeling Language User Guide, Addison Wesley.

CS2022	Theory of Computing	3-0-0-3

Finite Automata – deterministic and non-deterministic, regular operations, Regular Expression, Equivalence of DFA, NFA and REs, closure properties, Non regular languages and pumping lemma, DFA Minimization, CFGs, Chomsky Normal Form, Non CFLs and pumping lemma for CFLs, PDAs, Equivalence of PDA and CFG, Properties of CFLs, DCFLs, Turing Machines and its variants, Configuration graph, closure properties of decidable languages, decidability properties of regular languages and CFLs, Undecidability, reductions, Rice's Theorem, introduction to complexity theory.

Text:

1. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and computation, Pearson / Addison Wesley

References:

6. Michael Sipser, Introduction to the Theory of Computation, Cengage Learning India Private Limited
7. H. R. Lewis and C. H. Papadimitriou, Elements of the Theory of Computation, PHI Learning.

CS2143	Database Management Systems Lab	0-0-2-1

CS2141	Operating Systems Lab	0-0-2-1

Lab Assignment:

Implementation of CPU scheduling, Shared memory and IPC, Semaphores, file allocation strategies, File Organization Techniques, Dead Lock Avoidance & Detection, page replacement algorithms, Threading & Synchronization

Assignment on fork, shared memory and IPC, scheduling, deadlock, resource allocation graph, page replacement algorithms, disc scheduling

Reference Book:

1. Silberschatz, A. and Galvin, P.B. Operating System Concepts, Wileys.
2. Stalling, W. Operating Systems: Internals and Design Principles, Pearson
3. Tanenbaum, A. S. Modern Operating System, Pearson
4. Richard Stevens, Unix Network Programming, Volume 2, Second Edition: Interprocess Communications, Prentice Hall.

SEMESTER-V

5th Semester

Sem.	Course Code	Course Name	L	T	P	C
V	CS3044	Compiler Design	3	1	0	4
V	CS3081	Data Science - I	3	0	0	3
V	CS1061	Computer Organization and Architecture	3	0	0	3
V	CS2031	Computer Networks	3	1	0	4
V	HS30XX	HSS Elective – II	3	0	0	3
V	PE30XX	Professional Elective – I	3	0	0	3
V	CSXXXX	Computer Networks Lab	0	0	2	1
V	CSXXXX	Compiler Design Lab	0	0	2	1
		Total	**18**	**2**	**4**	**22**
		Contact Hours / Week	**24**			

Total Course Credit	Humanities & Social Science (HS)	Basic Science (BS)	Basic Engineering (BE)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Internship / Project
Credit	3	0	3	13	3	0	0

CS3044	COMPILER DESIGN	3-1-0-4

Compilers and translators, different phases of a compiler; Lexical analysis: specification of tokens, recognition of tokens, input buffering, automatic tools; Syntax analysis: context free grammars, top down and bottom up parsing techniques, construction of efficient parsers, syntax-directed translation, automatic tools; Semantic analysis: declaration processing, type checking, symbol tables, error recovery; Intermediate code generation: run-time environments, translation of language constructs; Code generation: flow-graphs, register allocation, code generation algorithms; Introduction to code optimization techniques.

Text Books:

1. A. V. Aho, L.S. Monica R. Sethi and J. D. Ullman, Compilers: Principles, Techniques, and Tools, 2nd Ed., Prentice Hall, 2009

Reference Books:

1. V. Raghavan, Principles of Compiler Design, McGrawHill, 2010.
2. C.N. Fischer and R.J. Le Blanc, Crafting a Compiler with C, Pearson Education, 2009

CS3081	DATA SCIENCE-I	3-0-0-3

Introduction to Data science. Brief history. Data Science Life cycle. Application of data science. Natural Language Processing. Computer Vision. Big Data. Issues in data science.

Core statistics for data science. Vectors. Matrices. Descriptive Statistics Mean. Median, Mode, Standard Deviation, Variance and Covariance, Measures of Central Tendency and Variance, Normal, Binomial and Poisson Distributions, Correlations, Normal and Continues Probability ,Stochastic Gradient Decent ,Confidence Interval ,Root Mean Square Error(RMSE).

Basics of Python. Working with script files in Python. Data structures and Data types in Python. Working with Programming Constructs in Python . Strings Exception, Lists, Tuples, Dictionaries Sets, Sorting , Object Oriented Programming.

Working with Python Libraries for Data Science. NumPy ,Arrays and its operations ,Indexing and Slicing ,Array Shape manipulation and sorting. Pandas Working with Data frames, Indexing of data frames, . Grouping and Merging of data frames Introduction to Scipy and iPython. Data Visualization with Matplotlib , Bar Chart , Line Chart ,Scatter Plot

Working with Models. Descriptive and Predictive Modeling , Supervised Vs Unsupervised Learning .Types of data : training, test, validation. Dataset Preparation. Model Preparation. Dimension Reduction : Principal Component Analysis (PCA) . Classification . Regression . Cross-Validation

Textbooks:

1. Python Data Science Handbook: Essential Tools for Working with Data, Jake VanderPlas, 1 January 2016,O'Relly Media,ISBN : 978- 1491912058.
2. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools , Davy Cielen et.al. , 1 January 2016,dreamtech,ISBN: 978-1633430037.
3. Data Science From Scratch: First Principles with Python, Second Edition, Joel Grus, 5 May 2019,O'Relly Media,ISBN: 9781492041139.
4. Python for Data Science For Dummies, 2ed,, Luca Massaron John Paul Mueller, Paperback – 2019, Wiley; January 2019, ISBN: 9781119547648.
5. Data Science with Python, Rohan Chopra, Aaron England, Et al, July 19, 2019,Packt , ISBN: 9781838552862
6. Python Data Science Essentials - Third Edition, Alberto Boschetti, Luca Massaron, September 27, 2018, Packt , ISBN: 9781789537864
7. Statistics for Data Science, James D. Miller, November 17, 2017 ,Packt, ISBN: 9781788290678

CS1061	Computer Organization and Architecture	3-0-0-3

Syllabus:

Review: History of computer architecture, combinational vs sequential logic, integer arithmetic: carry look-ahead, booths algorithm, division (restoring and non-restoring) [Covered in EC101], Hardware description languages, physical constraints (gate delay, fan-in, fan-out, energy/power). microcontrollers.

Instruction Set Architecture: Introduction to instruction set architecture, Basic organization of computing machine: fetch, decode, and execute; Instruction set types, instruction format, addressing modes, subroutine call and return mechanisms; Structure of machine-level programs; Low-level architectural support for high level languages. Performance assessment; ARM Instruction Set and Intel X86 instruction set.

Computer Arithmetic: Representation of numeric data, signed and unsigned arithmetic; floating-point arithmetic

representation, arithmetic: addition, subtraction, multiplication, division; design of arithmetic and logic unit.

Processor Architecture: CISC vs RISC Designs, simple implementation schemes, data path design, control unit: hardwired realization vs micro-programmed realization, multi-cycle implementation. Instruction level parallelism, instruction pipelining, pipeline hazards.

Memory Architecture: Storage systems, memory architecture (static and Dynamic RAM; row and column addressing; interleaving, banks), memory hierarchy: importance of temporal and spatial locality; main memory organization, cache memory: address mapping, block size, replacement, and store policies; virtual memory system: page table and TLB.

Interfacing and I/O Organization: External storage; Buses (daisy chaining; synchronous and asynchronous; point-to-point; PCI, PCIe); IO fundamentals: handshaking, buffering, programmed IO, interrupt driven IO; Interrupt handling mechanism, Buses: protocols, arbitration, direct memory access.

Texts:

1. David A. Patterson and John L. Hennesy, Computer Organization and Design: The Hardware Software Interface, ARM Edition, 4th edition, Elsevier India, 2010.

References:

1. W. Stalling, Computer Organization and Architecture, PHI Publication
2. J.P. Hayes, Computer Architecture and Organization, Mc Graw Hill
3. A.S. Tanenbaum, Structured Computer Organization, PHI Publication

CS2031	Computer Networks	3-1-0-4

Network Basics: Evolution of computer networks; Network Models, Network Media, LAN, MAN and WAN, needs and goals of networking topology, network architecture, need for protocols, OSI Reference Model, layer services, primitives and service access points Data link layer: Framing, HDLC, PPP, sliding window protocols, medium access control, Token Ring, Wireless LAN; Virtual circuit switching: Frame relay, ATM; Network Layer: Internet addressing, IP, ARP, ICMP, CIDR, routing algorithms (RIP, OSPF, BGP); Transport Layer: UDP, TCP, flow control, congestion control; Introduction to quality of service; Application Layer: DNS, Web, email, authentication, encryption.

Lab: Unix network measurement and analysis tools, Wireshark, Socket interface and programming, RPC, RMI, HTML, HTTP, CGI, XML, Assignments using Network Simulators

Text:

1. Andrew S. Tanenbaum, 'Computer Networks', Prentice Hall

References:

1. Forouzan, Data Communications and Networking, Tata Mcgraw Hill
2. Stevens, UNIX Network Programming, Volume 1: Networking APIs: Sockets and XTI, 2nd Ed, Prentice Hall
3. Panwar, Mao, Ryoo, and Li, TCP/IP Essentials: A Lab-based Approach, Cambridge Press

HS30XX	HSS Elective - II	3-0-0-3

PE30XX	Professional Elective - I	3-0-0-3

CSXXXX	Computer Networks Lab	0-0-2-1

CSXXXX	Compiler Design Lab	0-0-2-1

SEMESTER-VI

6th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
VI	CS3071	Computer Graphics	3	0	0	3
VI	CS4082	Data Science – II	3	0	0	3
VI	CS3052	Machine Learning - I	3	0	0	3
V	CS3023	Optimization Techniques	3	0	0	3
VI	PE30XX	Professional Elective – II	3	0	0	3

VI	OE30XX	Open Elective - I	3	0	0	3
VI	CSXXXX	Computer Graphics Lab	0	0	2	1
VI	CS3201	Project - I	0	1	4	3
		Total	**18**	**1**	**6**	**22**
		Contact Hours / Week	**25**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	3	10	3	3	3

CS3071	COMPUTER GRAPHICS	3-0-0-3

Introduction: Graphics input and output devices; Raster scan and random scan devices.

Output primitives: Points, lines; Line/circle/ellipse-drawing algorithms.

Filled area primitives: Scan line polygon fill algorithm; Boundary-fill and flood-fill algorithms.

2D geometrical transformation: Translation, rotation, scaling, reflection, shear; Matrix representations.

2D viewing: Viewing pipeline; Viewing coordinate reference frame; Window-viewport coordinate transformation; Line/polygon, clipping algorithms.

3D object representation: Polygon surfaces and quadric surfaces: Spline representation; Hermite, Bezier and BSpline curve representations; Bezier and B-Spline surfaces; Polygon rendering methods. 3D geometrical transformation and viewing.

Visible surface determination: Visible line and surface determination methods; Depth cueing. Graphics Architecture: GPU; Graphics pipeline; DirectX, OpenGL.

Text Books:

1. Donald D. Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, 4th Edition, Pearson Education, 2014.

Reference Books:

1. Peter Shirley, Michael Ashikhmin and Steve Marschner, Fundamentals of Computer Graphics, 3rd Edition, CRC Press, 2009.
2. Sumanta Guha, Computer Graphics through OpenGL: From Theory to Experiments, 2nd Edition, CRC Press, 2014.
3. John L. Hennesy and David A. Patterson, Computer Architecture: A Quantitative Approach, 5th Edition, Chapter 4 (Data-Level Parallelism in Vector, SIMD, and GPU Architectures), Elsevier India, 2012.

CS4082	DATA SCIENCE II	3-0-0-3

Data Science Applications in various domains, Challenges and opportunities, tools for data scientists,

Recommender systems – Introduction, methods, application, challenges.

Time series data – stock market index movement forecasting. Supply Chain Management – Real world case study in logistics.

Data Science in Education, Social media.

Data Science in Healthcare, Bioinformatics

Case studies in data optimization using Python.

Textbooks:

1. Aakanksha Sharaff, G.K.Sinha , "Data Science and its applications ", CRC Press, 2021. 2. Q. A. Menon, S. A. Khoja, "Data Science: Theory, Analysis and Applications", CRC Press, 2020.

CS3052	MACHINE LEARNING - I	3-0-0-3

Definitions, goals and history of Machine Learning; Introduction, linear classification; Classification errors; Regression Techniques

Supervised learning: generative/discriminative learning, parametric/non-parametric learning); decision trees, ML and MAP Estimates, K-nearest neighbor, Naive Supervised learning algorithms: Gradient descent, support vector machines, kernels, artificial neural networks, Bayesian networks

Unsupervised learning: K-means clustering, Gaussian mixture models, learning with partially observable data (EM); Dimensionality reduction and principal component analysis; learning theory (bias/variance trade-offs; VC theory; large margins)

Model selection and feature selection; Introduction to Markov decision processes, Applications of machine learning: Spam email identification, handwritten digit classification

Textbooks:

1. T. M. Mitchell, Machine Learning, McGraw-Hill, 2013.

2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2013.

Reference Books:

1. S. Theodoridis and K. Koutroumbas. Pattern Recognition. Academic Press, 2009.

2. S. Haykin. Neural Networks: A Comprehensive Foundation. Prentice-Hall of India, New Delhi, 2007.

3. T. Hastie, R. Tibshirani, J Friedman, Elements of Statistical Learning, Springer, 2009

CS3023	OPTIMIZATION TECHNIQUES	3-0-0-3

Linear programming problem: formulation and geometric ideas, simplex algorithm, duality, transportation and assignment problem, Integer programming problems; Nonlinear optimization: method of Lagrange multipliers, Karush-Kuhn-Tucker theory, numerical methods for nonlinear optimization; Convex optimization and quadratic programming; Applications of linear, integer and quadratic programming to various areas of science and engineering.

Text Books:

1. S. Chandra, Jayadeva, A. Mehra, Numerical Optimization with Applications, 1st Edition, Narosa Publishing House, 2009.

Reference Books:

1. John J. Jarvis, Mokhtar S. Bazaraa, Hanif D. Sherali, Linear Programming and Network Flows, 4th Edition, John Wiley & Sons, 2010.
2. Hamdy A. Taha. Operation Research: An Introduction, 9th Edition, Prentice Hall, 2011.
3. D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, 3rd Edition, Springer, 2008.

PE30XX	Professional Elective - II	3-0-0-3

OE30XX	Open Elective - I	3-0-0-3

CSXXXX	Computer Graphics Lab	0-0-2-1

CS3201	Project-I	0-1-4-3

The aim of this project-based learning course is to implement and integrate concept/courses covered till 4th semester including Computer organisation, Database, Network, Operating systems, Algorithm, Software engineering etc. Do not encourage students to implement machine learning based project in this course.

Permissible implementation environments are *NIX, C, C++, Go, Octave, Scilab, Java, JavaScript, PhP, HTML/CSS.

SEMESTER-VII

7th Semester

Sem.	Course Code	Course Name	L	T	P	C
VII	CS4035	Computer and Network Security	3	1	0	4
VII	CS4054	Machine Learning - II	3	0	0	3
VII	PE30XX	Professional Elective - III	3	0	0	3
VII	OE30XX	Open Elective - II	3	0	0	3
VII	CSXXXX	Project – III	0	1	4	3
VII	CS4204	Internship	0	1	2	2
		Total	**12**	**2**	**6**	**18**

					Contact Hours / Week	**20**	
Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	0	6	3	3	5

CS4035	COMPUTER AND NETWORK SECURITY	3-1-0-4

Objectives of cryptography, Basic cryptographic primitives, Cryptanalysis, Symmetric and Asymmetric key cryptography, stream cipher (Based on LFSR) and block cipher (AES), Public key encryption (RSA, Rabin and ElGamal), Digital signature, Entity authentication, Key Exchange (Diffie Hellman), Key distribution, Lightweight cryptography and its application.

Attacks and countermeasures: Buffer overflow attacks, Internet worms, viruses, spyware, Spam, phishing, botnets, denial of service, Web security, OWASP top ten, Wireless security.

Security and Privacy: Physical Media security, LAN security, TCP/IP and DNS security, routing protocol security, Firewalls and intrusion detection systems, Signature and Anomaly Detection, Traffic Analysis, Operational Network Security, Intrusion prevention system.

Text Books:

1. Behrouz A. Forouzan, Introduction to Cryptography and Network Security, McGraw-Hill 1st edition, 2008.
2. W. Stallings, Cryptography and Network Security: Principles and Practice, 5th Ed, Prentice Hall, 2011.

Reference Books:

1. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography CRC Press, October 1996, Fourth Printing (July 1999).
2. Kaufman, Perlman, and Speciner, Network Security (2nd edition), Prentice Hall (2002).

CS4054	MACHINE LEARNING - II	3-0-0-3

Theoretical foundations of ML: PAC learning, uniform convergence, Representational capacity, overfitting, underfitting, hyperparameter search, VC-Dimension, Loss Functions, Choosing loss functions: MLE, cross entropy Neural Networks and Training: Neural networks, unstable gradients, initialization strategies, non-saturating activation functions, batch normalization, Backpropagation: ill-conditioning; optimizing backpropagation: momentum, adaptive learning rates; regularization; local minima; model identifiability; saddle points

Fully Connected Neural Networks for MNIST, Convolutional Neural Networks, CNN for MNIST, CIFAR-10 and Adversarial attacks, Fast Gradient Sign Method attack for CNN for CIFAR 10, Introduction to Computer Vision Recurrent Neural Networks, Recurrent Neural Networks for Sequence Learning, Understanding LSTM Networks,

Examples of RNN and LSTM: Language Models, Machine Translation, Question Answering, Chatbots.

Introduction to autoencoders, Generative Models – Variational Autoencoders, Examples of Autoencoders and Variational Autoencoders, Generative Adversarial Networks, Introduction to reinforcement learning, Markov Decision Processes: Policy evaluation, policy iteration, value iteration.

Textbooks:

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016

Reference Books:

1. Avrim Blum, John Hopcroft and Ravi Kannan: Foundations of Data Science, Cambridge University Press 2021
2. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola: Dive into Deep Learning, 2022 Available Here
3. Richard S. Sutton and Andrew G. Barto: Reinforcement Learning: An Introduction, MIT Press (2nd ed) 2018 Available Here
4. Aurélien Géron: Hands-On Machine Learning with Scikit-Learn, Keras and Tensorflow (2nd ed), O'Reilly 2019
5. Francois Chollet: Deep Learning with Python, Manning Publications 2017
6. Stuart J Russell and Peter Norvig: Artificial Intelligence: A Modern Approach, Pearson (3rd ed) 2016

PE30XX	Professional Elective - III	3-0-0-3

OE30XX	Open Elective - II	3-0-0-3

CSXXXX	Project - III	0-1-4-3

CS4204	INTERNSHIP	0-1-2-2

Guidelines for Internship

Employers are increasingly prioritizing experience when picking students from academic institutions. Keeping this in view, students are encouraged to attend summer internship after 4th and 6th Semester. They are also encouraged to attend training or skill development program after 2nd semester. However, the training or skill development programs will not be considered as internship. A maximum of three credits will be awarded at the end of the internship (that is in 7th semester). Students are encouraged to read the following points in the context of internship.

Organization: Students are encouraged to opt a reputed IT/Electronics related industry or academic/ research institutions for their internship. The term reputed IT/Electronics related industry refers to an organization, who have recently introduced a disruptive sustainable business model. It may be start-ups or an established company. In case of the start-ups, the company must have a valid registration number according to the Company ACT (Country of origin). The term reputed academic/ research institutions refers to an academic or research organization either recognized as Institute of National Importance or organizations with NIRF ranking less than 100 if the organization is located in India. If the organization is located outside of India the times higher education ranking shall be less than 800. Internship in general should be outside the IIIT Senapati, Manipur only. In case of students are interested to do specific research work with any faculty member of IIIT Senapati, Manipur, they are encouraged to do so only during the semester as mini project but not in the summer vacation.

Duration: During the entire B.Tech. Program attending a minimum of 8 weeks of internship is mandatory. They might attend multiple internships in multiple organizations or one internship of at-least 8 weeks long in one organization. However, the minimum duration of each internship will be 4 weeks (in one organization), if students are opting for multiple internships. They must finish the 8-weeks internship program before enrolling in 7th semester. Students normally have two summer vacations of approximately two months each to complete the internship and one summer vaccination to complete the training and skill development program of their own. Mode of internship: No restrictions are there regarding the mode of the internship. It may be online or offline. However, the preferred mode of internship is offline.

Assistance: The single point of contact for Internship is: Faculty-in-Charge, Training and Placement Cell, IIIT Manipur, training@iiitmanipur.ac.in. Students may also contact the mentor faculty for any other assistance related to the internship.

Documents required to apply: Academic section of the institute will provide the certificates (if required, including No-objection-Certificate, Bonafide Certificate) to apply for the internship. However, students may approach any faculty member of their choice for the letter of recommendation (if required).

Report: At the end of the internship, students need to submit an internship report (Hardcopy, 40-60 Page long, template may download from http://iiitmanipur.ac.in/pages/essentialInfo.php) duly signed by the supervisor/ mentor appointed by the industry to the Head of Department along with the internship offer-letter. In case of multiple internships, they need to submit multiple reports and multiple offer letters. The internship report must include a certificate from the supervisor/ mentor stating that the work done during the internship is genuine and is not copied from any other sources. The name of the supervisor/ mentor, designation, name of the organization, email ID and phone-number should be vivid on the certificate. Each department will form a committee to evaluate the internship reports the first week of the seventh semester.

Evaluation: Students need to present the work done during internship(s) in the first week of beginning of the seventh semester in-front of a committee formed by the department; the committee will also evaluate the internship reports and will award grades.

SEMESTER-VIII

8th Semester						
Sem.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
VIII	CS4205	Industry/ Research Internship	0	1	22	12
		Total	**0**	**1**	**22**	**12**
		Contact Hours / Week	**23**			

Total Course Credit	**Humanities & Social Science (HS)**	**Basic Science (BS)**	**Basic Engineering (BE)**	**Professional Core (PC)**	**Professional Elective (PE)**	**Open Elective (OE)**	**Internship / Project**
Credit	0	0	0	0	0	0	12

Professional Elective-I (PE-I)

Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
PEXXXX	Distributed Systems	3	0	0	3
PEXXXX	Advanced Data Structure and Algorithm	3	0	0	3
PEXXXX	Principle of Programming Language	3	0	0	3
PEXXXX	HCI	3	0	0	3
PEXXXX	Advance Web Technology	3	0	0	3

PEXXXX	**DISTRIBUTED SYSTEMS**	**3-0-0-3**

Introduction, design issues; Naming, resolution; Process and threads in distributed system, code migration; Clock synchronization; Global state, election;

Distributed mutual exclusion, token and non-token based algorithms; Distributed deadlock prevention, avoidance, detection, resolution;

Distributed shared memory, memory coherence; Distributed file system, sharing semantics, caching, replication, fault-tolerance, atomicity; Distributed scheduling, load distribution, balancing, sharing;

Consistency and replication, data and client-centric models; Failure and recovery, synchronous and asynchronous check point, message logging; Fault tolerance, commit protocols, failure resilient processes, group membership; Security, secure channels, access control matrix.

Text book:

2. Distributed Systems: Concepts and Design, George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, 5th Ed., Addison-Wesley/Pearson Education

Reference Book:

1. Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum and Maarten Van Steen, 2nd Ed, Prentice-Hall/Pearson Education
2. Distributed Systems: Computing over Networks, Joel M. Crichlow, 2nd Ed, Prentice-Hall/Pearson Education

PEXXXX	ADVANCED DATA STRUCTURE AND ALGORITHM	3-0-0-3

Binary Tree, expression trees, Binary tree traversals, applications of trees Huffman Algorithm, Balanced Trees, AVL Tree, B-Tree, Splay Trees, Heap, Heap operations- Binomial & Fibonacci Heaps, Suffix trees.

Representation of graph, Graph Traversals, Depth-first and breadth-first traversal, Applications of graphs, Topological sort, shortest-path algorithms, Dijkstras algorithm, Bellman-Ford algorithm, Floyd's Algorithm, minimum spanning tree, Prim's and Kruskal's algorithms.

Backtracking, N-Queen's Problem, Branch and Bound, Assignment Problem, P & NP problems, NPcomplete problems, Approximation algorithms for NP-hard problems, Traveling salesman problem, Amortized Analysis.

String matching, Approximation algorithms, Stable matching, Number theoretic algorithms

Reference Books:

1. Thomas Cormen, Charles Leiserson, Ronald Rivest and Clifford Stein, Introduction to Algorithms
2. S. Dasgupta, C.H. Papadimitriou, and U.V. Vazirani, Algorithms, Mcgraw-Hill, 2006
3. Steven Skiena, The Algorithm Design Manual
4. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++

PEXXXX	PRINCIPLE OF PROGRAMMING LANGUAGE	3-0-0-3

Preliminary Concepts: Reasons for Studying Concepts of Programming Languages, Programming Domains, Language Evaluation Criteria, Influences on Language Design, Language Categories, Language Design Trade-Offs, Implementation Methods, Programming Environments

Syntax and Semantics: General Problem of Describing Syntax and Semantics, Formal Methods of Describing Syntax, Attribute Grammars, Describing the Meanings of Programs

Names, Bindings, and Scopes: Introduction, Names, Variables, Concept of Binding, Scope, Scope and Lifetime, Referencing Environments, Named Constants

Data Types: Introduction, Primitive Data Types, Character String Types, User Defined Ordinal Types, Array, Associative Arrays, Record, Union, Tuple Types, List Types, Pointer and Reference Types, Type Checking, Strong Typing, Type Equivalence

Expressions and Statements: Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short Circuit Evaluation, Assignment Statements, Mixed-Mode Assignment

Control Structures – Introduction, Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands.

Subprograms and Blocks: Fundamentals of Sub-Programs, Design Issues for Subprograms, Local Referencing

Environments, Parameter Passing Methods, Parameters that Are Subprograms, Calling Subprograms Indirectly, Overloaded Subprograms, Generic Subprograms, Design Issues for Functions, User Defined Overloaded Operators, Closures, Coroutines

Implementing Subprograms: General Semantics of Calls and Returns, Implementing Simple Subprograms, Implementing Subprograms with Stack-Dynamic Local Variables, Nested Subprograms, Blocks, Implementing Dynamic Scoping

Abstract Data Types: The Concept of Abstraction, Introductions to Data Abstraction, Design Issues, Language Examples, Parameterized ADT, Encapsulation Constructs, Naming Encapsulations

Concurrency: Introduction, Introduction to Subprogram Level Concurrency, Semaphores, Monitors, Message Passing, Java Threads, Concurrency in Function Languages, Statement Level Concurrency. Exception Handling and Event Handling: Introduction, Exception Handling in Ada, C++, Java, Introduction to Event Handling, Event Handling with Java and C#.

Functional Programming Languages:Introduction, Mathematical Functions, Fundamentals of Functional Programming Language, LISP, Support for Functional Programming in Primarily Imperative Languages, Comparison of Functional and Imperative Languages

Logic Programming Language: Introduction, an Overview of Logic Programming, Basic Elements of Prolog, Applications of Logic Programming.

Scripting Language: Pragmatics, Key Concepts, Case Study: Python – Values and Types, Variables, Storage and Control, Bindings and Scope, Procedural Abstraction, Data Abstraction, Separate Compilation, Module Library. (Text Book 2).

TEXT BOOKS:

1. Concepts of Programming Languages Robert. W. Sebesta 10/E, Pearson Education.

2. Programming Language Design Concepts, D. A. Watt, Wiley Dreamtech, 2007.

REFERENCE BOOKS:

1. Programming Languages, 2nd Edition, A.B. Tucker, R. E. Noonan, TMH.

2. Programming Languages, K. C. Louden, 2nd Edition, Thomson, 2003

PEXXXX	**HUMAN COMPUTER INTERACTION (HCI)**	**3-0-0-3**

HCI foundation: history, human abilities, state of the art in computing technology, interaction styles and paradigms; Design process: interaction design basics, HCI in software process, design rules and guidelines, implementation support (UI software), universal design; Interaction styles: direct manipulation, WIMP, web interface, natural language interaction; Evaluation techniques; Models in HCI: formal models, linguistic models, cognitive models (KLM/GOMS), cognitive architectures, hybrid models; Task analysis; Dialogue design; Advanced

topics (overview) pervasive computing, CSCW, virtual reality, tangible user interface, multimedia.

Reference Books:

1. A. Dix, J. Finlay, G. D. Abowd and R. Beale, Human Computer Interaction, Pearson Education,
2. C. Stephanidis (ed.), User Interface for All: Concepts, Methods and Tools. Lawrence Erlbaum Associates
3. J. M. Caroll (ed.), HCI Models, Theories and Frameworks: Towards a Multidisciplinary Science (Interactive Technologies), Morgan Kauffman
4. W. O Galitz, The Essential Guide to User Interface Design, John Wiley Sons, Inc.
5. B. Shneiderman, Designing the User Interface, Addison Wesley

PEXXXX	ADVANCE WEB TECHNOLOGY	3-0-0-3

Professional Elective-II (PE-II)

Code	Course Title	Hours per week			Credits
		L	T	P	
PEXXXX	Software Testing	3	0	0	3
PEXXXX	High Performance Computing	3	0	0	3
PEXXXX	Data Mining and Warehousing	3	0	0	3
PE3033	Cyber Security	3	0	0	3

PEXXXX **SOFTWARE TESTING** **3-0-0-3**

INTRODUCTION: Testing as an Engineering Activity – Testing as a Process – Testing Maturity Model- Testing axioms – Basic definitions – Software Testing Principles – The Tester‘s Role in a Software Development Organization – Origins of Defects – Cost of defects – Defect Classes – The Defect Repository and Test Design – Defect Examples- Developer/Tester Support of Developing a Defect Repository.

TEST CASE DESIGN STRATEGIES: Test case Design Strategies – Using Black Box Approach to Test Case Design – Boundary Value Analysis – Equivalence Class Partitioning – State based testing – Cause-effect graphing – Compatibility testing – user documentation testing – domain testing - Random Testing – Requirements based testing – Using White Box Approach to Test design – Test Adequacy Criteria – static testing vs. structural testing – code functional testing – Coverage and Control Flow Graphs – Covering Code Logic – Paths – code complexity testing – Additional White box testing approaches- Evaluating Test Adequacy Criteria.

LEVELS OF TESTING: The need for Levels of Testing – Unit Test – Unit Test Planning – Designing the Unit Tests – The Test Harness – Running the Unit tests and Recording results – Integration tests – Designing Integration Tests – Integration Test Planning – Scenario testing – Defect bash elimination System Testing – Acceptance testing – Performance testing – Regression Testing – Internationalization testing – Ad-hoc testing – Alpha, Beta Tests – Testing OO systems – Usability and Accessibility testing – Configuration testing –Compatibility testing – Testing the documentation – Website testing.

TEST MANAGEMENT: People and organizational issues in testing – Organization structures for testing teams – testing services – Test Planning – Test Plan Components – Test Plan Attachments – Locating Test Items – test management – test process – Reporting Test Results – Introducing the test specialist – Skills needed by a test specialist – Building a Testing Group- The Structure of Testing Group- .The Technical Training Program.

TEST AUTOMATION: Software test automation – skills needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation – Test metrics and measurements – project, progress and productivity metrics.

TEXT BOOKS:

1. Srinivasan Desikan and Gopalaswamy Ramesh, ―Software Testing – Principles and Practices‖, Pearson Education, 2006.
2. Ron Patton, ―Software Testing‖, Second Edition, Sams Publishing, Pearson Education, 2007. AU Library.com

REFERENCES:

1. Ilene Burnstein, ―Practical Software Testing‖, Springer International Edition, 2003.
2. Edward Kit,‖ Software Testing in the Real World – Improving the Process‖, Pearson Education, 1995.
3. Boris Beizer,‖ Software Testing Techniques‖ – 2nd Edition, Van Nostrand Reinhold, New York, 1990.
4. Aditya P. Mathur, ―Foundations of Software Testing _ Fundamental Algorithms and Techniques‖, Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008.

PEXXXX	**HIGH PERFORMANCE COMPUTING**	**3-0-0-3**

Parallel Processing Concepts; Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation; Parallel architectures: superscalar architectures, multi- core, multi-threaded, server and cloud; Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms; Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE; Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

HPC programming assignments: Hands on experiment and programming on parallel machine and HPC cluster using Pthread, OpenMP, MPI, Nvidia Cuda and Cilk. Also there will be some hands on experiments on standard
multiprocessor simulator or cloud simulator.

Reference Books:

1. Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers (1st ed.). CRC Press, Chapman amp;amp; Hall/CRC Computational Science, India, 2010

2.Vipin Kumar , Ananth Grama , Anshul Gupta , George Karypis. Introduction to Parallel Computing (2nd ed.). Pearson India . 2003.

3.John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach (5th ed.). Elsevier India Pvt. Ltd. 2011.

4.David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.

5.Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011

PEXXXX	**DATA MINING AND WAREHOUSING**	**3-0-0-3**

Data Mining: Introduction, related technologies - Machine Learning, DBMS, OLAP, Statistics; Goals; Stages of the Data Mining Process, Knowledge Representation Methods; Applications; knowledge representation; Representing input data and output knowledge; Visualization techniques; Attribute-oriented analysis, Attribute generalization, Attribute relevance , Class comparison, Statistical measures

Association Analysis: Association Analysis: Problem Definition, Frequent Item set Generation, Rule generation. Alternative Methods for Generating Frequent Item sets, FP-Growth Algorithm, Evaluation of Association Patterns.

Classification: Decision Trees Induction, Method for Comparing Classifiers, Rule Based Classifiers, Nearest Neighbor Classifiers, Bayesian Classifiers.

Clustering Analysis: Overview, K-Means, Agglomerative Hierarchical Clustering, DBSCAN, Cluster Evaluation, Density-Based Clustering, Graph- Based Clustering, Scalable Clustering Algorithms.

Data Warehousing & modeling: Basic Concepts: Data Warehousing: A multitier Architecture, Data warehouse models: Enterprise warehouse, Data mart and virtual warehouse, Extraction, Transformation and loading, Data Cube: A multidimensional data model, Stars, Snowflakes and Fact constellations: Schemas for multidimensional Data models, Dimensions: The role of concept Hierarchies, Measures: Their Categorization and computation, Typical OLAP Operations.

Data warehouse implementation: Efficient Data Cube computation: An overview, Indexing OLAP Data: Bitmap index and join index, Efficient processing of OLAP Queries, OLAP server Architecture ROLAP versus MOLAP Versus

HOLAP.

Reference Books:

1. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0-12-088407-0

PE3033	CYBER SECURITY	3-0-0-3

Introduction to Cyber security

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Cyber crime and Cyber law

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cyber-criminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offenses, Organizations dealing with Cyber crime and Cyber security in India, Case studies.

Social Media Overview and Security

Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

E-Commerce and Digital Payments

Definition of E-Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorized banking transactions. Relevant provisions of Payment Settlement Act,2007

Digital Devices Security, Tools and Technologies for Cyber Security

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Text book:

Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.

Reference Book:

1. Cyber Crime Impact in the New Millennium, by R. C Mishra , Auther Press. Edition 2010
2. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform
3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers

4. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Ed, Wiley India Pvt. Ltd.
5. Fundamentals of Network Security by E. Maiwald, McGraw Hill.

Professional Elective-III (PE-III)

Code	Course Title	Hours per week			Credits
		L	T	P	
PEXXXX	Introduction to Intelligent System	3	0	0	3
PEXXXX	Dependable Artificial Intelligence	3	0	0	3
PEXXXX	Advanced Artificial Intelligence	3	0	0	3

PEXXXX	**INTRODUCTION TO INTELLIGENT SYSTEM**	**3-0-0-3**

PEXXXX	**DEPENDABLE ARTIFICIAL INTELLIGENCE**	**3-0-0-3**

PEXXXX	**ADVANCED ARTIFICIAL INTELLIGENCE**	**3-0-0-3**

Open Elective-I (OE-I)

Code	Course Title	Hours per week			Credits
		L	T	P	
OEXXXX	Deep Learning	3	0	0	3
OEXXXX	Computer Vision	3	0	0	3
OEXXXX	Audio and Speech Processing	3	0	0	3

OEXXXX	**DEEP LEARNING**	**3-0-0-3**

INTRODUCTION : Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates

DEEP NETWORKS : History of Deep Learning- A Probabilistic Theory of Deep LearningBackpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks-Convolutional Networks- Generative Adversarial Networks (GAN), Semisupervised Learning

DIMENTIONALITY REDUCTION Linear (PCA, LDA) and manifolds, metric learning Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization

OPTIMIZATION AND GENERALIZATION : Optimization in deep learning Non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs Deep Reinforcement Learning - Computational Artificial Neuroscience

CASE STUDY AND APPLICATIONS : Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec -

Joint Detection-Bioinformatics- Face Recognition- Scene Understanding Gathering Image Captions.

Reference Books:

1. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
2. Deng Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
4. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

OEXXXX	**COMPUTER VISION**	**3-0-0-3**

INTRODUCTION: Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image, Analysis, Bio-metrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.

IMAGE FORMATION MODELS: Monocular imaging system , Orthographic Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading , Photometric Stereo, Depth from Defocus , Construction of 3D model from images.

IMAGE PROCESSING, FEATURE EXTRACTION, AND MOTION ESTIMATION: Image pre-processing, Image representations (continuous and discrete) , Edge detection, Regularization theory , Optical computation ,Stereo Vision , Motion estimation , Structure from motion.

SHAPE REPRESENTATION AND SEGMENTATION: Contour based representation, Region based representation, De- formable curves and surfaces, Snakes and active contours, Level set representations, Fourier, and wavelet descriptors , Medial representations , Multi-resolution analysis, Object recognition.

IMAGE UNDERSTANDING AND COMPUTER VISION APPLICATIONS: Pattern recognition methods, Face detection, Face recognition, 3D shape models of faces Application: Surveillance foreground-background separation human gait analysis Application: In-vehicle vision system: locating roadway road markings identifying road signs locating pedestrians.

Reference Books:

1. D. Forsyth and J. Ponce, Computer Vision - A modern approach, Prentice Hall
2. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA), Springer, 2010
3. E. R. Davies, , Computer Machine Vision, Academic Press, 2012
4. Dana H. Ballard, Christopher M. Brown, Computer Vision, Prentice Hall 1st Edition (May 1, 1982) , ISBN-978-0131653160
5. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004. 28
6. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
7. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

OEXXXX	**AUDIO AND SPEECH PROCESSIN**	**3-0-0-3**

Speech production, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis, Speech coding, Speech recognition, Speech enhancement, Text to speech conversion. Signal Processing Models of Audio Perception, Psycho-acoustic analysis, Spatial Audio Perception and rendering, Audio compression methods, Parametric Coding of Multichannel audio, Transform coding of digital audio, audio quality analysis.

Online Tutorials and Resources:

1. HTML5, CSS3, JavaScript, PHP Tutorials http://www.w3schools.com
2. jQuery Tutorial https://learn.jquery.com
3. MongoDB Tutorial and Certifications https://university.mongodb.com
4. Express https://expressjs.com/en/starter/installing.html
5. React Tutorialhttps://reactjs.org/tutorial/tutorial.html 6. Node https://nodeschool.io

Reference Books:

1. L. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall
2. L. Rabiner and R. W. Schafer, Digital Processing of Speech Signals, Prentice Hall
3. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, 2001, Prentice Hall

Open Elective-II (OE-II)

Code	**Course Title**	**Hours per week**			**Credits**
		L	**T**	**P**	
OEXXXX	Image Processing	3	0	0	3
OEXXXX	Quantum Computing	3	0	0	3
OEXXXX	Block chain Technologies	3	0	0	3

OEXXXX	Soft Computing	3	0	0	3
OEXXXX	Pattern Classification	3	0	0	3
OEXXXX	IOT	3	0	0	3

OEXXXX	**IMAGE PROCESSING**	**3-0-0-3**

OEXXXX	**QUANTUM COMPUTING**	**3-0-0-3**

Brief review of linear algebra and probability preliminaries; Basic notions: Qubits, Dirac's notation, operations on qubits, unitary operators and matrix representations. Single qubit gates - Hadamard, Rotation, NOT and Phase gates. Multi-qubit gates – CNOT, Toffoli. SWAP test.; Quantum circuits, Church-Turing hypothesis and extensions, Universality of quantum circuits; No cloning theorem, Relation to probabilistic computation, Bell pair, EPR paradox

Quantum Oracles, Quantum algorithms for promise problems: Deutsch-Jozsa, Bernstein-Vazirani and Simon; Phase estimation, Eigenvalue estimation and Quantum Fourier Transforms; Searching in an unstructured database: Grover search – geometric and diffusion views. Quantum walks. Optimality of Grover search.

Shor's algorithm for factoring. Order finding, Period finding, Reductions; Quantum algorithms for hidden subgroup, element distinctness, collision detection and triangle counting problems.

Lower bounds. Adversary method, polynomial method, quantum query complexity; Quantum Complexity Theory. Complexity class BQP and its connections to classical computation; Advanced topics in quantum computation like Noisy intermediate scale quantum models, quantum error correction and quantum proofs for classical theorems

Text book:

1. Quantum Computation and Quantum Information by Michael A. Nielsen and Isaac L. Chuang
2. An Introduction to Quantum Computing by Phillip Kaye, Raymond Laflamme and Michele Mosca

Reference Book:

1. Quantum Computing since Democritus by Scott Aaronson
2. •Quantum Algorithms via Linear Algebra: A Primer by Richard J. Lipton and Kenneth W. Regan

OEXXXX	**BLOCKCHAIN TECHNOLOGIES**	**3-0-0-3**

History, Types, Consensus – Decentralization using Blockchain, Blockchain and Full Ecosystem, Decentralization – Platforms for Decentralization; Bitcoin – Digital Keys and Addresses, Transactions, Mining, Bitcoin Networks and Payments, Wallets, Alternative Coins, Theoretical Limitations, Bitcoin Limitations – Name Coin, Prime Coin, Zcash, Smart Contracts, Ricardian Contracts.

The Ethereum Network, Components of Ethereum Ecosystem, Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule, Supporting Protocols, Solidity Language.

Introduction to Web3, Contract Deployment, POST Requests, Development frameworks, Hyperledger as a protocol, The Reference Architecture – Hyperledger

Fabric – Distributed Ledger – Corda

Kadena, Ripple-Rootstock, Quorum, Tendermint, Scalability, Privacy, Other Challenges, Current Research on Blockchain, Notable Projects – Miscellaneous tools.

Text book:

1. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Princeton University Press

Reference Book:

1. Mastering Bitcoin, Andreas Antonopoulos, Satoshi Nakamoto, O'Reilly Publishing

OEXXXX **SOFT COMPUTING** **3-0-0-3**

Introduction of Soft Computing, Soft computing vs. hard computing, applications of soft Computing, Various types of Soft Computing techniques, Neuron, Nerve structure and Synapse, Neural network architecture, single layer and multilayer feed-forward networks, McCulloch Pitts neuron model, perceptron model, MLP, back propagation learning methods, effect of learning rule coefficient.

Evolutionary Computation, Historical Development of EC, genetic Algorithms, Genetic programming, Evolutionary Strategies, Evolutionary programming, features of Evolutionary computation, Advantages and Applications of Evolutionary Computation. Basic concept of Genetic algorithm, Conventional Optimization and Search Techniques, Comparison of Genetic Algorithm with Other Optimization Techniques, Advantages, Applications and Limitations of Genetic Algorithm.

Terminologies and Operators of GA, Introduction to basic terms: Encoding, Breeding, Search Termination, Diploidy, Dominance and Abeyance. Classification of Genetic Algorithm- Simple Genetic Algorithm (SGA), Parallel and Distributed Genetic Algorithm (PGA and DGA), Parallel and Distributed Genetic Algorithm (PGA and DGA), Adaptive Genetic Algorithm (AGA), Fast Messy Genetic Algorithm (FMGA), Independent Sampling Genetic Algorithm (ISGA).

Introduction to Fuzzy Logic, Utility, Limitations, Different faces of imprecision, inexactness, Ambiguity, Undecidability, Fuzziness and certainty, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of Membership Functions, Fuzzification, and Defuzzification.

Automated Methods for Fuzzy Systems, Batch Least square and recursive Least Square Algorithms, Clustering methods, Fuzzy system Simulation, fuzzy relational equations, Fuzzy associative memories. Fuzzy Classification and pattern Recognition, Cluster analysis and validity, c-Means clustering, Single sample Identification, Multifeatured pattern recognition and Image processing.

Text Books:

1. Deepa, S.N. and Sivanandam, S.N., "Principles of Soft Computing", 2nd Edition, Wiley India, 2011.
2. Zimmermann H. J. "Fuzzy set theory and its applications" Springer international edition, 2011.

Reference Books:

1. Timothy, J. Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley India, 2010.

OEXXXX	PATTERN CLASSIFICATION	3-0-0-3

Introduction to Pattern Recognition, Tree Classifiers -Decision Trees: CART, C4.5, ID3., Random Forests. Bayesian Decision Theory. Linear Discriminants. Discriminative Classifiers: the Decision Boundary- Separability, Perceptrons, Support Vector Machines. Parametric Techniques- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics. Non -Parametric Techniques Kernel Density Estimators, Parzen Window, Nearest Neighbor Methods. Feature Selection- Data Preprocessing, ROC Curves, Class Separability Measures, Feature Subset Selection, Bayesian Information Criterion. The Curse of Dimensionality-Principal Component Analysis. Fisher Linear Discriminant, Singular Value Decomposition, Independent Component Analysis, Kernel PCA Locally Linear Embedding. Clustering-. Sequential Algorithms, Hierarchical Algorithms, Functional Optimization-Based Clustering, Graph Clustering, Learning Clustering, Clustering High Dimensional Data, Subspace Clustering, Cluster Validity Measures, Expectation Maximization, Mean Shift. Classifier Ensembles-Bagging, Boosting / AdaBoost. Graphical Models- Bayesian Networks, Sequential Models- State-Space Models, Hidden Markov Models, Context Dependent Classification. Dynamic Bayesian Networks.

Reference Books:

1. R.O. Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3. C. M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

OEXXXX	INTERNET OF THINGS (IOT)	3-0-0-3

FUNDAMENTALS OF IoT Evolution of Internet of Things - Enabling Technologies IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models Simplified IoT Architecture and Core IoT Functional Stack - Fog, Edge and Cloud in IoT Functional blocks of an IoT ecosystem Sensors, Actuators, Smart Objects and Connecting Smart Objects.

IoT PROTOCOLS IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN Network Layer: IP versions, Constrained Nodes and Constrained Networks Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks Application Transport Methods: Supervisory Control and Data Acquisition Application Layer Protocols: CoAP and MQTT.

DESIGN AND DEVELOPMENT Design Methodology - Embedded computing logic - Microcontroller, System on Chips- IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

DATA ANALYTICS AND SUPPORTING SERVICES Structured Vs Unstructured Data and Data in Motion Vs Data in Rest Role of Machine Learning No SQL Databases Hadoop Ecosystem Apache Kafka, Apache Spark Edge Streaming Analytics and Network Analytics Xively Cloud for IoT, Python Web Application Framework Django AWS for IoT System Management with NETCONF-YANG.

CASE STUDIES/INDUSTRIAL APPLICATIONS Cisco IoT system - IBM Watson IoT platform Manufacturing -

Converged Plantwide Ethernet Model (CPwE) Power Utility Industry GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things A hands-on approach, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012 (for Unit 2).
4. Jan Ho ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, ”From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence”, Elsevier, 2014.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.

HSS Elective

Course Code	Course Title	Hours per week			Credits
		L	T	P	
HS3093	Introduction to Linguistics	2	0	2	3
HS3094	Environmental Sciences	3	0	0	3
HS3095	Professional Ethics for Engineers/ Ethics and Human Values	3	0	0	3
HS3096	Principles of Management	3	0	0	3
HS3097	Entrepreneurship and Management Functions	3	0	0	3
HS3098	Organizational Behaviour	3	0	0	3
HSXXXX	Computational Linguistics	3	0	0	3
HSXXXX	Introduction of IPR	3	0	0	3
HSXXXX	Sustainable Development Goals	3	0	0	3
HSXXXX	Supply Chain and Logistic Management	3	0	0	3
HSXXXX	Consumer Behaviour and Welfare Economics	3	0	0	3
HSXXXX	Understanding Democracy and Governance in India	3	0	0	3
HS3099	Language, Cognition and Culture	3	0	0	3

HS3093	INTRODUCTION TO LINGUISTICS	2-0-2-3

Historical Linguistics, Linguistic Typology: Language universals; the major language families; types of languages in the world (isolating, agglutinating, polysynthetic etc.); languages of India

Phonetics, Phonology, Morphology: The production of speech; the organs of speech; a phonetic description of speech sounds (vowels and consonants and their place and manner of articulation); combination of speech sounds; minimal pairs; free and bound morphemes; word building strategies; inflectional and derivational morphology

Syntax, Semantics: The structure of sentences and their constituents; basic sentence patterns; the subject, verb and object/ complement; IC Analysis; word meaning and sentence relations; sense relations (synonymy, homonymy etc)

Sociolinguistics, Applied Linguistics, Neurolinguistics: What is language/ mother-other tongue?; language, society and variation; basic concepts: language/ dialect/ sociolect/ idiolect/ style/ context/ register; methods of teaching language; language and the brain

Text:

1. Murray, T. 1995.The Structure of English: Introduction to Phonetics, Phonology and Morphology. Boston: Allyn & Bacon
2. Mathews, P.H. 2003 Linguistics: A Very Short Introduction. Oxford University Press

References:

1. Fromkin, V., Rodman R. and Hyams, N. 2003. An Introduction to Language. Heinle and Thompson.
2. Radford, A., Atkinson, M., Britain, D., Clahsen, H. and Spenser, A. 2009 Linguistics: An Introduction. Cambridge University Press.
3. Additional reference material to be provided by Instructor.

HS3094	ENVIRONMENTAL SCIENCES	3-0-0-3

Environmental studies and Natural Resources:

Definition, scope and importance of environmental studies.

Natural Resources:

Renewable and non-renewable resources:

Natural resources and associated problems;

(a) Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people.

(b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.

(c) Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.

(d) Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity.

(e) Energy Resources: Growing energy needs, renewable and non- renewable energy sources, use of alternate energy sources.

Eco Systems:

Concept of an eco-system, Structure and function of an eco-system, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystems:

(a) Forest ecosystem

(b) Grass land ecosystem

(c) Desert ecosystem.

(d) Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Environmental Pollution:

Definition: Causes, effects and control measures of;

(a) Air pollution

(b) Soil pollution

(c) Marine pollution

(d) Noise pollution

(e) Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

Disaster management: Floods, earth quake, cyclone and landslides.

Social issues and the Environment:

From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection Act, Forest conservation Act, Issues involved in enforcement of environmental legislations.

Texts:

1. Textbook of Environmental studies, Erach Bharucha, UGC.
2. Fundamental concepts in Environmental Studies, D. D. Mishra, S Chand & Co Ltd.

HSXXXX PROFESSIONAL ETHICS FOR ENGINEERS/ETHICS AND HUMAN VALUES 3-0-0-3

HS3096	PRINCIPLES OF MANAGEMENT	3-0-0-3

Introduction of organisations and management, Concept of Industrial Management, Characteristics of Management, Management as an art – profession, Principles of Management, The evolution of management, Organisational environment, , Decision making- types, conditions and decision making process, Decision Making Aids.

Dimensions of P-O-L-C: Vision & Mission; Strategizing; Goal & Objectives; Organization Design, Culture, Human

Resource Management, Understanding Work Teams, Motivation, Leadership and Communication and Interpersonal Skills, foundation of Control.

Introduction to Functional areas of Management: Operations Management, Marketing Management, Financial Management.

Introduction to Entrepreneurship: Starts ups, Prospects & Challenges., Environmental Issues, CSR, Sustainability, The role of statistics for Industrial management: Simple Linear Regression and Correlation Assumptions and Properties of Least Square Estimator, Its Application by taking industrial data and its interpretations, Statistical

Software-Eview to be utilized to solve the industrial problems.

Text Books:

1. Koontz, H., and Weihrich, H., Essentials of Management: An International, Innovation and Leadership Perspective, 10th ed., McGraw Hill, 2015.
2. Robbins, SP, Bergman, R, Stagg, I, and Coulter, M, Management 7, Prentice Hall, 7th edition, 2015.
3. Richard I Levin, David S Rubin, Statistical management, 7th Edition, Prentice Hall India, 2011.
4. Kotler, P., Keller, Kevin Lane Keller et al. Marketing Management, 3rd Edition, 2016.
5. Eugene F. Brigham and Michael C. Ehrhardt, Financial Mangement: Theory and Practice, SouthWestern College Pub; 15th Edition, 2016.

Reference Books:

1. Mahadevan, B., Operations Management, Theory and Practice, Pearson Education Asia,
2. A. Aswathapa, Organizational Behaviour, 2010
3. Robert R. Reeder, Briety & Betty H. reeder, Industrial Marketing, Prentice Hall of India Pvt. Ltd, New delhi,2008.

HSXXXX	ENTREPRENEURSHIP AND MANAGEMENT FUNCTIONS	3-0-0-3

HSXXXX	ORGANIZATIONAL BEHAVIOUR	3-0-0-3

HSXXXX	COMPUTATIONAL LINGUISTICS	3-0-0-3

HSXXXX	INTRODUCTION OF IPR	3-0-0-3

HSXXXX	SUSTAINABLE DEVELOPMENT GOALS	3-0-0-3

HSXXXX	SUPPLY CHAIN AND LOGISTIC MANAGEMENT	3-0-0-3

HSXXXX	CONSUMER BEHAVIOUR AND WELFARE ECONOMICS	3-0-0-3

HSXXXX	UNDERSTANDING DEMOCRACY AND GOVERNANCE IN INDIA	3-0-0-3

HS3099	LANGUAGE, COGNITION AND CULTURE	3-0-0-3

Language evolution: Form and content; ways of thinking; role of meaning in comprehension

Cognitive and semantic issues: Structural and linguistic issues; categorization, metaphor and mental imagery; sense relations; spatial and temporal language

Socio-cultural issues: Embodiment, universalism / relativism, schemas; kinship relations

Theoretical perspectives: Various approaches and views; Separate Worlds Hypothesis; Gender Theory; Speech Act Theory; Gricean Maxims; Performative Theory etc.

Text Books:

1. A. Akmajian, R. A. Demers, A. K. Farmer, R. M. Harnish. 2001. Linguistics: An Introduction to Language and Communication. (PART II: 'Communication and Cognitive Science'). MIT Press, London.
2. Croft, W. and D.A. Cruse. 2004. Cognitive Linguistics, Cambridge University Press.
   (Select papers (Langacker, Harris, van Djik etc) to be provided by Instructor)

References:

1. Friedenberg, J. and Silverman, G. 2006. Cognitive Science: An Introduction to the Study of Mind. Sage Publications, Thousand Oaks, California.
2. Albertazzi, L. 2000. Meaning and Cognition: A Multidisciplinary Approach. John Benjamins Publishing Company.
3. Gumperz, J. and Levinson, S. C. 1996. Rethinking Linguistic Relativity. Cambridge University Press.

Sunderland, J. 2006. Language and Gender: An Advanced Resource Book. Routledge, New York.