Indian Institute of Information Technology Kalyani

Autonomous institution under MoE, Govt. Of India & Department of Information Technology & Electronics, Govt. of West Bengal, WEBEL IT Park Campus, West Bengal 741235, India

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Course Structure and Syllabus

for

4 Years B. Tech.

in

Computer Science and Engineering

Indian Institute of Information Technology Kalyani

WEBEL IT Park Campus

West Bengal 741235, India

Course Structure

1st Year (Semester: I)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credits
			L	T	P	Total	
Theoretical Papers							
1	MAC101	Mathematics - I (Linear Algebra)	3	1	0	4	4
2	PHC101	Physics	3	1	0	4	4
3	ECC101	Basic Electrical and Electronics Engineering	3	0	0	3	3
4	CSC101	Programming -I (C Language)	3	0	0	3	3
5	HUC101	English for Communication	3	0	0	3	3
6	HUC102	Humanities - I (Values & Ethics in Profession)	3	0	0	3	3
Sessional Papers							
7	CSC111	Programming-I (C Language) Laboratory	0	0	3	3	2
8	ECC111	Basic Electronics Engineering Laboratory	0	0	3	3	2
Total			**18**	**2**	**6**	**26**	**24**

1st Year (Semester: II)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credits
			L	T	P	Total	
Theoretical Papers							
1	MAC201	Mathematics-II (Probability and Statistics)	3	1	0	4	4
2	PHC201	Engineering Mechanics	3	1	0	4	4
3	ECC201	Digital Logic Design and Circuit	3	0	0	3	3
4	CSC201	Data Structures and Algorithms	3	1	0	4	4
5	HUC201	Humanities - II (Economics)	3	0	0	3	3
Sessional Papers							
6	ECC211	Digital Logic Design and Circuit Laboratory	0	0	3	3	2
7	CSC211	Data Structures and Algorithms Laboratory	0	0	3	3	2
Total			**15**	**3**	**6**	**24**	**22**

2nd Year (Semester: III)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credit
			L	T	P	Total	
Theoretical Papers							
1	MAC301	Mathematics - III (Calculus and Differential Equations)	3	1	0	4	4
2	CSC301	Computer Organization and Architecture	3	0	0	3	3
3	CSC302	Algorithms - I	3	1	0	4	4
4	CSC303	Discrete Mathematics	3	1	0	4	4
5	HUC301	Humanities - III (Psychology)	3	0	0	3	3
Sessional Papers							
6	CSC311	Computer Organization and Architecture Laboratory	0	0	3	3	2
7	CSC312	Algorithms - I Laboratory	0	0	3	3	2
8	CSC313	Programming - II Laboratory (Python)	1	0	2	3	2
Total			**16**	**3**	**8**	**27**	
						Total Credits	**24**

2nd Year (Semester: IV)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credit
			L	T	P	Total	
Theoretical Papers							
1	MAC401	Mathematics - IV (Numerical Analysis and Computing)	3	1	0	4	4
2	CSC401	Operating Systems	3	1	0	4	4
3	CSC402	Formal Languages and Automata Theory	3	0	0	3	3
4	CSC403	Object Oriented Programming (JAVA)	3	1	0	4	4
5	HUC404	IPR Law: Concepts and Applications	3	0	0	3	3
Sessional Papers							
6	CSC411	Operating Systems Laboratory	0	0	3	3	2
7	CSC412	Numerical Analysis and Computing Laboratory (R/Sci Lab)	0	0	3	3	2
8	CSC413	Programming- III Laboratory (JAVA)	0	0	3	3	2
Total			**15**	**3**	**9**	**27**	
						Total Credits	**24**

3rd Year (Semester: V)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credit
			L	T	P	Total	
Theoretical Papers							
1	CSC501	Compiler Design	3	1	0	4	4
2	CSC502	Artificial Intelligence	3	1	0	4	4
3	ECC502	Microprocessor and Microcontroller System	3	0	0	3	3
4	HUC501	Humanities - IV (Organizational Behaviour)	3	0	0	3	3
Sessional Papers							
5	CSC511	Compiler Design Laboratory	0	0	3	3	2
6	ECC512	Microprocessor and Microcontroller System Laboratory	0	0	3	3	2
7	HUC511	Soft Skill Development	0	0	3	3	2
8	CSC591	Project - I (A)	0	0	5	5	3
Total			**12**	**2**	**14**	**28**	
						Total Credits	**23**

3rd Year (Semester: VI)							
Sl No.	Code No.	Subject	Contact Periods/Week				Credits
			L	T	P	Total	
Theoretical Papers							
1	CSC601	Computer Networks	3	1	0	4	4
2	CSC602	Machine Learning	3	0	0	3	3
3	CSC603	Database Management System	3	1	0	4	4
4	CSC604	Cryptography and Network Security	3	0	0	3	3
Sessional Papers							
5	CSC611	Computer Networks Laboratory	0	0	3	3	2
6	CSC612	Machine Learning Laboratory	0	0	3	3	2
7	CSC613	Database Management System Laboratory	0	0	3	3	2
8	CSC691	Project - I (B)	0	0	5	5	3
Total			**12**	**2**	**14**	**28**	
						Total Credits	**23**

4thYear (Semester: VII)							
Sl No.	Code No.	Subject	Contact Periods/week				Credit
			L	T	P	Total	
Theoretical Papers							
1	CSC701	Algorithms - II	3	0	0	3	3
2	CSC702	Software Engineering	3	0	0	3	3
3	CSE7XX	Elective - I	3	0	0	3	3
4	CSE7XX	Elective - II	3	0	0	3	3
Sessional Papers							
5	CSC711	Algorithms - II Laboratory	0	0	3	3	2
6	CSC791	Project - II (A)	0	0	15	15	10
Total			**12**	**0**	**18**	**30**	
						Total Credits	**24**

4th Year (Semester: VIII)							
Theoretical Papers							Credits
Sl No.	Code No.	Subject	Contact Periods/Week				
			L	T	P	Total	
1	CSE8XX	Elective - III	3	0	0	3	3
2	CSE8XX	Elective - IV	3	0	0	3	3
3	CSE8XX	Elective - V	3	0	0	3	3
Sessional Papers							
4	CSC891	Project - II (B)	0	0	15	15	10
5	CSC892	Comprehensive Viva	0	0	0	0	3
Total			**9**	**0**	**15**	**24**	
						Total Credits	**22**

Total Program Credit	**24+22+24+24+23+23+24+22**	**186**

List of Elective Subjects

Sl. No.	Semester	Course Name	Course code	L-T-P	Credit
	Autumn	**CSE**			
1		Logic & Reasoning	CSE721	3-0-0	3
2		Data Analytics & Optimization Techniques	CSE722	3-0-0	3
3		Ad-Hoc and Sensor Networks	CSE723	3-0-0	3
4		Mobile Computing	CSE724	3-0-0	3
5		Cyber Law and Security	CSE725	3-0-0	3
6		Computational Number Theory	CSE726	3-0-0	3
7		Computational Complexity	CSE727	3-0-0	3
8		Computer Graphics and Multimedia	CSE728	3-0-0	3
9		Computational Geometry	CSE729	3-0-0	3
10		Computer Vision and Image Understanding	CSE730	3-0-0	3
11		Fuzzy Logic and Applications	CSE731	3-0-0	3
12		Mathematical Methods	CSE732	3-0-0	3
13		Neural Networks and Deep Learning	CSE733	3-0-0	3
14		Data Communications	CSE734	3-0-0	3
15		Digital Signal Processing	CSE735	3-0-0	3
		ECE			
1		Optical Communication	ECE721	3-0-0	3
2		Remote Sensing and GIS	ECE722	3-0-0	3
3		Modern Radar Systems	ECE723	3-0-0	3
4		Satellite Communication Systems	ECE724	3-0-0	3
5		Mixed-Signal and RF Design	ECE725	3-0-0	3
6		Principle of Nano-electronics and devices	ECE726	3-0-0	3
7		VLSI Technology	ECE727	3-0-0	3
8		Embedded System Design	ECE728	3-0-0	3
		CSE			
1	Spring	Data Mining	CSE821	3-0-0	3
2		Speech and Natural Language Processing	CSE822	3-0-0	3
3		Soft Computing	CSE823	3-0-0	3
4		Big Data Analytics	CSE824	3-0-0	3
5		Coding Theory	CSE825	3-0-0	3
6		Distributed Operating Systems	CSE826	3-0-0	3
7		Distributed Database Management System	CSE827	3-0-0	3
8		Advanced Computer Architecture	CSE828	3-0-0	3
9		Fault Tolerant Computing	CSE829	3-0-0	3
10		Real Time Systems	CSE830	3-0-0	3
11		Robotics: Machines and Control	CSE831	3-0-0	3
12		Internet of Things	CSE832	3-0-0	3
13		Blockchain Technology	CSE833	3-0-0	3
14		Information Theory and Coding	CSE834	3-0-0	3
15		Advanced Cryptography	CSE835	3-0-0	3
16		Digital and Cyber Forensics	CSE836	3-0-0	3
17		Cyber Physical Systems	CSE837	3-0-0	3
18		Cloud Computing	CSE838	3-0-0	3
19		Parallel and Distributed Computing	CSE839	3-0-0	3
20		Quantum Computing	CSE840	3-0-0	3

		ECE			
1		Multiple Input Multiple Output System	ECE821	3-0-0	3
2		Sensors and Instrumentation	ECE822	3-0-0	3
3		Adaptive Systems and Signal Processing	ECE823	3-0-0	3
4		CAD for VLSI	ECE824	3-0-0	3
5		Low power circuits and systems	ECE825	3-0-0	3
6		RF and Microwave Networks	ECE826	3-0-0	3
7		MEMs and Applications	ECE827	3-0-0	3
8		Biomedical System Engineering and Automation	ECE828	3-0-0	3
9		5G and Wireless Technology	ECE829	3-0-0	3
10		Integrated Nano photonics	ECE830	3-0-0	3
11		Mobile Communication and Fading	ECE831	3-0-0	3
12		Fiber Optics, Components and Devices	ECE832	3-0-0	3

Syllabus

for 4 years B. Tech. in

Computer Science and Engineering

SEMESTER – I

Course Title	**: MATHEMATICS – I (LINEAR ALGEBRA)**
Course Code	**: MAC101**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Solving a linear system of equations:

Geometric (row) and algebraic (column) picture of matrix equations, Gaussian elimination, LU decomposition, pivoting, round-off errors, pivoting, matrix inverse and transpose, finite difference matrices – tridiagonal and their LU decomposition.

Vector spaces:

Definitions of vector spaces and sub-spaces, column and null space of a matrix with examples, echelon and row reduced echelon form of a matrix, matrix rank and dimensionality of col space and null space, span of a vector space, basis, dimension, four fundamental subspaces related to a matrix, inverses of rectangular matrices, linear transformations.

Orthogonality:

Orthogonality of vectors, subspaces, notion of orthogonal compliment of a subspace, and orthogonality relations between the four fundamental subspaces of a matrix, Solutions to least square error problems and connection to pseudo-inverse

Projection onto a vector space as a matrix operation, projection onto a line. Minimum norm solution in the under-determined case, and connection to pseudo-inverse. Orthogonal vector and matrices. Gram-Schmidt process of orthonormalization, QR decomposition of a matrix. Hilbert spaces, function spaces and the concept of orthogonality in these spaces

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Determinants:

Properties of determinants, Geometrical interpretation of determinants, determinant of the Jacobian.

Eigenvalues and Eigenvectors:

Definition and properties of the matrix eigenvalue problem, Algebraic and geometric multiplicity of an eigenvalue, Diagonalization of a matrix and its use to compute powers of a matrix. Hermitian matrices and their properties, Spectral theorem, Unitary matrices. Change of basis and similarity transforms. Schur decomposition of a matrix

Positive definite matrices and SVD:

Idea of optimization, quadratic forms, definition of and tests for positive definite matrices, geometric interpretations, Proof of the singular value decomposition. Properties of the Singular value decomposition SVD and matrix computations; psuedo-inverses, condition number, regularization.

Reference Books:

1. G. Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press.
2. S. Lang, Linear Algebra, Springer.
3. S. Boyd, Introduction to Applied Linear Algebra, Cambridge University Press.

Course Title	**: PHYSICS**
Course Code	**: PHC101**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Introduction:

Review of Simple Harmonic Motion, Damped and Forced Oscillations, Resonance, Coupled Oscillations, Normal Modes.

Wave Motion:

Longitudinal and transverse waves, wave equation, plane waves, phase velocity, superposition, wave packets and group velocity, dispersion relations, two- and three-dimensional waves, polarisation.

Electromagnetic waves:

Maxwell's Equations, wave equation, plane electromagnetic waves, energy-momentum, Poynting's theorem, electromagnetic boundary conditions, reflection and refraction, Stokes relations.

Interference, Coherence, Young's experiment, interferometers, thin films, Fraunhofer Single Slit diffraction and Grating, dispersion, radiation.

Wave Mechanics

Failure of classical physics, review of experiments leading to wave mechanics, de Broglie waves, uncertainty principle, wave function and Schrodinger equation, probability interpretation, infinite square well, potential barrier and quantum tunnelling, qualitative summary of simple harmonic oscillator and Hydrogen atom.

Reference Books:

1. Crawford F.S. Waves, Vol. 3, Berkely Physics Series.
2. Goldstein, Classical Mechanics, Pole and Safko, Pearson Education Inc.
3. Saleh and Teich. Fundamentals of Photonics, Wiley-Interscience.
4. Griffiths D.J. Introduction to Quantum Mechanics, Pearson Education Inc.
5. Pain H. J. The Physics of Vibrations and Waves, Wiley.
6. Resnick R. Introduction to Special Relativity, John Wiley (Asia).
7. Landau L. and Lifshitz E. Mechanics, Oxford
8. Zweibach B. A First Course in String Theory, Cambridge University Press
9. Hecht E. Introduction to Optics, Addison-Wesley.
10. Feynmann Lecture series on Physics.
11. Sakurai J. J. Modern Quantum Mechanics, Benjamin-Cummings.
12. Beiser, Mahajan and Chowdary, Concepts of Modern Physics

Course Title	**: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**
Course Code	**: ECC101**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

DC Network Theorem:

Definition of electric circuit network; linear circuit, non-linear circuit, bilateral circuit, unilateral circuit; Source: AC, DC, average and RMS values, peak factor, form factor; Dependent source; Kirchhoff's law, Principle of superposition; Source equivalence and conversion; Thevenin's theorem, Norton Theorem, nodal analysis, mesh analysis, star-delta conversion; Maximum power transfer theorem with proof.

Semiconductors Diode:

Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Fermi levels; Semiconductors: intrinsic and extrinsic, energy band diagram, P-type and N-type semiconductors. Formation of P-N junction, energy band diagram, built-in-potential; Forward and Reverse biased P-N junction, formation of depletion zone, V-I characteristics, Avalanche breakdown and its reverse characteristics; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency; Filters and Regulators: Capacitor filter, π-section filter, Zener diode, idea of regulation.

Bipolar Junction Transistors:

Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, current amplification factors for CB and CE modes.

Biasing and Bias stability: Transistor Biasing and Stability: Q-point, Self Bias-CE, calculation of stability factor; Compensation techniques.

Feed Back Amplifier, Oscillators:

Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability; effect of positive feedback: instability and oscillation, condition of oscillation, Barkhausen criteria.

Operational Amplifier:

Ideal OPAMP, Differential Amplifier, CMRR, Open & Closed loop circuits, inverting & noninverting amplifiers, voltage follower/buffer circuit. Applications of Operational Amplifiers: adder, integrator & differentiator, comparator, Log & Anti-log amplifiers, voltage to current and current to voltage converter.

Reference Books:

1. D Chattopadhyay and P.C. Rakshit, Electronics Fundamentals and Applications, New Age International Publications.
2. Malvino—Electronic Principles, 6/e , McGraw Hill
3. Boylested & Nashelsky- Electronic Devices and Circuit Theory-Pearson/PHI
4. Sedra & Smith-Microelectronic Circuits- Oxford UP

Course Title	**: PROGRAMMING -I (C LANGUAGE)**
Course Code	**: CSC101**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Introduction to Computer, Input & Output devices, Computer memory and Processor, Computer Software and Computer Networks, Number System, Computer code and Boolean Algebra

Introduction to C
The language of C : Phases of developing and running computer program in C, Simple C programs, C Tokens, Keywords, Identifiers, Data types, Constants, Variables, Operators and I/O statements

Loops and conditionals
Control statements, Conditional branching statements (if, if-else, if-else-if, switch), Iterative statements (for, while, do-while), Nested loops, Break, Continue, and Goto statements.

Functions
Function declaration, Function definition, Function call (call-by-value, call-by-reference), Recursive function, Storage classes, and Scope of variables.

Arrays
Array (1D array, 2D array, 3D array and multi-dimensional) declaration, Operations on array, Searching and Sorting, Passing arrays to functions, String representation, Operation on strings, Different string manipulation function.

Pointers

Pointer variables, pointer arithmetic, pointers with arrays, pointers with strings, pointers with functions, pointers to pointers, and dynamic memory allocation.

Structure and Union

User-defined data types- structure and unions (declaration, initialization and access), nested structures, use of structures and unions with pointers, arrays, functions.

File Handling

File handing in C, opening a file, closing a file, reading of data from a file, writing data to a file, error handling,

Preprocessor Directives

C preprocessor directives, C Libraries

Reference Books:

1. Brian W. Kernighan, The C Programming Language, Prentice Hall.
2. Y. P. Kanetkar, Let Us C: Authentic Guide to C PROGRAMMING Language
3. R. Thareja, Computer Fundamentals and Programming in C. 2nd Edition, Oxford University Press.
4. J.R. Hanly and E.B. Koffman, Problem Solving and Program Design in C. 5th Edition. Pearson Education
5. Y. Patt, S. Patel. Introduction to Computing Systems: From bits & gates to C & beyond, 2nd Edition, McGraw Hill

Course Title	**: ENGLISH FOR COMMUNICATION**
Course Code	**: HUC101**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Writing Skill:

Paragraph Writing, Commercial Correspondence, Précis, Preparing Instruction Manuals, Preparing Proposals, Report Writing, Writing of Dissertation/Thesis, Elements of Grammas and Vocabulary.

Oral communication:

Group Discussion; Extempore Speaking; Presentation Strategies; Interview Preparation.

This course seeks to develop a sense of language through texts drawn from contemporary writings in newspapers, news magazines, reports, etc.

Reference Books:

1. Oxford Book of Writing and Speaking - Peter Seeley
2. Technical Communication Principles and Practice, Meenakshi Raman & Sangeeta Sharma

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Course Title	**: HUMANITIES - I (VALUES & ETHICS IN PROFESSION)**
Course Code	**: HUC102**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction

Definition of Science, Technology, Engineering and Ethics. Relationship between the science, technology and Ethics, Different types of Ethics, Dimensions of Ethics, Essence of Ethics, Approaches to Ethical study as Indian Perspective and western perspective, basic concepts of ethics, morality and value, Virtue Ethics, Ethics in public life, ethics in engineering, Ethics in work place. Definition and characteristic of profession.

Effects of Technological growth and various Engineering Activities

Resource Depletion: Club of Rome, Objectives of Club of Rome, Sustainable Development.

Energy Crisis: History, cause and effect, National and international Case studies.

E.f. Schumacher's Appropriate Technology Movement (ATM): Influential factors, advantages and disadvantages of ATM, Case studies National and International.

Environmental Ethics: Pollution, contributions of engineers in eradicating/ reducing pollution, Government's measures

Man-Machine Interaction: Emotional Intelligence and ethics, AI and Ethics, Robotics and Brain Computer interface.

Ethical and Social Responsibilities of an Engineer:

Engineering as Experimentation – Engineers as responsible Experimenters – Safety Engineering- Codes of Ethics – A Balanced Outlook on Law.

Human values and Good Life:

Lessons from the lives and teachings of great leaders, reformers and administrators; role of family, society and educational institutions in inculcating value, , Freedom and discipline, Duties and rights, Contribution of Family in Value education, Contribution of society in inculcating values, Role of educational institutions in inculcating values.

Value crisis in modern day world and a way out- Components of a Good Life- Psychological values, Aesthetic values, Moral and Ethical Values , Material values, Spiritual Values, Social values- Values of Indian Constitution, Democracy, Secularism, Fundamental Rights.

Reference Books:

1. Professional Ethics and Human Values by R.S NAAGARAZAN
2. Engineering Ethics Fourth Edition by CHARLES B. FLEDDERMANN

SEMESTER – II

Course Title	**: MATHEMATICS – II (PROBABILITY AND STATISTICS)**
Course Code	**: MAC201**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Probability:

Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes Theorem and independence

Random Variables:

Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev's inequality

Special Distributions:

Discrete uniform, Binomial, Geometric, Poisson, Exponential, Gamma, Normal distributions

Functions of a Random Variable

Joint Distributions:

Joint, marginal and conditional distributions, product moments, correlation, independence of random variables, bivariate normal distribution

Statistics

Sampling Distributions, Distribution of Mean, Chi Square Distribution, t distribution, Hypothesis Testing, Goodness of fit, Regression and Correlation, Method of least squares, linear regression

Reference Books:

1. John E. Fruend's Mathematical Statistics, 6th Edition by Irwin Miller and Marylees Miller.
2. M.A. Berger, An Introduction to Probability and Stochastic Processes, Springer.
3. I. Florescu, Probability and Stochastic Processes, O'Reilly.
4. E. Bas, Basics of Probability and Stochastic Processes, Springer.
5. K. Najim, E. Ikonen, A.K. Daoud, Stochastic Processes, Elsevier.
6. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md.E.Saleh.

7. Introduction to Probability and Statistics by J.S. Milton & J.C.Arnold.
8. Introduction to Probability Theory and Statistical Inference by H.J. Larson.
9. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross
10. A First Course in Probability by S.M. Ross
11. Probability and Statistics in Engineering by W.W. Hines, D.C. Montgomery, D.M. Gpldsman & C.M.Borror

Course Title	**: ENGINEERING MECHANICS**
Course Code	**: PHC201**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Force systems:
Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple

Equilibrium:
Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses

Friction:
Laws of Coulomb friction, problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance.

Kinematics and Kinetics of particles:
Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion

Properties of areas:
Moments of inertia and product of inertia of areas, polar moment of inertia, principal axes and principal moments of inertia

Concept of stress and strain:
Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; analysis of axially loaded members.

Torsion and Transformation of stress and strain:
Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation, Transformation of stress and strain, principal stresses, principal strains, Mohr's circle for stress and strain.

Flexural loading:

Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams.

Combined loading:
Axial bending, and torsion, Mohr circle

Column:
Buckling of slender columns, Euler bucking load for different end conditions

Reference Books:

1. Vector Mechanics for Engineers: Statics and Dynamics - Ferdinand P.
2. Beer, E. Russell Johnston, Jr. (TMH)
3. Engineering Mechanics: Statics and Dynamics - I.H. Shames (Pearson)
4. Engineering Mechanics - S. Timoshenko, D. H. Young (TMH)
5. Mechanics of Materials - Ferdinand Beer , E. Russell Johnston, Jr., J. DeWolf (TMH)
6. Elements of Strength of Materials - S. Timoshenko, D. H. Young (East West Press)
7. Mechanics of Materials - James M. Gere, Barry J. Goodno (CL Engg)
8. Engineering Mechanics - Stephan Timoshenko, D. Young (TMH)
9. Strength of Materials (Part 1) – S P Timoshenko (CBS)

Course Title	**: DIGITAL LOGIC DESIGN AND CIRCUIT**
Course Code	**: ECC201**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Number System:
Binary numbers, decimal, Octal & Hexadecimal Numbers, Number Base Conversion, 1's & 2's Complements, Binary arithmetic, Binary codes.

Boolean algebra & Logical Gates:
Basic Definitions, Boolean Algebra Theorems of Boolean Algebra, Boolean Functions, Digital Logic Gates, SOP, POS, Minterms, Maxterms, Simplification of Boolean functions: algebraic method, Karnaugh maps.

Combinational Logic Circuits
Half and Full adder, Half and Full subtractor, Parallel Adder, CLA, Code conversion circuit, Decoder, Encoder, Multiplexer, De- Multiplexer.

Sequential logic circuits:

Different flip flops and latches, Registers, Asynchronous and Synchronous counters. Finite state machine, State transition diagrams and state transition tables.

Memory elements:
ROM, PROM, RAM-SRAM, DRAM. PLA, PLD, FPGA

Analog-to-digital Converter

Digital-to-analog data converters

Concept of programmable processors and microcontrollers.

Case studies: a simple computer, instruction coding and decoding, timing and controller circuits.

Reference Books:
1. Digital Electronics by Morris Mano
2. Digital Electronics by Salivahanan
3. Fundamental of Digital Circuits by A. Anand Kumar

Course Title	**: DATA STRUCTURES AND ALGORITHMS**
Course Code	**: CSC201**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Introduction
Introduction, objective, motivation. Definition of Data Structure, Classification of Data Structures, Operations on Data Structures

Algorithm and Asymptotic Analysis
Algorithm: Definition, Time Complexity, Space Complexity

Basic Data Structures and Applications
Arrays, Strings, Pointers, Structures ,
Singly Linked List: Traversal, Searching, Insertion, and Deletion.
Circular Linked List: Insertion, and Deletion. Doubly Linked List: Insertion, and Deletion. Circular Doubly Linked List: Insertion, and Deletion
Applications: Use of Linked List, Polynomial Representation of Linked List

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Stack: Array Representation, Operations on a Stack (Push, Pop), Linked Representation of Stack, Operations on a Linked Stack
Applications of Stack: Evaluation of Arithmetic Expressions, Recursion: Factorial function, Towers of Hanoi
Queue: Array Representation, Linked Representation, Circular Queue, Deque, Priority Queues

Sorting

Sorting: Bubble Sort, Insertion Sort, Selection Sort, Merge Sort, Quick Sort, and Heap Sort

Tree

Tree: Binary Tree, Binary Search Tree, Creating a Binary Tree from a General Tree. Traversing a Binary Tree: Pre-order, In-order and Post-order Traversal, Huffman's Tree and Application.

Searching

Searching Techniques: Linear Search, Binary Search. Operations on Binary Search Tree: Searching, Insertion, and Deletion. Determining the Height of a Binary Search Tree, Search the Smallest Node in a Binary Search Tree, Search the Largest Node in a Binary Search Tree, Threaded Binary Tree. AVL Tree, Operations on AVL Tree, Searching for a Node in an AVL Tree, Red-Black Tree, m-way Search Tree, B Tree, B+ Tree, 2-3 Tree, Binary Heap: Insertion, and Deletion, Binomial Heap, Fibonacci Heap

Graph

Graph: Directed Graph and Undirected Graph.
Representation of Graph: Adjacency Matrix.
Graph Traversal: Breadth-First Search and Depth-first Search.
Topological Sorting, Shortest Path Algorithms: Minimum Spanning Tree (Prim's Algorithm and Kruskal's Algorithm)

Hashing

Hashing: Definition, Hash Table, Hash Function.
Collision Resolution techniques: Open addressing and Chaining

Reference Books:

1. Seymour Lipschutz, Data Structures. Mc-Graw Hill Education.
2. Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures Using C and C++. Pearson, 2nd Edition, 1996.

3. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structures in C. University Press.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms. Prentice Hall of India, 3rd ed., 2009

Course Title	**: HUMANITIES - II (ECONOMICS)**
Course Code	**: HUC201**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Point of Initiation – Central Concepts of Economics

Scarcity and efficiency – Goods: Use & Exchange Value – The three fundamental questions of economic organization – Micro & Macroeconomics – Positive v/s Normative economics – Circular flow of income – Market, command and mixed economies – Society's technological possibilities

Introducing Demand & Supply

Demand Function and demand Curve, determinants of demand – Individual & Market Demand – changes in demand – Marshallian Law of Demand & its exceptions – Demand Elasticities – Techniques of Demand Forecasting.

The Supply Function & Supply Curve – general principle and exception – changes in supply – Supply elasticity – Concept of Market equilibrium & impacts of changes in demand and supply – Revenue

Theory of Consumer Behaviour

Concept of Utility – Cardinal v/s ordinal utility – Law of Diminishing Marginal Utility – Tools of analysis: Axiomatic Approach of Consumer Behaviour – Indifference Curves & Budget Space/Line – Consumer Equilibrium – Income & Substitution effects – derivation of Demand Curve from Indifference curve analysis – Price Consumption Curve and Income Consumption Curve – Engel Curve – Giffens & Inferior Goods - Taxes & Subsidies

Production & Cost

Production Function – the technological relationship between inputs & output – Short Run & Long Run Production analyses – Production with single variable input (short run) – stages of production & concept of economic zone of production; Long run production and tools of analysis: Isoquants and Isocost

line, Producer's Equilibrium with two variable inputs, Ridge Lines and economic region – Expansion Paths

Different concepts of Cost of production, Fixed & variable Costs, Short run & Long run costs – concept of Opportunity Cost – The short run and long run total, average and marginal cost curves and their relations – economies of scale and concept of Optimum Plant-size

Market Morphology

Market Equilibrium and the Rule of Profit-maximization – Concept of Profit – Financial Profit v/s Economic Profit – concepts of break-even & shut-down points; Types of markets & their characteristics – Perfect Competition and its short run & long run equilibrium – concepts of increasing, decreasing & constant cost industry; Monopoly – causes of monopoly – Natural Monopoly – measure of monopolistic power (Lerner's Index) – Short run and Long run equilibrium of Monopoly – Concepts of different types of monopoly pricing – Monopoly has no supply curve – Multi-plant Monopolist, Price-discriminating Monopolist – welfare costs of monopoly

Rudiments of Macroeconomics

Measurement of economic activity – National Income; Closed & Open economy - foreign trade and balance of payments; Inflation & Unemployment – Economic policies

Reference Books:

1. Economics, by P. Samuelson & W. Nordhaus, 19th Edn. Indian Adaption by Sudip Choudhury & Anindya Sen
2. Managerial Economics - by Peterson & Lewis
3. Managerial Economics - by Mansfield
4. Economics - Principles & Applications - by G. Mankiw
5. Micro Economic Theory - by G.S. Maddala
6. Macroeconomics - by R. T. Froyen

SEMESTER – III

Course Title	**: MATHEMATICS-III (CALCULUS AND DIFFERENTIAL EQUATIONS)**
Course Code	**: MAC301**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Differential Calculus (Functions of one Variable):
Rolle's theorem, Cauchy's mean value theorem (Lagrange s mean value theorem as a special case), Taylor's and Maclaurin's theorems with remainders, indeterminate forms, concavity and convexity of a curve, points of inflexion, asymptotes and curvature.

Differential Calculus (Functions of several variables):
Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables, maxima and minima of functions of several variables - Lagrange's method of multipliers

FIRST ORDER ODEs
Introduction to DE, Order of DE, First Order ODE F (x, y, y') = O.
Concept of solution (general solution, Particular solution, implicit solution etc.), Geometrical interpretations (direction fields, isoclines), orthogonal trajectories, Separable form, Reduction to separable form, Exact equations, Integrating factors [of the form F(x) and F(y)], Linear equations, Bernoulli equation, Picard's existence and uniqueness theorem (without proof), Picard's iteration method, Numerical methods: Euler's method, improved Euler's method.

SECOND ORDER ODEs
Homogeneous Linear ODEs of Second Order: Fundamental system and general solutions of homogeneous equations, reduction of order.
Homogeneous Linear ODEs with Constant Coefficients: Characteristic equations, real distinct roots, complex roots, repeated roots. Differential Operators. Euler-Cauchy equation, Existence and Uniqueness of Solutions, Linear Dependence and Independence of Solutions: Wronskian, Non-homogeneous equations: Method of undetermined coefficients, Solution by Variation of Parameters, Extension to higher order differential equations,

SERIES SOLUTIONS OF ODEs & SPECIAL FUNCTIONS
Power series Solutions: ordinary points (Legendre equation).
Legendre's Equation & Legendre Polynomials Pn(x)
Extended Power Series Method: Frobenius Method

Bessel's Equation & Bessel Functions Jn(x)

LAPLACE TRANSFORMS

Laplace and inverse Laplace transforms, first shifting theorem, existence and uniqueness of Laplace transform.
Laplace transforms of derivatives and integrals, Solving ODEs with Laplace Transform.
Unit step function, second shifting theorem, Dirac Delta Function/Unit Impulse Function
Convolution and Applications (Initial Value Problems)
Differentiation and Integration of Transforms

Reference Books:

1. Advanced Engineering Mathematics, E. Kreyzig, 10th Edition, Wiley.
2. M.D.Weir, J. Hass, F.R. Giordano, Thomas Calculus, 11th Edition, Pearson Education
3. J. Stewart, Essential Calculus, Thomson (2003).
4. Deborah Hughes-Hallett, Andrew M. Gleason, William G. McCallum – Calculus Multivariable Wiley (2017)
5. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Edition, Wiley India, 2005.
6. S. L. Ross, Introduction to Ordinary Differential Equations, 4th Edition-Wiley, 1989.
7. G. F. Simmons, Differential equations with applications and historical notes, Chapman and Hall_CRC, 2017

Course Code	**: CSC301**
Course Title	**: Computer Organization and Architecture**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Basic functional blocks of a computer:

CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study - instruction sets of some common CPUs.

Data representation

Signed number representation, fixed and floating point representations, character representation.

Computer arithmetic

Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - restoring and non-restoring techniques, floating point arithmetic.

CPU Control unit design

Hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU.

Memory system design
Semiconductor memory technologies, memory organization

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

Performance enhancement techniques
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

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

Reference Books:
1. Mano, M.M., "Computer System Architecture", PHI.
2. Behrooz Parhami " Computer Architecture", Oxford University Press

Course Code	**: CSC302**
Course Title	**: Algorithm - I**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Review of Data structures
Stack, queue, linked lists, trees, binary search trees, heaps, priority queues, min-max heaps, heapsort, AVL trees, height balancing, data structure for disjoint sets.

Complexity of algorithms
Asymptotic notations and their significance, complexity analysis of algorithms, worst case and average case analysis.

Algorithm paradigms
Recursion, divide-and-conquer, greedy, dynamic programming, lower bounds and optimal algorithms.

Algorithms on arrays
Linear-time median finding, sorting in linear time (counting sort, radix sort, bucket sort), string matching (Rabin-Karp and Knuth-Morris-Pratt algorithms).

Graph algorithms
Introduction to graphs, BFS, DFS, connected components, strongly connected components, topological sort, single source shortest paths, Dijkstra's algorithm, Bellman-Ford algorithm, all pair shortest paths, Floyd-Warshall's algorithm, minimum spanning trees, Krushkal's and Prim's algorithm, maximum flow, flow networks, Ford-Fulkerson's algorithm, min-cut-max-flow theorem, maximum bipartite matching.

Complexity classes
Computation model; classes: P, NP, NP-hard and NP-complete; CIRCUIT-SAT, 3SAT, CLIQUE, VERTEX-COVER as NP-complete problems.

Approximation algorithms
Approximation ratio, examples.

Reference Books:
1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press/McGraw-Hill, 2001.
2. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
3. Vijay V. Vazirani, Approximation Algorithms, Springer-Verlag, 2001.
4. Sara Baase and Allen Van Gelder, Computer Algorithms: Introduction to Design and Analysis, third edition, Addison-Wesley, 2000.
5. Gilles Brassard and Paul Bratley, Algorithmics: Theory and Practice, Prentice-Hall, 1995.
6. E. Harowitz, S. Sahani, S. Rajasekaran, Fundamentals of Computer Algorithms, 2nd edition, University Press, 2008

Course Code	**: CSC303**
Course Title	**: Discrete Mathematics**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Sets, Relations, and Functions
Basics, Ordered pair, Power set, Cardinality, Operations on sets; Properties and classification of relations, Combining relations, Closures, Equivalence, Partial ordering. Sequences and Summations; Function: one-to-one, onto, inverse, composition, graphs.

Combinatorics
Basic counting rules, Pigeon hole principle, Permutations and combinations, Binomial theorem: Pascal's triangle and Multinomial theorems; Recursion and Recurrence relation.

Algebraic Structure

Binary operations; Group, Ring, Field, Semigroup, Subgroup, Coset. Order and Relation: POSET, Isomorphism; Lattices: Properties, classification, and types; Lattice Homomorphism.

Mathematical Logic and Proofs

Propositional logic, logical equivalence, predicates & quantifiers, logical reasoning, rules of inference, proof strategies and techniques. Mathematical reasoning: Mathematical Induction, Recursive definitions, Structural Induction

Matrix Algebra

Definition, types, operations on matrices; Rank of a matrix; Representation and solutions of linear equations; Eigenvalues and eigenvectors.

Graphs

Directed, undirected graphs.

Reference Books:

1. Discrete Mathematics- S. K. Chakraborty and B. K. Sarkar, Oxford Univ. Press.
2. Algebraic Coding Theory - Elwyn R. Berlekamp - McGraw-Hill

Course Title	**: HUMANITIES – III (PSYCHOLOGY)**
Course Code	**: HUC301**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Basic psychological processes and development:

Scope and Methods of Psychology – Biological basis of behaviour

Cognitive Processes:

(a) Sensation: attributes of sensation, Psychophysics (Weber – Fechner Law), Methods of Psychophysics
(b) Attention: determinants of attention, fluctuation of attention, selectivity of attention
(c) Perception: Movement, space, depth and time perception, perceptual organization, Gestalt View

Learning: Conditions of learning:

(a) Theory of classical conditioning
(b) Theory of operant conditioning
(c) Trial and error theory

(d) Theory of insight learning
(e) Programmed learning

Memory: Encoding, storage, retrieval:
(a) Types of memory (STM & LTM, Iconic, Echoic and Procedural)
(b) Forgetting curve
(c) Theories of forgetting

Motivation and Emotion:
Physiological and psychological basis of motivation and emotion
(a) Intrinsic and extrinsic motivation – factors of influencing intrinsic motivation
(b) Theories of motivation – Maslow, Maclelland
(c) Theories of emotion – James-Lange Theory, Canon-Bard and Schachter-Singer Theory
(d) Effects of motivation and emotion on behaviour

Intelligence
(a) Spearman's two factor theory
(b) Thursetone's theory
(c) Guilford's structure of intellect
(d) Gardner's theory
(e) Measurement of intelligence – IQ and deviation IQ, Tests of intelligence – Stanford Binet
(f) Types of intelligence – Social, abstract, concrete, emotional, artificial,
(g) Gifted and mentally challenged children

Thinking
(a) Piaget's theory of cognitive development – Problem solving
(b) Creative thinking – Nature and stages

Application of Psychology in different fields
(a) Rehabilitation
(b) Entrepreneurship and economic development
(c) Psychosocial problems of teenage and old age

Reference Books:

1. Baron, R. &Misra.G. (2013).Psychology. New Delhi: Pearson.
2. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. (2001). Introduction to Psychology (7th Edition), McGraw Hill Booh Company.
3. Munn, N. L., Fernald, L. D., & Fernald, P. S.(2007). Introduction to Psychology (5th Edition). A.I.T.B.S Publishers India (ref)
4. Kenneth S. Bordens, Bruce B. Abbott. Research design and methods: a process approach 8th ed.

5. Levinthal, C.F. (2005). Introduction to Physiological Psychology, 3rd Edition, Prentice -Hall of India Pvt. Ltd., New Delhi.
6. Breedlove, S. M., Rosenzweig, M. R., & Watson, N. V. (2007) Biological Psychology: An introduction to behavioral, cognitive, and clinical neuroscience, 5th Edition. Sinauer Associates, Inc., Sunderland, Massachusetts. (Reference Book)

SEMESTER – IV

Course Code	**:**	**MAC402**
Course Title	**:**	**Mathematics - IV (Numerical Analysis and Computing)**
Weekly contact	**:**	**3 – 1 – 0 (L – T – P)**
Credit	**:**	**4**

Error Analysis
Exact and approximate numbers, Rounding of numbers, Significant digits, Correct digits, various types of errors encountered in computations, Propagation of errors.

Solution of system of linear equations
(i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU-decomposition method.
(ii)Iterative methods: Jacobi and Gauss-Seidel methods.

Roots of non-linear equations
Bisection method, Regula-Falsi method, Newton-Raphson method, direct iterative method with convergence criteria, Newton-Raphson method for solution of a pair of non-linear equations.

Interpolation
Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation.

Numerical differentiation
First and second order derivatives by various interpolation formulae.

Numerical integration

Trapezoidal, Simpsons 1/3rd and 3/8th rules with errors and their combinations, Gauss Legendre 2-points and 3-points formulae

Solution of first and second order ordinary differential equations
Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.

Case studies

Reference books:

1. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw-Hill Publisher
2. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th
3. Edition, Wesley.
4. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for
5. Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.
6. Atkinson, K. E., "Introduction to Numerical Analysis", John Wiley

Course Code	**: CSC401**
Course Title	**: Operating Systems**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Overview and Functions of operating systems
Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management.

System calls
System Calls, Types of System Calls, System Programs, Virtual Machines, System Booting.

Processes
Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Examples of IPC Systems, Synchronisation.

Threads
Basic Threads, Multithreading Models, Thread Libraries, Threading Issues, POSIX Threads.

CPU Scheduling

Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Examples.

Memory Management
Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Virtual Memory.

File Management
File Concept, Access Methods, Disk and Directory Structure, File-System Mounting, File Sharing, Protection.

I/O Systems
I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations, STREAMS, Performance.

Protection and Security
Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Access Control, Revocation of Access Rights, Language-Based Protection, User Authentication, Miscellaneous Issues.

Reference books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts. Sixth edition. Addison-Wesley. (2003)
2. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation. Prentice-Hall. (2006)

Course Code	**: CSC402**
Course Title	**: Formal Languages and Automata Theory**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Introduction and motivation, Infinite sets, proofs, Closures
Alphabets, languages, and representations

Finite automata and regular languages
Deterministic finite automata, Non-deterministic finite automata, Closure properties and equivalences, Regularity
State Minimization, Moore Machine and Mealy Machine

Context free languages and push down automata
Context free grammars, Parse trees and ambiguity, Push down automata

Equivalence of PDA and CFG, Properties of context free languages, Properties of context free languages, Determinism and parsing, DCFG Top-down and bottom-up parsing

Turing machines
Turing machines – introduction, Turing machines - notation
Recursive and recursively enumerable languages, Random access Turing machines, Linear Bounded Automaton, Non-deterministic Turing machines Grammars, Church-Turing thesis and universal computing machines

Computability and decidability
Decidability and Undecidablity

Reference Books:
1. Harry Lewis and Chistos Papadimitrou: Elements of Theory of Computation, 2nd. Ed., Pearson Education, Asia 1998 (https://www.ucursos.cl/ingenieria/2010/2/CC3102/1/material_docente/)
2. John Hopcroft, Rajeev Motwani and Jeffrey Ullman, Introduction to Automata Theory, Languages and Computation, 2nd. Ed., Pearson, Asia 2001 (http://www.columbia.edu/~ncd2118/CS/HMU.pdf)
3. Dexter C. Kozen: Automata and Computability, Springer, 1997 (http://thequeen.org.uk/compsci/kozen.pdf)
4. Daniel I. A. Cohen: Introduction to Computer Theory, John Wiley & Sons (https://pakistandasti.files.wordpress.com/2013/11/introduction-to-computer-theory-by-cohen-copy.pdf)
5. Michae Sipser: Introduction to the Theory of Computation, 3rd Ed., Cengage Learning. (https://theswissbay.ch/pdf/Book/Introduction%20to%20the%20theory%20of%20computation_third%20edition%20-%20Michael%20Sipser.pdf)
6. Peter Linz; An Introduction to Formal Languages and Automata, 5th. Ed., Jones & Bartlett Learning. (http://almuhammadi.com/sultan/books/Linz.5ed.pdf)
7. Kamala Krithivasan and R.Rama; "Introduction to Automata Theory, Formal Languages and Computation", Pearson Education, 2009.

Course Code	**: CSC403**
Course Title	**: Object Oriented Programming (Java)**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Principles of Object Oriented Programming
Programming Paradigms, Basic concepts, Properties of OOP, Benefits of OOP, Applications of OOP.

Introduction to Java

History of Java, Java byte code, JVM, JRE, Basic data types, Variables, Operators, Control structures including selection, Looping, Comparison with C and C++.

Classes and objects
Encapsulation, Class specification, member function specification, scope resolution operator, Access qualifiers, Instance creation, Constructors, parameterized constructors, Overloaded constructors, Constructors with default arguments, copy constructors, static class members and static objects.

Inbuilt classes
String, Character, StringBuffer, File, this reference, Array of objects.

Inheritance and Polymorphism
Inheritance in java, Super and sub class, Overloading, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java,

Package
Package in java, UTIL package, Collections in java

Exception Handling
Principle of Exception handling, Exception handling mechanism, multiple catch, Nested try, Rethrowing the exception.

Object Oriented Design
Introduction to Object oriented design and UML, Use case diagram, Class diagram, Sequence diagram

Event and GUI programming
Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers- Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.

I/O programming
Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files.

Thread in Java
Thread life cycle and methods, Runnable interface, Thread synchronization,

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Design Patterns in Java

Introduction, Singletone design pattern, Creational design patterns, Structural design patterns

Case studies

JavaBeans, Network Programming, Graphics, Database handling.

Reference books:

1. Bruce, Foundations of Object Oriented Languages, PHI
2. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" - TMH
3. Priestley – " Practical Object Oriented Design using UML" – TMH
4. "Advanced Programming for JAVA 2 Platform" Austin and Pawlan, Pearson
5. Ivor Horton, "Beginning J2EE 1.4" SPD Publication.
6. Rambaugh, James Michael, Blaha - "Object Oriented Modelling and Design" - Prentice Hall India/ Pearson Education

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Course Title	**: IPR LAW: CONCEPTS AND APPLICATIONS**
Course Code	**: HUC401**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction to Intellectual Property Rights

Definition, Evolution and Governance Frameworks, Various Categories of IPRs, TRIPS Agreement and its Provisions, Institutions for Intellectual Property Rights and International Treaties/Covenants

Laws of Patents, Trademarks, Designs and Copyrights

Definitions, Patent Laws – provisions, amendments, attributes, Patentable subject matter, Criteria of patentability, Procedures of patenting – drafting, filing, prosecution and grants, Copyright Laws – provisions, amendments, attributes, Copyrightable subject matter, Ownership, renewal and transmission of copyrights, Designs and Trademark Laws –provisions, amendments, attributes, Comparative Aspects of Patents, Trademarks and Designs, Enforcement and Infringement of Rights, Comparative Aspects of International Laws, Layout - Designs of Integrated Circuits

IPRs in Information Technology

Protecting Information, Data Security Laws – India, UK, USA, Rights and Obligations in IT Applications, Cyber Security and International Data Highway Rules

Intellectual Property Laws in Technology Transfer

Technology and IPRs, Commercialization of Technologies by Licensing – Provisions of IPRs, Valuation of IPRs, Negotiation of IPR protected Transactions, IPR Assets for Start-ups and Entrepreneurship

Contemporary Issues in IPR

Interface between IPR and Human Rights, Interface between IPR and Competition Law, IPR and sustainable development, The Impact of Internet on IPR, E-Commerce and IPR issues, IP Case Laws

Reference Books:

1. Susan K Sell, Private Power, Public Law: The Globalization of Intellectual Property Rights, Cambridge University Press, 2003
2. N.S. Gopalakrishnan & T.G. Ajitha, Principles of Intellectual Property, Eastern Book Company,2nd Edition , 2014
3. Jayashree Watal, Intellectual Property Rights in the WTO and Developing Countries, Oxford University Press, 2001
4. Duggal Pavan, Legal Framework on Electronic Commerce & Intellectual Property Rights, Universal Publishing House, 2014
5. Paul Torremans, Intellectual Property And Human Rights, Kluwer Law International, 2008
6. Steven D Anderman, Interface Between Intellectual Property Rights and Competition Policy, Cambridge University Press, 2007.
7. Philippe Cullet, Intellectual Property Protection and Sustainable Development, Lexis Nexis, 2005

SEMESTER – V

Course Title	**: Compiler Design**
Course Code	**: CSC501**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Introduction
Phases of compilation and overview.

Lexical analysis

Regular language, finite automata, regular expression, regular expression to finite automata, recognition of tokens, reserved words, identifiers, scanner generator (lex, flex).

Syntax analysis
Context-free language and grammar, pushdown automata, derivations, parsing, parse trees, ambiguity, eliminating ambiguity, elimination of left recursion, top-down parsing, bottom-up parsing,
recursive-descent parsing, LL(1) grammars, predictive parsing, Shift-Reduce parsing, LR(0), SLR, LR(1), LALR(1) grammars and parser generator.

Semantic analysis
Attributed grammar, syntax directed definition, evaluation and flow of attribute in a syntax tree.

Symbol table
Structure, symbol attributes and management.

Runtime environment
Procedure activation, parameter passing, value return, memory allocation, and scope.

Intermediate Code Generation
Translation of different language features, different types of intermediate forms.

Code Improvement/optimization and Target code generation
Analysis: control flow, data flow dependence etc.; Code improvement local optimization, global optimization, loop optimization etc. Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization etc, register allocation and target code generation.

Reference Books:

1. A. Aho, M. Lam, R. Sethi and J. Ullman, Compilers: Principles, Techniques and Tools, 2007.
2. Allen I. Holub, Compiler Design in C, Prentice-Hall.
3. Andrew W. Appel, Modern Compiler Implementation in C/Java, Cambridge University Press.

Course Title	**: Artificial Intelligence**
Course Code	**: CSC502**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Introduction
What Is AI? , Definition and the Foundations of Artificial Intelligence,

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The History of Artificial Intelligence, The State of the Art

Intelligent Agents
Agents and Environments, Good Behavior, The Concept of Rationality, The Nature of Environments, The Structure of Agents

Solving Problems by Searching
Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies Informed (Heuristic), Search Strategies, Heuristic Functions

Beyond Classical Search
Local Search Algorithms and Optimization Problems, Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments

Constraint Satisfaction Problem
Games, Optimal Decisions in Games, Alpha–Beta Pruning, Imperfect Real-Time Decisions, Stochastic Games, Partially Observable Games, State-of-the-Art Game Programs, Alternative Approaches

Logical Agents, First Order Logic and Inference
Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs, Local Search for CSPs, The Structure of Problems, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic, Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution

Planning
Definition of Classical Planning, Algorithms for Planning as State-Space Search, Planning Graphs, Other Classical Planning Approaches, Analysis of Planning Approaches, Summary, Bibliographical and Historical Notes, Time, Schedules, and Resources, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Multiagent Planning

Uncertainty and Reasoning
Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes' Rule and Its Use, The Wumpus World Revisited, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Relational and First-Order Probability Models, Other Approaches to Uncertain Reasoning

Decision Making

Combining Beliefs and Desires under Uncertainty, The Basis of Utility Theory, Utility Functions, Multiattribute Utility Functions, Decision Networks, The Value of Information, Decision-Theoretic Expert Systems

Robotics
Introduction, Robot Hardware, Robotic Perception, Planning to Move

Reference Book:

1. Artificial Intelligence A Modern Approach, Stuart J. Russell and Peter Norvig

Course Title	**: Microprocessor and Microcontroller Systems**
Course Code	**: ECC502**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Introduction to Microcomputer based system.

8085 Microprocessor
Architecture of 8085 Microprocessor. Address / Data Bus multiplexing and demultiplexing. Status and Control signal.
Instruction set of 8085 Microprocessor. Classification of instructions, addressing modes, timing diagram of the instructions.
Assembly language programming: Addition, Multiplication, Block Transfer, Ascending order, Descending order, Finding largest & smallest number, Look-up table, Delay etc.
Memory interfacing with 8085, Basic concept of serial I/O, DMA
ADC / DAC interfacing with 8085.
Interrupts of 8085 processor: classification of interrupts,
Support IC chip: PPI 8255

8051 Microcontroller
8051 architecture :8051 microcontroller hardware, input/output pins, ports, external memory, counters and timers,
Instruction set, addressing modes,
Serial data i/o, Interrupts of 8051 microcontroller

Assembly language Programming using 8051
External data moves, Logical operations: Byte-level, bit-level, rotate and swap operations, Arithmetic operations, Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic. Jump and call instructions, Interfacing of 8051 with different sensors.

Arduino Uno
Introduction to Arduino, Architecture of Arduino, Pin description
Programming with Arduino, Interfacing of Arduino with different sensors.

Raspberry pi
Introduction to Raspberry pi, Architecture of Raspberry pi, Pin description Programming with Raspberry pi, Interfacing of Raspberry pi with different sensors.

Reference Books:
1. Microprocessor architecture, programming and applications with the 8085 - Ramesh Gaonkar
2. Microcontroller : Theory and Applications - Ajay V Deshmukh
3. Programming Arduino : Getting started with sketch - Simon Monk
4. Raspberry Pi Cookbook-Simon Monk

Course Title	**: HUMANITIES - IV (ORGANIZATIONAL BEHAVIOUR)**
Course Code	**: HUC501**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Historical development; concept of organization; elements of organizational structure; scope of organizational behaviour.

Motivation and job satisfaction
Major theories; content and process; Maslow, Herzberg, Douglas McGregor's theory X and theory Y, Intrinsic and extrinsic motivation; incentive systems: Job satisfaction; concept and determinants.

Leadership
Functions and approaches; trait, behavioural and contingency models; characteristics of successful leaders; role of power in leadership.

Communication
Communication process: types of communication; communication channels and networks; barriers to communication.

Group behaviour and conflict
Defining and classifying groups; stages of group development; concept, causes and consequences of conflicts; methods of conflict-resolution.

References:
1. Luthans, F. (2005). Organizational Behavior (12th Ed.). New York: McGraw Hill.
2. Robbins , S., Judge, T.A., & Sanghi, S.. (2009). Organizational Behavior 13th Ed., Pearson Education.
3. Aamodt, M. G. (2001). Industrial/organizational psychology. New Delhi: Cengage

SEMESTER – VI

Course Code	:	**CSC601**
Course Title	:	**Computer Network**
Weekly contact	:	**3 – 1 – 0 (L – T – P)**
Credit	:	**4**

Introduction
Introduction to Computer Network, Uses of Computer Networks, Modes of Communications, Different types of Networks, Network Structure, Communication Model, Internet, Protocol, OSI and TCP/IP models

Layers
Design Issues for the layers, Discussion about Layers.

Application Layer
DNS, Remote login (TelNet), Email (SMTP, MIME, POP3, IMAP4), WWW, HTTP, Cookie, Proxy Server, File Transfer Protocol, TFTP.

Transport Layer
Multiplexing, Demultiplexing, UDP, TCP, RTT Estimation and Timeout, TCP Flow Control. TCP Error Control and Congestion Control

Network Layer
Virtual Circuits and Datagram Networks, Inside a Router, Forwarding and Addressing in the Internet. IPv4 Addressing

Routing
Routing Algorithms, Shortest Path, Flooding, Link State, Distance Vector, Hierarchical Routing, Routing in the Internet: RIP, OSPF, Border Gateway Protocol, and Multicasting.

Data Link Layer
Services, Error Detection and Correction Techniques

Multiple Access Protocol
TDM, FDM, Slotted ALOHA, Pure ALOHA, CSMA, CSMA/CD, LAN, Ethernet, Point to Point Protocol.

Link Layer Addressing
MAC Addresses, ARP, DHCP.

Interconnections
Hubs, Bridges, and Switches.

Physical Layer

Reference books:
1. B. A. Forouzan, & F. Mosharraf. Computer Networks: A top down approach, 1st Edition, McGraw-Hill, 2012
2. B. A. Forouzan, TCP/IP Protocol Suite, 4th Edition, McGraw-Hill, 2010.
3. J. F. Kurose & K. W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Ed., Pearson, 2006.
4. B. A. Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill, 2009.
5. W. Stallings, Data and Computer Communication, Prentice Hall.
6. A. S. Tanenbaum, Computer Networks, 5th Edition, Pearson, 2006

Course Code	**: CSC602**
Course Title	**: Machine Learning**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Concept Learning: Find-S, Candidate Elimination, Decision Tree

Learning Problems
Well-Posed Learning Problems, Designing A Learning System, Perspectives And Issues In Machine Learning, A Concept Learning Task, Concept Learning As Search, Find-S, Version Spaces And The Candidate-Elimination Algorithm, Inductive Bias

Decision Tree
Decision Tree representation, Appropriate problems for Decision Tree Learning, Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive bias in Decision Tree Learning, Issues in Decision Tree Learning

Artificial Neural Networks
Gradient Descent, Artificial Neural Networks, Bayesian Learning, Expectation Maximization, Cost Function, Gradient Descent, Linear Regression, Neural Network Representations, Problems for Neural Network Learning, Perceptron, Multilayer Networks and Backpropagation Algorithm.

Bayes Theorem and Concept Learning
Bayes theorem**,** Maximum Likelihood and Least-Squared Error Hypotheses, Maximum Likelihood Hypotheses for Predicting Probabilities, Bayes Optimal Classifier, Naive Bayes Classifier, Learning to Classify Text, Bayesian Belief Networks, EM Algorithm, EM Algorithm for Gaussian Distribution

Generative and Discriminative approaches
Difference between Generative and Discriminative approaches, Naive Bayes, Hidden Markov model, Gaussian mixture model, Latent Dirichlet Allocation, Conditional Random Fields, Maximum-Entropy Markov models

Instance Based Learning
k-Nearest Neighbor, Support Vector machine, Reinforcement Learning, Evaluation Methods, Application in NLP.

Reference books:
1. Tom M. Mitchell, Machine Learning, 2013 Indian Edition, McGraw-Hill Education, Inc.
2. Machine Learning Course in coursera by Andrew Ng, Link: https://www.coursera.org/learn/machine-learning#syllabus
3. Introduction to Machine Learning, Third Edition, Ethem Alpaydin, The MIT Press
4. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, The MIT Press
5. Online ppts: https://web.cs.hacettepe.edu.tr/~ilyas/Courses/BIL712/

Course Code	**: CSC603**
Course Title	**: Database Management System**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**
Credit	**: 4**

Introduction
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Entity-Relationship Model
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Relational Model

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

SQL and Integrity Constraints

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, SQL queries, Nested Subqueries, PL/SQL, NoSQL, Query optimization: join algorithm, statistics and cost bas optimization.

Relational Database Design

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF,5NF

Transaction Management System

Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

File Organization & Index Structures

File & Record Concept, placing file records on Disk, Fixed and Variable Sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Index, Dynamic Multilevel Indexes using B-tree and B+ tree, Hashing.

Reference books:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.GrawHill.
2. Elmasri Ramez and Navathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System, McGraw-Hill
4. Gray Jimand Reuter Address, “Transaction Processing: Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System Cyber Tech
6. DateC.J.,“IntroductiontoDatabaseManagement”, AddisonWesley.
7. Ullman JD., “Principles of Database Systems”, Galgottia

Course Title	**: Cryptography and Network Security**
Course Code	**: CSC604**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction

Introduction to Network Security, Trends, Architecture, Levels, Attacks, Services, Mechanism, Response Teams, Network Security model and Standards.

Classical Encryption Techniques

Basics of Cryptography, Simple Symmetric Ciphers, General thought on breaking cryptosystems, Modular Arithmetic, Substitution and, Transposition Ciphers, Stream Cipher, RC4, Random Numbers, Cryptographically Secure Random Number Generators, One Time Pad

Block Ciphers and the Data Encryption Standard

Block Cipher Principles, Data Encryption Standard (DES), Block Cipher Design Principles, Advanced Encryption Standard, The Extended Euclidean Algorithm, Galois Fields, AES Structure, AES Round Functions, AES Key Expansion, AES Implementation, Block Cipher Operation, Multiple Encryption, 3DES, DESX, Modes of Operations: Electronic Codebook Mode, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode.

Cryptographic Hash Functions and MAC

Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm, MAC from hash functions and block ciphers.

Number Theory

Relevant Number Theory for public-key algorithms, Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality.

Public-Key Cryptography

Principles of Public-Key Cryptosystems, RSA, ElGamal Cryptosystem, Diffie-Hellman Key Exchange, Attacks in RSA, RSAES-OAEP.

Digital Signatures

Digital Signatures, RSA Digital Signature, ElGamal Digital Signature Scheme, Schnorr Digital Signature Scheme, Digital Signature Standard.

User Authentication Protocols

Remote User Authentication Principles, Remote User Authentication Using Symmetric Encryption, Kerberos, Remote User Authentication Using Asymmetric Encryption

Key Management and Distribution

Symmetric Key Distribution Using Symmetric Encryption, Symmetric Key Distribution Using Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Public Key Infrastructure

Transport Layer Security
Secure Sockets Layer (SSL), Transport Layer Security (TLS)
Electronic Mail Security, Pretty Good Privacy (PGP), S/MIME

IP Security
IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, IKE, Virtual Private Network (VPN), Wireless Security, Intruders, Firewall and Malwares.

Reference Books:
1. W. Stallings: Cryptography and Network Security, 5e, Pearson.
References
2. B. A. Forouzan & D. Mukhopadhyay: Cryptography and Network Security, 2e, McGraw-Hill.
3. D. R. Stinson: Cryptography: Theory and Practice (Discrete Mathematics and Its Applications), 3e, CRC Press.
4. B. Schneier: Applied cryptography: protocols, algorithms, and source code in C, 2e, John Wiley & Sons.
5. Bernard Menezes: Network Security & Cryptography, 1st Edition, Cengage Learning, Delhi, 2011.

SEMESTER – VII

Course Title	**: Algorithms - II**
Course Code	**: CSC701**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Geometric algorithms

Convex hulls, Voronoi diagram, line segment intersections, closest pairs, range searching, KD-trees, polygon triangulation.

Revisiting Complexity

Computation model, classes: P, NP, NP-hard and NP-complete; reducibility between problems and NP-completeness: discussion on different NP-complete problems like satisfiability, clique, vertex cover, independent set, Hamiltonian cycle, TSP, knapsack, set cover, bin packing, etc.

Approximation Algorithms

Approximation ratio, vertex cover, set cover, knapsack problem, art gallery problems, and other examples.

Randomized Algorithms

Monte Carlo and Las Vegas algorithms, examples.

Algorithms on Arrays

Linear-time median finding, sorting in linear time, string matching (Rabin-Karp and Knuth-Morris-Pratt algorithms).

Parallelism

The Idea of Parallelism, PRAM Model of Parallel Computation, Pointer

Jumping and Divide & Conquer

Useful Techniques for Parallelization. PRAM Algorithms: Parallel Reduction, Prefix Sums, List Ranking, Preorder Tree Traversal, Merging Two Sorted Lists, Graph Coloring, sorting, matrix multiplication etc.

Reference Books:

1. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.

2. T. H. Cormen, C. E. Leiserson and R. L. Rivest, Introduction to Algorithms, Second Edition, Prentice-Hall, India, 2003.

3. V. Vazirani, Approximation Algorithms, Springer, 2003.

4. M. de-Berg, O. Cheong, M. van-Kreveld, M. Overmars, Computational Geometry, Springer.

Course Title	**: Software Engineering**
Course Code	**: CSC702**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction

Objectives, Definitions, Software Development Life Cycles Models - Waterfall Model, Classical and Iterative Waterfall Model, V Model, Prototype Model, RAD, Evolutionary Models, Spiral Model.

Software Project Management

Issues in Project Management, Project Planning, Metrics for Project Size Estimation – LOC, FP analysis, Project Estimation Techniques, Software Cost Estimation Techniques, COCOMO model, Halstead's Metrics, Software Project Complexity, Staffing Level Estimation – Norden's Work, Putnam's Work, Project Scheduling – CPM/PERT, Risk Management.

Requirements Analysis and Design

Software Requirement Specification (SRS), Software Design Aspects: Top-Down And Bottom-Up design, Cohesion and Coupling; Function Oriented Software Design – ERD, DFD, Decision Tree, Decision Table and Structure chart, Transform Analysis, Functional vs. Object- Oriented approach, User Interface Design.

Coding and Testing

Levels of Testing, Unit Testing, Black-box Testing – Equivalence Class Partitioning, Boundary Value Analysis; White-Box Testing – Basics Concepts, Statement Coverage, Branch Coverage, Multiple Condition Coverage, Path Coverage, McCabe's Cyclomatic Complexity Metric, Data Flow Based Testing, Mutation Testing, Debugging, Integration Testing, System Testing.

Software Reliability and Quality Management

Software Quality, Quality Assurance, ISO, SEI/CMM, Software Maintenance, Software Reuse.

Reference Books:

1. Software Engineering : A practitioner's approach – Pressman (TMH)
2. Software Engineering- Pankaj Jalote (Wiley-India)
3. Software Engineering- Rajib Mall (PHI)
4. Software Engineering -Agarwal and Agarwal (PHI)

Course Title	**: Computational Number Theory (Elective I)**
Course Code	**: CSE726**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Integers

Division algorithm, Euclid's algorithm, linear Diophantine equations, prime numbers, fundamental theorem of arithmetic, distribution of primes, Fermat and Mersenne primes, primality testing and factorization.

Congruence
Basic properties, Modular arithmetic, linear congruences, Chinese Remainder Theorem, arithmetic modulo p, pseudo-primes and Carmichael numbers, Euler's phi function, Fermat's, Euler's and Wilson's theorems, RSA
Quadratic Reciprocity Quadratic residues, Legendre symbol, Gauss lemma, quadratic reciprocity.

Group Theory
Group, Subgroup, Cosets, Lagrange's Theorem, Cyclic groups, order of an element, quotient groups, normal subgroups, Ring, Homomorphisms, Isomorphisms, quotient rings, ideals, prime ideals, maximal ideals, integral domains, division ring/skew field, Integral domain, Field, Galois Field, minimal polynomial, Primitive polynomial.

Elliptic Curve
Definition, Group Structure on an Elliptic Curve, Integer Factorization Using Elliptic Curves, Elliptic Curve Cryptography, Computational Problems on Elliptic Curve.

Reference Books:

1. Gareth A. Jones and J. Mary Jones: Elementary Number Theory, Springer, 8th Ed., 2007.
2. Ivan Niven, Herbert S. Zuckerman, Hugh L. Montgomery: Introduction to the Theory of Numbers, Wiley, 5th Ed., 2000.
3. David M. Burton: Elementary Number Theory, McGraw-Hill, 6th Ed., 2005.
4. D. Hankerson, A.J. Menezes, S. Vanstone: Guide to Elliptic Curve Cryptography, Springer, 2004.
5. J. Scherk, Algebra: A Computational Introduction. University of Toronto.
6. Thomas Koshy: Elementary Number Theory with Applications, 2nd Ed., Academic Press, 2007.
7. Victor Shoup; A Computational Introduction to Number Theory and Algebra, 2nd edition, Cambridge University Press.
8. Martin E. Hellman; Number Theory for Computing, Second Edition, Springer.
9. Eric Bach, Jeffrey Shallit; Algorithmic Number Theory, Vol. 1: Efficient Algorithms (Foundations of Computing), The MIT Press (August 26, 1996).

Course Title	**: Computer Graphics and Multimedia (Elective I)**
Course Code	**: CSE728**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Basics, Graphics primitives (drawing line and curve), Application and scope, Graphics standard, Interaction and GUI

Display Systems
Raster displays, CRT basics, Video basics, Flat panel basics, Input devices

Drawing and Clipping Algorithms
Raster Graphics; line and circle drawing algorithms; Windowing and 2D/3D clipping. Cohen and Sutherland line clipping, Cyrus Beck clipping method

2D and 3D Geometrical Transformations
Scaling, translation, rotation, reflection; Viewing Transformations: parallel and perspective projection

Curves and Surfaces
Cubic splines, Bezier curves, B-splines, Parametric surfaces.
Surface of revolution Sweep surfaces, Fractal curves and surfaces
Hiddenline/surface removal methods;

Illumination and Shading
Illuminations model; Shading algorithms- Gouraud and Phong shading, Introduction to Ray-tracing

Multimedia
Basics, Multimedia applications, Multimedia system architecture, Evolving technologies for multimedia, text, graphics, audio, video, animation, Multimedia authoring and user interface

Compression and decompression
Audio and video compression standards, Data and file format standards,

Multimedia Database
Data structures – quad trees , R-trees ; image databox, text and document database ; video database ; audio database ; design and architecture of a MM database.

Reference Books:

1. Computer Graphics - C version; D. Hearn and M. P. Baker; Pearson Education
2. Computer Graphics - OpenGL version; D. Hearn and M. P. Baker; Pearson Education
3. Computer Graphics; Principles and practice; J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes; Addison Wesley
4. P. K. Andleigh, Kiran Thakrar, Multimedia Systems and Design, PHI

Course Code	**: CSE730**
Course Title	**: Computer Vision and Image Understanding (Elective II)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Digital Image Fundamentals

Imaging and image representation, digital distances, intensity transformation and image enhancement: point processing, basic intensity transformation functions, histogram processing, image binarization, segmentation of grey level images, advanced binarization techniques. Detection of edges and lines in 2D images, Canny's edge detection algorithm, Hough transform for detecting lines and curves, morphological processing, medial axis, skeletonization, connected-component labelling, thinning

Filtering and Images Enhancement

Spatial filtering, frequency domain filtering and enhancement, color models, color representation

Image Representation and Description

Chain codes, polygonal approximation, boundary descriptors, topological descriptors, curve and surface, digital straightness.

Camera Geometry and Feature Extraction

Predictive and camera geometry, Harris corner detection, Scale Invariant Feature Transform (SIFT), Speeded-Up Robust Features, (SURF) and other techniques.

Feature Matching and Model Fitting

Feature description, matching and model fitting, dimensionality reduction,

Deep Architecture

Deep neural architecture and application in Computer Vision problems.

Reference books:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson.
2. R. Klette and A. Rosenfeld, Digital Geometry: Geometric Methods for Digital Picture analysis, Morgan Kaufmann Publishers.
3. Rosenfeld and A. C. Kak, Digital Picture Processing, Elsevier.
4. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.

5. Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press.
6. Computer Vision: Algorithms & Applications, R. Szeleski, Springer.
7. Computer vision: A modern approach: Forsyth and Ponce, Pearson

Course Code	**: CSE722**
Course Title	**: Data Analytics and Optimization Techniques (Elective II)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction

Introduction to Data Analytics, Data Analysis vs. Data Analytics, Data Analytics and its applications, Descriptive, Predictive and Perspective data analytics for optimal solutions, Basic concept of Probability & Statistics, Descriptive statistics – Different Approaches.

Statistical and Machine Learning Approaches

Inferential Statistics, Programming Approach for Distributions, Hypothesis Testing, ANOVA, Machine Learning Approaches: Classification and Regression, Linear and Non-linear Regression, Estimation, Prediction, Confusion Matrix, RoC analysis, Optimal Threshold Value Estimation and Analysis, Classification Report on Optimal Threshold Value, Goodness of Fit Test - Chi-square Test, Data analytics for Randomness, Concept of Big Data Analysis, Different Data Analytic Tools.

LPP

Canonical forms of LPP and its Economic Interpretation, Solving LPP using Simultaneous Equations and Graphical Methods, Cost optimization, Simplex Method, Charne's Method of Penalties, Duality Theory, Optimal solutions using NWC Rule, LCM, Vogel's Approximation, etc., Assignment problem - Hungarian method, IPP, Different Problem Solving Tools.

Optimization Algorithms

Particle Swarm Optimization, Ant Colony Optimization, Bee Colony Optimization, Butterfly Optimization, Artificial Fish Swarm Optimization, Project Data Analytics - Time-Cost Optimization Techniques, Optimum Scheduling Period.

Reference books:

1. Predictive Analytics - Eric Siegel

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2. Core Concepts in Data Analysis: Summarization, Correlation, Visualization - Boris Mirkin
3. Data Science for Business - Tom Faucett
4. Optimization Techniques – Chader Mohan and Kusum Deep
5. Optimization Techniques – L.R. Foulds
6. Operation Research with C Programs – S. Kalavathy
7. Optimization Techniques – A.K. Malik, S.K. Jadav, S.R Jadav
8. Data Analytics using Python - Bharti Motwani

Course Code	**: CSE733**
Course Title	**: Neural Network & Deep Learning (Elective II)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Introduction to the Neural Network, Training Feed Forward Network

Mechanics of Machine Learning
Building Intelligent Machines, The Limits of Traditional Computer Programs, The Mechanics of Machine Learning, The Neuron, Expressing Linear Perceptrons as Neurons, Feed-Forward Neural Networks, Linear Neurons and their Limitations, Sigmoid, Tanh, and ReLU Neurons, Softmax Output Layers

Gradient Descent
Gradient Descent, The Delta Rule and Learning Rates, Gradient Descent with Sigmoidal Neurons, The Backpropagation Algorithm, Stochastic and Minibatch Gradient Descent, Overfitting, Preventing Overfitting in Deep Neural Networks

Convolutional Neural Networks
Beyond Gradient Descent, Convolutional Neural Networks, Embedding

Challenges with Gradient Descent
The Challenges with Gradient Descent, Local Minima in the Error Surfaces of Deep Networks, Model Identifiability, How Pesky Are Spurious Local Minima in Deep Networks?, Flat Regions in the Error Surface

Architectural Description of Convolution Networks
Neurons in Human Vision, The Shortcomings of Feature Selection, Vanilla Deep Neural Networks Don't Scale, Filters and Feature Maps, Full Description of the Convolutional Layer, Max Pooling, Full Architectural Description of Convolution Networks

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Lower-Dimensional Representations
Learning Lower-Dimensional Representations, Principal Component Analysis, Motivating the Autoencoder Architecture, Denoising to Force Robust Representations, Sparsity in Autoencoders, When Context Is More Informative than the Input Vector, The Word2Vec Framework, Skip-Gram Architecture,

Sequence Analysis
Models for Sequence Analysis, Memory Augmented Neural Networks Analyzing Variable-Length Inputs, Tackling seq2seq with Neural N-Grams, Implementing a Part-of-Speech Tagger, Dependency Parsing and SyntaxNet, Beam Search and Global Normalization, A Case for Stateful Deep Learning Models, Recurrent Neural Networks, Long Short-Term Memory (LSTM) Units, Solving seq2seq Tasks with Recurrent Neural Networks

Neural Turing Machines
Neural Turing Machines, Attention-Based Memory Access, NTM Memory Addressing Mechanisms, Differentiable Neural Computers

Neural network using Tensorflow
What Is TensorFlow? How Does TensorFlow Compare to Alternatives? Installing TensorFlow, Creating and Manipulating TensorFlow Variables, TensorFlow Operations, Placeholder Tensors, Sessions in TensorFlow, Specifying the Logistic Regression Model in TensorFlow, Implementing an Autoencoder in TensorFlow

Reference books

1. Fundamentals of Deep Learning - Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma, O'REILLY publisher
2. Learning Tensorflow - A Guide to Building Deep Learning Systems, Tom Hope, Yehezkel S. Resheff & Itay Lieder, O'REILLY publisher

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Course Code	**: CSE727**
Course Title	**: Computational Complexity**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Easy and hard problems. Algorithms and complexity.

Turing machines

Turing machines, Models of computation. Multitape deterministic and non deterministic Turing machines.

Decision problems

The Halting Problem and Undecidable Languages. Counting and diagonalisation. Tape reduction, Universal Turing machine. Undecidability of halting, Reductions, Rice's theorem.

Deterministic Complexity

Deterministic Complexity Classes, Linear Speed-up Theorem, Polynomial reducibility.
Polytime algorithms: 2-satisfiability, 2-colourability.

NP

NP and NP-completeness. Non-deterministic Turing machines, Polynomial time verification.
NP-completeness, Cook-Levin Theorem, Polynomial transformations: 3-satisfiability, clique, colourability, Hamilton cycle, partition problems. Pseudo-polynomial time. Strong NP-completeness, Knapsack, NP-hardness.

Space complexity

Space complexity and hierarchy theorems. Linear Space Compression Theorem, PSPACE, NPSPACE.
PSPACE = NPSPACE, PSPACE-completeness. The Quantified Boolean Formula problem is PSPACE-complete.
L, NL and NL-completeness, NL=coNL, Hierarchy theorems.

Optimization and approximation

Optimization and approximation, Combinatorial optimisation problems, Relative error, Bin-packing problem.
Polynomial and fully polynomial approximation schemes, Travelling salesman problem, minimum partition.

Randomized Complexity

Randomized Complexity, The classes BPP, RP, ZPP.

Reference books:

1. Computers and Intractability: A Guide to the Theory of NP-Completeness by Michael R. Garey, David S. Johnson
2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.

3. Vijay Vazirani, Approximation Algorithms, Springer.
4. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.
5. C H Papadimitriou. Computational Complexity, Addison-Wesley.
6. T H Cormen, S Clifford, C E Leiserson and R L Rivest. Introduction to Algorithms, MIT Press, Second edition.

SEMESTER – VIII

Course Title	**: Speech and Natural Language Processing (Elective III)**
Course Code	**: CSE822**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Introduction to Natural Language Processing.

Regular Expressions and Automata
Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithms, Language, Thought, and Understanding, The State of the Art and The Near-Term Future, Some Brief History: Foundational Insights- 1940's and 1950's, The Two Camps- 1957–1970, Four Paradigms- 1970–1983, Empiricism and Finite State Models Redux- 1983-1993, The Field Comes Together- 1994-1999, A Final Brief Note on Psychology, Regular Expressions, Basic Regu-lar Expression Patterns, Disjunction, Grouping, and Precedence, A simple example, A More Complex Ex-ample, Advanced Operators, Regular Expression Substitution, Memory, and ELIZA, Finite-State Automata, Using an FSA to Recognize Sheep talk, Formal Languages, Another Example, Nondeterministic FSAs, Using an NFSA to accept strings, Recognition as Search, Relating Deterministic and Non-deterministic Automata, Regular Languages and FSAs, Dealing with Spelling Errors, Spelling Error Patterns, Detecting Non-Word Errors, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance

N-gram Language Modelling, Smoothing
Counting Words in Corpora, Simple (Un-smoothed) N-grams, More on N-grams and their sensitivity to the training corpus, Smoothing, Add-One Smoothing, Witten-Bell Discounting, Good-Turing Discounting, Backoff, Combining Backoff with Discount-ing, Deleted Interpolation, N-grams for Spelling and Pronunciation, Context-Sensitive Spelling Error Cor-rection, N-grams for Pronunciation Modeling, Entropy, Cross Entropy for Comparing Models, The Entropy of English, Naive Bayes, MaxEnt

POS Tagging, Parsing
Part of Speech Tagging, Rule-based Part-of-speech Tagging, Sto-chastic Part-of-speech Tagging, A Motivating Example, The Actual Algorithm for HMM tagging, Transfor-mation-Based Tagging, How TBL rules are applied, How TBL Rules are Learned, Multiple tags and multiple words,
Unknown words, Class-based N-grams, Sentiment Analysis, Parsing as Search, Top-Down Parsing, Bottom Up Parsing, Comparing Top-down and Bottom-up Parsing, A Basic Top-down Parser, Adding Bottom-up Filtering, Problems with the Basic Top-down Parser, Left-Recursion, Ambiguity, Repeated Parsing of Sub-trees, The Earley Algorithm, Finite-State Parsing Methods, Information Extraction, Named Entity Recogni-tion

Information Retrieval, Question Answering, Semantics
Relations among Lexemes and Their Senses, Homonymy, Polysemy, Synonymy, Hyponymy, WordNet: A Database of Lexical Relations, Selection Restriction-Based Disambiguation, Limitations of Selection Restrictions, Robust Word Sense Dis-ambiguation, Machine Learning Approaches, Dictionary-Based Approaches, Information Retrieval, The Vector Space Model, Term Weighting, Term Selection and Creation, Summarization, What Makes Dialogue Different?, Turns and Utterances, Grounding, Conversational Implicature, Dialogue Acts, Automatic Interpretation of Dialogue Acts, Plan-Inferential Interpretation of Dialogue Acts, Cue-based interpretation of Dialogue Acts, Dialogue Structure and Coherence, Dialogue Managers in Conversational Agents

Reference Books:
1. Speech and Natural Language Processing, D. Jurafsky and J. H. Martin, Pearson, Second Edition

Course Title	**: Cyber Physical System (Elective III)**
Course Code	**: CSE837**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction
Definition, Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications Building Automation, Medical CPS

Design and Implementation
Sensors and Actuators, Embedded Processors, Memory Architectures, Input and Output Interface, Multitasking, Scheduling

CPS implementation issues

From features to automotive software components, Mapping software components to ECUs

Analysis and Verification
Invariants and Temporal Logic, Equivalence and Refinement, Rechability Analysis, Model Checking, Timing Analysis

Intelligent CPS
Safe Reinforcement Learning
Robot motion control
Autonomous Vehicle control
Gaussian Process Learning
Smart Grid Demand Response
Building Automation

Secure Deployment of CPS
Secure Task mapping and Partitioning
State estimation for attack detection
Automotive Case study : Vehicle ABS hacking
Power Distribution Case study : Attacks on SmartGrids

Reference Books:

1. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.
2. Rajeev Alur. Principles of Cyber-Physical Systems. MIT Press. 2015.
3. K. J. Astrom and R. M. Murray. Feedback Systems: An Introduction for Scientists and Engineers. Prince- ton University Press, 2009. http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page.

Course Code	**: CSE834 (Elective IV)**
Course Title	**: Information Theory and Coding**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction to Information Theory
What is information; Relationship of information theory to other fields, e.g., electrical science, computer science, physics, mathematics, economics;

Entropy
Relative entropy; Mutual Information; Asymptotic Equipartition Property (AEP); Entropy rate.

Data Compression

Lossy and loss-less compression; Huffman and Lempel Ziv coding.

Channel Capacity and Channel Coding
Noiseless Binary Channel; Binary Symmetric Channel, Binary Erasure Channel; Channel Coding theorem; Classification of Coding Schemes, Linear Block Code: Hamming Code.

Rate Distortion Theory
Definitions; Calculation of Rate Distortion Function; Converse and achievability of Rate Dis-tortion Function; Characterization of Rate Distortion Function;

Information Theory and Statistics
Law of Large Numbers; Large Deviation Theory; Hypothesis Testing; Fisher Information; Rao-Cramer inequality; Information Theory based Statistical Inference.
Kolmogorov Complexity

Information Theoretic Methods in Machine Learning
Information Theoretic (IT) Clustering; IT Feature Selection; IT Semi-Supervised Learning; Information Theoretic metrics.

Reference books:
1. Elements of Information Theory- Thomas M. Cover and Joy A. Thomas, 2nd ed, Wiley
2. Information Theory, Inference and Learning Algorithms - David J. C. MacKay, Ebook (http://www.inference.phy.cam.ac.uk/mackay/itila/)
3. Algebraic Coding Theory - Elwyn R. Berlekamp - McGraw-Hill
4. The Theory of Information and Coding - Robert J. McEllice

Course Code	**: CSE835 (Elective IV)**
Course Title	**: Advanced Cryptography**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Introduction and Classical Cryptography
Introduction and motivation, Classical Cryptography,
Security Attacks: Definition, Historical Ciphers and Their Cryptanalysis
Basic Principles of Modern Cryptography

Probability Theory

Probability theory, Information theory, Computational Complexity

Perfectly Secure Encryption
Perfect Secrecy: Definitions and Basic Properties
The One-Time Pad (Vernam's Cipher), Limitations of Perfect Secrecy
Shannon's Theorem

Private-Key Encryption
Basic Idea of Computational Security, Definition of Negligible Success, Proofs by Reduction, Computationally-Secure Encryption, Pseudorandomness and Secure Encryption, Chosen-Plaintext Attacks (CPA), CPA-Secure Encryption Schemes, Security Against Chosen-Ciphertext Attacks (CCA)

Collision-resistance Hash Function
Collision-resistance Hash Function: Definitions and Properties
Random Oracle Model and Birthday Attack

Digital Signature
The RSA signature scheme and attacks, The Rabin public-key signature scheme, The Fiat-Shamir signature schemes, The Guillou-Quisquater Signature Scheme

Public Key Cryptosystem
Publlic Key Encryption: Chosen-Plaintext Attack, RSA Encryption and Attacks, OAEP, The Rabin Encryption Scheme, The Paillier encryption scheme

Elliptic Curve Cryptography
Introduction to elliptic curves, Point representation and the group law
Point multiplication, The elliptic curve discrete logarithm problem, ECC-based Diffie-Hellman Key Agreement Protocol

Reference books:

1. J. Katz, Y. Lindell: “Introduction to Modern Cryptography”, Chapman & Hall/CRC Press, 3rd Ed., 2007.
2. Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone: “Handbook of Applied Cryptography”, CRC Press, 2018.
3. Wenbo Mao: "Modern Cryptography: Theory and Practice", Pearson, 1st Ed., 2003.
4. Darrel Hankerson, Alfred Menezes, Scott Vanstone: "Guide to Elliptic Curve Cryptography", Springer, 1st Ed., 2004.

Course Code	**: CSE825**
Course Title	**: Coding Theory (Elective V)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**
Credit	**: 3**

Overview of Coding Theory

Error detection, correction and decoding, Communication channels, Maximum likelihood decoding, Hamming distance.

Finite (Galois) fields

Groups, Rings, Fields, Polynomial rings, Structure of finite fields, Minimal polynomials

Linear Codes

Vector spaces over finite fields, Linear codes, Hamming weight, Bases for linear codes, Generator matrix and parity-check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Syndrome decoding.

Cyclic Codes

Definitions, Generator polynomials, Generator and parity-check matrices, Decoding of cyclic codes

Bounds on codes

The main coding theory problem, Lower bounds, Sphere-covering bound, Gilbert–Varshamov bound, Hamming bound and perfect codes, Singleton bound and MDS codes.

BCH Codes

Definitions, Parameters of BCH codes, Decoding of BCH codes
Additional codes (Reed-Muller, Goppa etc.) if time permits.

Reference books :

1. MacWilliams, F. J. and Sloane, N. J. A. The theory of error-correcting codes. North-Holland Mathematical Library. North-Holland Publish- ing Co., New York, 1977.
2. Van Lint, J. H. Introduction to coding theory, Third edition. Graduate Texts in Mathematics, 86. Springer-Verlag, Berlin, 1999.

Course Code	**: ECE825**
Course Title	**: Low Power Circuits & Systems (Elective V)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Credit : 3

Basics of MOS circuits
MOS Transistor structure and device modeling
MOS Inverters
MOS Combinational Circuits - Different Logic Families

Sources of Power dissipation
Dynamic Power Dissipation
Short Circuit Power, Switching Power, Gliching Power
Static Power Dissipation
Degrees of Freedom

Supply Voltage Scaling Approaches
Device feature size scaling
Multi-Vdd Circuits
Architectural level approaches: Parallelism, Pipelining
Voltage scaling using high-level transformations
Dynamic voltage scaling
Power Management

Switched Capacitance Minimization Approaches
Hardware Software Tradeoff
Bus Encoding
Two's complement Vs Sign Magnitude
Architectural optimization
Clock Gating
Logic styles

Leakage Power minimization Approaches
Variable-threshold-voltage CMOS (VTCMOS) approach
Multi-threshold-voltage CMOS (MTCMOS) approach
Power gating
Transistor stacking
Dual-Vt assignment approach (DTCMOS)

Special Topics
Adiabatic Switching Circuits
Battery-aware Synthesis
Variation tolerant design

Reference books

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1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.

2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint)

3. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000