Course structure of B. Tech. (CSE-2021 onwards)

Semester	Course Code	Course name	L-T-P-Credit	Offering Department
Semester I	CE111	Engineering Drawing	1-0-3-5	Civil
	EE101	Electrical Sciences	3-1-0-8	Electrical
	HS103	Communicative English for Engineers	2-0.5-1-6	Humanities and Social Science
	MA101	Mathematics I	3-1-0-8	Mathematics
	ME110	Workshop-I	0-0-3-3	Mechanical
	PH103	Physics –I	3-1-0-8	Physics
	PH 110	Physics Laboratory	0-0-3-3	Physics
	Total credits: 41			
Semester II	CB102&CE102	Biology and Environmental Studies	3-0-0-6	CB & CE
	CH103	Introductory Chemistry	3-1-0-8	Chemistry
	CH110	Chemistry Laboratory	0-0-3-3	Chemistry
	CS102	Programming and Data Structures	3-0-0-6	CS
	CS112	Programming and Data Structures Laboratory	0-0-3-3	CS
	EE103	Basic Electronics Laboratory	0-0-3-3	EE
	MA102	Mathematics –II	3-1-0-8	Mathematics
	ME102	Engineering Mechanics	3-1-0-8	ME
	Total credits: 45			
Semester III	MA2XX	Mathematics III	3-0-0-6	Mathematics
	HS2XX	HSS Elective – I	3-0-0-6	Humanities and Social Science
	CS204	Algorithms	3-0-0-6	CS
	CS224	Algorithms Laboratory	0-0-3-3	CS
	CS203	Discrete Mathematics	3-0-0-6	CS
	CS227	Digital Systems	2-0-2-6	CS

	CS271	Optimization techniques	3-0-0-6	CS
	CS230	Software Lab/Tools	0-0-3-3	CS
			Total credits: 42	
Semester IV	HS2XX	HSS Elective – II	3-0-0-6	Humanities and Social Science
	MA225	Prob. Theory and Random Processes	3-0-0-6	Mathematics
	CS209	Computer Architecture	3-0-0-6	CS
	CS210	Computer Architecture Lab	0-0-3-3	CS
	CS267	Theory of computation	3-0-0-6	CS
	CS259	Database	3-0-0-6	CS
	CS260	Database Lab	0-0-3-3	CS
		Total credits: 36		
Semester V	XX3XX	Open Elective-II	3-0-0-6	Science/Egg.
	CS358	Computer Network	3-0-0-6	CS
	CS359	Computer Network Lab	0-0-3-3	CS
	CS341	Operating Systems	3-0-0-6	CS
	CS340	Operating Systems Lab	0-0-3-3	CS
	CS304	Algorithm-II	3-0-0-6	CS
	CS389	Innovative Design Lab	0-0-3-3	CS
		Total credits: 33		
Semester VI	HS3XX	HSS Elective – III	3-0-0-6	Humanities and Social Science
	CS3XX	CS Elective-I	3-0-0-6	CS
	CS351	PPL + Compiler	3-0-0-6	CS
	CS352	PPL + Compiler Lab	0-0-3-3	CS
	CS366	Artificial Intelligence	3-0-0-6	CS
	CS367	Artificial Intelligence Lab	0-0-3-3	CS
	CS309	Machine Learning Data Science	3-0-0-6	CS
	CS397	Capstone Project	0-0-3-3	CS

	Total credits: 39	

Course structure for B. Tech. (CSE-2020)

VII SEMESTER

Sl.No.	Course No.	Course Title	L	T	P	C
1	XX4nn	Open Elective	3	0	0	6
2	CSXXX	CS Elective -2	3	0	3	9
3	CSXXX	CS Elective -3	3	0	0	6
4	CSXXX	CS Elective -4	3	0	0	6
5	CS491	Project-I	0	0	6	6
TOTAL			12	0	9	33

VIII SEMESTER

Sl.No.	Course No.	Course Title	L	T	P	C
1	CSXXX	CS Elective -5	3	0	0	6
2	CSXXX	CS Elective -6	3	0	0	6
3	CSXXX	CS Elective -7	3	0	0	6
4	CS492	Project-II	0	0	12	12
TOTAL			9	0	12	30

Detailed Syllabus

Semester I

CE111	Engineering Drawing	1-0-3-5	Civil

Geometrical construction of simple plane figure: Bisecting the line, draw perpendicular, parallel line, bisect angle, trisect angle, construct equatorial triangle, square, polygon, inscribed circle.

Free hand sketching: prerequisites for freehand sketching, sketching of regular and irregular figures.

Drawing scales: Engineering scale, graphical scale, plane scale, diagonal scale, comparative scale, scale of chord.

Orthographic projection: Principle of projection, method of projection, orthographic projection, plane of projection, first angle of projection, third angle of projection, reference line.

Projection of points, lines and plane: A point is situated in the first quadrant, point is situated in the second quadrant, point is situated in the third quadrant, point is situated in the fourth quadrant, projection of line parallel to both the plane, line contained by one or both the plane, line perpendicular to one of the plane, line inclined to one plane and parallel to other, line inclined to both the plane, true length of line.

Missing views: Drawing of missing front view of a solid, missing top view of solids, missing side view of solids, Orthographic projection of simple solid: Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

Orthographic projection of simple solid: Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

Text and Reference Books:

1. B. Agrawal and CM Agrawal, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2008.
2. D. A. Jolhe, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2006.
3. K. Venugopal, Engineering Drawing and Graphics, 2nd ed., New Age International, 1994.

EE101	Electrical Sciences	3-1-0-8	Electrical

Circuit Analysis Techniques, Circuit elements, Simple RL and RC Circuits, Kirchhoff’s law, Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Thevnin's and Norton's Theorems, Time Domain Response of RC, RL and RLC circuits, Sinusoidal Forcing

Function, Phasor Relationship for R, L and C, Impedance and Admittance.

Semiconductor Diode, Zener Diode, Rectifier Circuits, Clipper, Clamper, Bipolar Junction Transistors, Transistor Biasing, Transistor Small Signal Analysis, Transistor Amplifier, Operational Amplifiers, Op-amp Equivalent Circuit, Practical Op-amp Circuits, DC Offset, Constant Gain Multiplier, Voltage Summing, Voltage Buffer, Controlled Sources, Instrumentation Circuits, Active Filters and Oscillators.

Number Systems, Logic Gates, Boolean Theorem, Algebraic Simplification, K-map, Combinatorial Circuits, Encoder, Decoder, Combinatorial Circuit Design, Introduction to Sequential Circuits.

Magnetic Circuits, Mutually Coupled Circuits, Transformers, Equivalent Circuit and Performance, Analysis of Three-Phase Circuits, Electromechanical Energy Conversion, Introduction to Rotating Machines.

Text and Reference Books:

1. C. K. Alexander and M. N. O. Sadiku, Fundamentals of Electric Circuits, 3rd Edition, McGraw-Hill, 2008.
2. W. H. Hayt and J. E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill, 1993.
3. Donald A Neamen, Electronic Circuits; analysis and Design, 3rd Edition, Tata McGraw-Hill Publishing Company Limited.
4. Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.
5. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 6th Edition, PHI, 2001.
6. M. M. Mano, M. D. Ciletti, Digital Design, 4th Edition, Pearson Education, 2008.
7. Floyd and Jain, Digital Fundamentals, 8th Edition, Pearson.
8. A. E. Fitzgerald, C. Kingsley Jr. and S. D. Umans, Electric Machinery, 6th Edition, Tata McGraw-Hill, 2003.
9. D. P. Kothari and I. J. Nagrath, Electric Machines, 3rd Edition, McGraw-Hill, 2004.

HS103	Communicative English for Engineers	2-0.5-1-6	HSS

In today's 'global village', there are many who believe that 'Communication is like breathing and life would cease to continue without it'. This particular course on communication skills imbibes the same and therefore, it aims to equip the students with getting the basics right of communication and presentation skills for academic and professional purposes. It is designed to help the second language learners acquire fluency in both spoken and written English to communicate information with clarity, precision and confidence especially in the professional

sphere. It will introduce learners not only to the basic concepts in communication but also focus on providing them a hands-on experience of the same. It is hoped that after commanding the skills required in spoken and written English, learners will be able to express themselves more effectively.

The course will have ten units and shall focus on the following topics:

Unit 1: Language and Communication

What is Communication

Nature, Style and Process of Communication

Communication Barriers

Objectives and Importance of Communication

Formal and Informal Communication

Verbal and Non Verbal Communication

Unit 2: English Language Remedial Skills

Construction of Sentences

Subject-Verb Agreement

Tenses

Active and Passive Voice

Direct and Indirect Speech

Common Errors

Unit 3: Oral Skills

Public Speaking

Dealing with lack of confidence

Making an Effective Presentation

Telephone Etiquette

Understanding GD

Why conduct a GD?

How to gear up for a GD?

Different Phases of GD

Unit 4: Listening Skills

Meaning of Listening

Different Types of Listening

Barriers to Listening and Methods to overcome them

Various strategies to develop effective Listening

Semantic Markers

Unit 5: Reading Skills

What is Reading?

Types of Reading

Reading Comprehension

Unit 6: Writing Skills

Business Correspondence

Element and Style of Writing

Report Writing

Notice, Agenda and Minutes

Unit 7: Interview Techniques

How to prepare for an Interview

An Interview

Text and Reference Books:

1. V. S. Kumar, P.K. Dutt and G. Rajeevan, A Course in Listening and Speaking-I, Foundation books, 2007.
2. V.Sasikumar, P.KiranmaiDutt, GeethaRajeevan, "A Course in Listening and Speaking-II', Foundation books, 2007.
3. Rizvi, Ashraf, Effective Technical Communication, Tata McGraw Hill, 2005.
4. Nitin Bhatnagar and MamtaBhatnagar, 'Communicative English for Engineers and Professionals, Pearson, 2010.

MA101	Mathematics I	3-1-0-8	Mathematics

Properties of real numbers. Sequences of real numbers, monotone sequences, Cauchy sequences, divergent sequences. Series of real numbers, Cauchy’s criterion, tests for

convergence. Limits of functions, continuous functions, uniform continuity, monotone and inverse functions. Differentiable functions, Rolle's theorem, mean value theorems and Taylor's theorem, power series. Riemann integration, fundamental theorem of integral calculus, improper integrals. Application to length, area, volume, surface area of revolution. Vector functions of one variable and their derivatives. Functions of several variables, partial derivatives, chain rule, gradient and directional derivative. Tangent planes and normals. Maxima, minima, saddle points, Lagrange multipliers, exact differentials. Repeated and multiple integrals with application to volume, surface area, moments of inertia. Change of variables. Vector fields, line and surface integrals. Green's, Gauss' and Stokes' theorems and their applications.

Text Books:

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 6th Ed/9th Ed, Narosa/ Addison Wesley/ Pearson, 1985/ 1996.
2. T. M. Apostol, Calculus, Volume I, 2nd Ed, Wiley, 1967. T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969.

Reference Books:

1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 5th Ed, Wiley, 1999.
2. J. Stewart, Calculus: Early Transcendentals, 5th Ed, Thomas Learning (Brooks/ Cole), Indian Reprint, 2003.

ME110	Workshop-I	0-0-3-3	Mechanical

Sheet Metal Working:

Sheet material: GI sheets, aluminum, tin plate, copper, brass etc.; Tools: steel rule, vernier calipers, micrometer, sheet metal gauge, scriber, divider, punches, chisels,

hammers, snips, pliers, stakes etc.; operations: scribing, bending, shearing, punching

etc.; Product development: hexagonal box with cap, funnel etc.

Pattern Making and Foundry Practice:

Pattern material: wood, cast iron, brass, aluminum, waxes etc.; Types of patterns: split, single piece, match plate etc.; Tools: cope, drag, core, core prints, shovel, riddle, rammer, trowel, slick, lifter, sprue pin, bellow, mallet, vent rod, furnace etc. Moldings

sands: green sand, dry sand, loam sand, facing sand etc., Sand casting: Sand

preparation, mould making, melting, pouring, and cleaning. Joining:

Classifications of joining processes; Introduction to Arc welding processes; power

source; electrodes; edge preparation by using tools bench vice, chisels, flat file, square

file, half round file, round file, knife edge file, scrapers, hacksaws, try squares; cleaning

of job, Job: lap and butt joints using manual arc welding.

Machining centre:

Introduction to different machine tools; Working principle of lathe, milling, drilling etc.; Setting and preparation of job using lathe and milling; Performing different operations namely, straight turning, taper turning, knurling, thread cutting etc.; Introduction to dividing head, indexing, performing operation in milling using indexing mechanism. CNC centre: Introduction to CNC machines; Fundamentals of CNC programming using G and M code; setting and operations of job using CNC lathe and milling, tool reference, work reference, tool offset, tool radius compensation.

Text and Reference Books:

1. H. Choudhury, H. Choudhary and N. Roy, Elements of Workshop Technology, vol. I,Mediapromoters and Publishers Pvt. Ltd., 2007.
2. W. A. J. Chapman, Workshop Technology, Part -1, 1st South Asian Edition, Viva Book Pvt Ltd., 1998.
3. P.N. Rao, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill PublishingCompany, 2009.
4. B.S. Pabla, M.Adithan, CNC machines,New Age International, 2012.
5. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 6th Ed/9th Ed, Narosa/Addison Wesley/Pearson, 1985/1996.
6. T. M. Apostol, Calculus, Volume I, 2nd Ed, Wiley, T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969/1967.

PH103	Physics-I	3–1–0–8	PH

Orthogonal coordinate systems and frames of reference, conservative and non-conservative forces, work-energy theorem, potential energy and concept of equilibrium; Rotation about fixed axis, translational-rotational motion, vector nature of angular velocity, rigid body rotation and its applications, Euler's equations; Gyroscopic motion and its application; Accelerated frame of reference, centrifugal and Coriolis forces.

Harmonic oscillator damped and forced oscillations, resonance, coupled oscillations, small oscillation, normal modes, longitudinal and transverse waves, wave equation, plane waves, phase velocity, superposition wave packets and group velocity, two and three dimensional waves.

Failure of classical concepts, Black body radiation, photo-electric effect, Compton effect, Davison and Germer's experiment, Frank-Hertz experiment, Bohr's theory, Sommerfeld's model, correspondence principle, Planck hypothesis, De Broglie's hypothesis, Hilbert space, observables, Dirac notation, principle of superposition, wave packets, phase and group velocities, probability & continuity equation, eigenvalues and eigen functions, orthonormality,

expectation values, uncertainty principle, postulates of Quantum Mechanics, Schrodinger equation & its applications to 1D potentials, field quantization, periodic potential wells: Kronig Penny model and origin of band gap.

Textbooks:

1. D. Kleppner and R. J. Kolenkow, An introduction to Mechanics, Tata McGraw-Hill, New Delhi, 2000.
2. David Morin, Introduction to Classical Mechanics, Cambridge University Press, NY, 2007.
3. Frank S. Crawford, Berkeley Physics Course Vol 3: Waves and Oscillations, McGraw Hill, 1966.
4. Eyvind H. Wichmann, Berkeley Physics Course Vol 4: Quantum physics, McGraw Hill, 1971.

Reference Books:

5. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol I, Narosa Publishing House, New Delhi, 2009.
6. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol III, Narosa Publishing House, New Delhi, 2009.
7. R. Eisberg and R. Resnick, Quantum Physics of atoms, molecules, solids, nuclei and particles, John Wiuley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
8. A. J. Dekker, Solid State Physics, Macmillan Pub. India Ltd., New Delhi, 2009
9. David J. Griffith, Introduction to Quantum Mechanics, Pearson Education Ltd, New Delhi, 2009.
10. B.H. Bransden& C.J. Joachain, Quantum Mechanics, Pearson Education Ltd, New Delhi, 2008.

PH110	Physics Laboratory	0-0-3-3	PH

The list of experiments is as follows:

- Instructions to Students
- Introduction to Error Analysis

Ex 1 Decay of Current in A Capacitive Circuit

Ex 2 Q-Factor of an LCR Circuit

Ex 3 Study of Hall Effect

Ex 4 Speed of Sound in Air

Ex 5 ‘g’ by A Compound Pendulum

Ex 6 Speed of Light in Glass

Ex 7 Determination of e/m

Ex 8 Interference of Light: Newton's Ring

Ex 9 Surface Tension of Water by Method of Capillary Ascent

Ex 10 Determination of Plank's constant by Photoelectric Effect

Semester II

CB102&CE102	Biology and Environment Studies	3-0-0-6	CB & CE

Module 1 - Biology: 1. Cell – Structure and logic of optimization; 2. Blood – The following tissue – Basis and rationale; 3. Organs – Structure, function, interactions, failure; 4. Molecular basis of disorders – example: Diabetes; 5. Modern techniques of evaluations and corrections; 6. Open discussions – Feedback from students

Module 2 – Environmental Science / Studies: 1.Ecology and Sustainable Development – Ecosystems, Natural cycles, Biodiversity, Man and environment; 2. Water Resources – Hydrologic cycle and its components, Groundwater and surface water, Water quality; 3. Environmental Sanitation: Conventional and ecological sanitation; 4. Environmental Pollution and Control – Air, Water, Soil, Noise Pollution, Solid and Hazardous Waste, Biomedical Waste, E-waste: Sources, effect, treatment and control; 5. Environmental Legislations and Standards; 6.Current Environmental Issues: Greenhouse gases and global warming, Acid rain, Ozone layer depletion, Climate change

Text Books:

1. Any basic Biology Book of CBSE Curriculum at +2 Level/ E-text Books
2. Davis, M.L. and Masten,S.J., Principles of Environmental Engineering and Science,2nd Edition, McGraw-Hill, 2013.
3. Kaushik, A. and Kaushik, C.P., Perspectives in Environmental Studies, 4thEdition, New Age International, 2014.

Reference Books:

4. Botkin,D.B. and Keller,E.A., Environmental Science,8th Edition, Wiley, 2012.
5. Cunningham, W.P. and Cunningham, M.A., Environmental Science: A Global Concern, 13thEdition, McGraw-Hill, 2015

CH103	Introductory Chemistry	3-1-0-8	Chemistry

PHYSICAL CHMEISTRY

Thermodynamics: The fundamental definition and concept, the zeroth and first law. Work, heat, energy and enthalpies. Second law: entropy, free energy and chemical potential. Change of Phase. Third law. Chemical equilibrium, Chemical kinetics: The rate of reaction, elementary reaction and chain reaction.

Electrochemistry: Conductance of solutions, equivalent and molar conductivities and its variation with concentration. Kohlrausch's law-ionic mobilities, Transference number of ions. activities, application of Debye-Huckel theory. The Walden's rule. Debye-Huckel-Onsager treatment. Electrochemical cells, Nernst equation. Application of EMF measurements. Liquid junction potential, commercial cells – the primary and secondary cells. Fuel cells.

INORGANIC CHEMISTRY

Coordination chemistry: ligand, nomenclature, isomerism, stereochemistry, valence bond, crystal field and molecular orbital theories. Bioinorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, hemoglobin and myoglobin; organometallic chemistry.

ORGANIC CHEMISTRY

Stereo and regio-chemistry of organic compounds, conformers. Bioorganic chemistry: amino acids, peptides, proteins, enzymes, carbohydrates, nucleic acids and lipids. Modern techniques in structural elucidation of compounds (UV – Vis, IR, NMR). Solid phase synthesis and combinatorial chemistry. Green chemical processes.

Textbooks:

P. W. Atkins, Physical Chemistry, ELBS, 5th Ed, 1994.

J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 and 2, Kluwer Academic, 2000.

K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India, 2nd Ed, 1986.

F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern Ltd, New Delhi, 3rd Ed, 1972 (reprint in 1998).

D. J. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, ELBS, 2nd Ed, 1994.

S. H. Pine, Organic Chemistry, McGraw Hill, 5th Ed, 1987

Reference Books:

Levine, Physical Chemistry, McGraw Hill, 4th Ed, 1995.

J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principle, structure and reactivity, Harper Collins, 4th Ed, 1993.

L. G. Wade Jr., Organic Chemistry, Prentice Hall, 1987

CH110	Chemistry Laboratory	0-0-3-3	Chemistry

Estimation of metal ion: Determination of total hardness of water by EDTA titration. Experiments based on chromatography: Identification of a mixture containing two organic compounds by TLC. Experiments based on pH metry.: Determination of dissociation constant of weak acids by pH meter. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. Synthesis and characterization of inorganic complexes: e.g. Mn(acac)3, Fe(acac)3, cis-bis(glycinato)copper(II) monohydrate and their characterization by m. p. IR etc. Synthesis and characterization of organic compounds: e.g. Dibenzylideneacetone. Kinetics: Acid catalyzed hydrolysis of methylacetate. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution. Experiments based on electrogravimetry and electroplating. Experiments based on magnetometry.

CS102	Programming and Data Structures	3-0-0-6	CS

Introduction to digital computers; introduction to programming - variables, assignments; expressions; input/output; conditionals and branching; iteration; functions; recursion; arrays; introduction to pointers; structures; introduction to data-procedure encapsulation; dynamic allocation; linked structures; introduction to data structures stacks, queues and trees; time and space requirements.

References:

1. B. W. Kernighan and D. Ritchie, The C Programming Language, Prentice Hall of India (2nd Edition).

2. A. Kelley and I. Pohl, A Book on C, Pearson Education (4th Edition).

3. P.J. Deitel and H.M. Deitel , C How To Program, Pearson Education (7th Edition).

CS112	Programming and Data Structures Laboratory	0-0-3-3	CS

Introduction to Unix Commands; Introduction to Program development tools - vi editor, GNU compiler, testing and debugging, etc.; Implementation of programs in C language.

EE103	Basic Electronics Laboratory	0-0-3-3	EE

Experiments using diodes and bipolar junction transistor (BJT): design and analysis of half -wave and full-wave rectifiers, clipping circuits and Zener regulators,

BJT characteristics and BJT amplifiers; experiments using operational amplifiers (op-amps): summing amplifier, comparator, precision rectifier, a stable and mono stable multi-vibrators and oscillators; experiments using logic gates: combinational circuits

such as staircase switch, majority detector, equality detector, multiplexer and

demultiplexer; experiments using flip-flops: sequential circuits such as non- overlapping pulse generator, ripple counter, synchronous counter, pulse counter and

numerical display.

Reference Books:

1. A. P. Malvino, Electronic Principles. New Delhi: Tata McGraw-Hill, 1993.
2. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits. New Delhi: Prentice Hall of India, 2002.
3. R.J. Tocci: Digital Systems; PHI, 6e, 2001.

MA102	Mathematics-II	3-1-0-8	MA

Linear Algebra: Vector spaces (over the field of real and complex numbers). Systems of linear equations and their solutions. Matrices, determinants, rank and inverse. Linear transformations. Range space and rank, null space and nullity. Eigenvalues and eigenvectors. Similarity transformations. Diagonalization of Hermitian matrices. Bilinear and quadratic forms.

Ordinary Differential Equations: First order ordinary differential equations, exactness and integrating factors. Variation of parameters. Picard's iteration. Ordinary linear differential equations of n-th order, solutions of homogeneous and non-homogeneous equations. Operator method. Method of undetermined coefficients and variation of parameters.

Power series methods for solutions of ordinary differential equations. Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kind. Systems of ordinary differential equations, phase plane, critical point stability.

Textbooks:

1. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall, 1996.
2. T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969.
3. S. L. Ross, Differential Equations, 3rd Ed, Wiley, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall, 1995.
5. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 7th Ed, Wiley, 2001.

Reference Books:

6. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.

ME102	Engineering Mechanics	3-1-0-8	ME

1. Rigid body statics: Equivalent force system. Equations of equilibrium, Free body diagram, Reaction, Static indeterminacy.
2. Structures: 2D truss, Method of joints, Method of section. Beam, Frame, types of loading and supports, axial force, Bending moment, Shear force and Torque Diagrams for a member:
3. Friction: Dry friction (static and kinetic), wedge friction, disk friction (thrust bearing), belt friction, square threaded screw, journal bearings, Wheel friction, Rolling resistance.
4. Centroid and Moment of Inertia
5. Virtual work and Energy method: Virtual Displacement, principle of virtual work, mechanical efficiency, work of a force/couple (springs etc.), Potential Energy and equilibrium, stability.
6. Introduction to stress and strain: Definition of Stress, Normal and shear Stress. Relation between stress and strain, Cauchy formula.
7. Stress in an axially loaded member,
8. Stresses due to pure bending,
9. Complementary shear stress,
10. Stresses due to torsion in axis-symmetric sections:
11. Two-dimension state of stress, Mohr's circle representation, Principal stresses

Text and Reference books:

1. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002.
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, 3rd Ed, Tata McGraw Hill, 2000.
3. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I - Statics, 5th Ed, John Wiley, 2002.
4. E.P. Popov, Engineering Mechanics of Solids, 2nd Ed, PHI, 1998.

5. F. P. Beer and E. R. Johnston, J.T. Dewolf, and D.F. Mazurek, Mechanics of Materials, 6th Ed, McGraw Hill Education (India) Pvt. Ltd., 2012.

Semester III

MA201	Mathematics-III	3–0–0–6	MA

Complex Analysis: Complex numbers, geometric representation, powers and roots of complex numbers. Functions of a complex variable: Limit, Continuity, Differentiability, Analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, Harmonic conjugates. Elementary Analytic functions (polynomials, exponential function, trigonometric functions), Complex logarithm function, Branches and Branch cuts of multiple valued functions. Complex integration, Cauchy's integral theorem, Cauchy's integral formula. Liouville's Theorem and Maximum-Modulus theorem, Power series and convergence, Taylor series and Laurent series. Zeros, Singularities and its classifications, Residues, Rouches theorem (without proof), Argument principle (without proof), Residue theorem and its applications to evaluating real integrals and improper integrals. Conformal mappings, Mobius transformation, Schwarz-Christoffel transformation.

Fourier series: Fourier Integral, Fourier series of 2p periodic functions, Fourier series of odd and even functions, Half-range series, Convergence of Fourier series, Gibb's phenomenon, Differentiation and Integration of Fourier series, Complex form of Fourier series.

Fourier Transformation: Fourier Integral Theorem, Fourier Transforms, Properties of Fourier Transform, Convolution and its physical interpretation, Statement of Fubini's theorem, Convolution theorems, Inversion theorem

Partial Differential Equations: Introduction to PDEs, basic concepts, Linear and quasi-linear first order PDE, Second order PDE and classification of second order semi-linear PDE, Canonical form. Cauchy problems. D' Alembert's formula and Duhamel's principle for one dimensional wave equation, Laplace and Poisson equations, Maximum principle with application, Fourier method for IBV problem for wave and heat equation, rectangular region. Fourier method for Laplace equation in three dimensions.

Text Books:

1. R. V. Churchill and J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, 1990.
2. K. Sankara Rao, Introduction to Partial Differential Equations, 2nd Edition, 2005.

Reference Books:

3. J. H. Mathews and R. W. Howell, Complex Analysis for Mathematics and Engineering, 3rd Edition, Narosa, 1998.
4. I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957.
E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.

HS2XX	**HSS Elective – I**	**3–0–0–6**	**HSS**

CS204	**Algorithms**	**3–0–0–6**	**CS**

Asymptotic notations, introduction to complexity (time/space) analysis of algorithms. Basic introduction to algorithmic paradigms like divide and conquer, recursion, greedy, dynamic programming, etc. Searching: binary search trees, balanced binary search trees, AVL trees and red-black trees, B-trees, hashing. Priority queues, heaps, Interval trees. Sorting: quick sort, heap sort, merge sort, radix sort, bucket sort, counting sort, etc and their analysis. Graph Algorithms: BFS, DFS, connected components, topological sort, minimum spanning trees, shortest paths, network flow. Reducibility between problems and NP-completeness: discussion of different NP-complete problems.

Books

M. A. Weiss, Data Structures and Problem Solving Using Java, 2nd Ed, Addison-Wesley, 2002.

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

B. W. Kernighan and D. Ritchie, The C Programming Language, 2nd Ed, Prentice

Hall of India, 1988.

A. Aho, J. E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer

Algorithms, Addison-Wesley, 1974.

S. Sahni, Data Structures, Algorithms and Applications in C++, McGraw-Hill, 2001.

M. T. Goodrich and R. Tamassia, Algorithm Design: Foundations, Analysis and Internet

Examples, John Wiley & Sons, 2001.

CS224	**Algorithms Laboratory**	**0–0–3–3**	**CS**

The laboratory component will emphasize two areas: Implementation of algorithms covered in class: This will involve running the algorithms under varying input sets and measuring running times, use of different data structures for the same algorithm (wherever applicable) to see its effect on time and space, comparison of different algorithms for the same problem etc. Design of Algorithms: This will involve design and implementation of algorithms for problems not covered in class but related to topics covered in class. The exact set of algorithms to design and

implement is to be decided by the instructor. In addition, there will be at least one significantly large design project involving some real world application. An efficient design of the project should require the use of multiple data structures and a combination of different algorithms/techniques. The lab work can be carried out using any programming language.

CS203	Discrete Mathematics	3–0–0–6	CS

Propositional logic: Syntax, semantics, valid, satisfiable and unsatisfiable formulas, encoding and examining the validity of some logical arguments; Recurrences, summations, generating functions, asymptotic; Sets, relations and functions: Operations on sets, relations and functions, binary relations, partial ordering relations, equivalence relations, principles of mathematical induction, Finite and infinite sets, countable and uncountable sets, Cantor's diagonal argument and the power set theorem; Introduction to counting: Basic counting techniques - inclusion and exclusion, pigeon-hole principle, permutation, combination, generating function; Algebraic structures and morphisms: semigroups, groups, subgroups, homomorphism, rings, integral domains, fields; Introduction to graphs: paths, connectivity, subgraphs, isomorphic and homeomorphic graphs, trees, complete graphs, bipartite graphs, matchings, colourability, planarity, digraphs;

Text Books:

1. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1999.

2. C. L. Liu, Elements of Discrete Mathematics, 2nd Ed, Tata McGraw-Hill, 2000.

3. R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed, Addison-Wesley, 1994.

4. N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1974.

5. S. Lipschutz and M. L. Lipson, Schaums Outline of Theory and Problems of Discrete Mathematics, 2ndEd, Tata McGraw-Hill, 1999

CS227	Digital Systems	2–0–2–6	CS

Number Systems, Boolean algebra, logic gates, minimization of completely and incompletely specified switching functions, Karnaugh map and Quine-McCluskey method, multiple output minimization, twolevel and multi-level logic circuit synthesis. Clocks, flip-flops, latches, counters and shift registers, finite state machine model, synthesis of synchronous sequential

circuits, minimization and state assignment, Programmable logic devices: memory design. Data path control path partition-based design.

Experiments: Combinational logic circuits: Design and implementation of combinational circuits such as ALU and 7-segment LED display driver; Sequential Circuits: Design of sequence generators and detectors, counters, design of ASMs such as, traffic light controllers, lift controllers, etc. Digital design project: The students design and implement a final digital project of their choice.

References:

1. Z. Kohavi, Switching and Finite Automata Theory, 2nd Ed, Tata McGraw-Hill, 1995.
2. M. M. Mano, Digital Design, 3rd Ed, Pearson Education Asia, 2002.
3. S. Brown and Z. Vranesic, Fundamentals of Digital Logic - With Verilog Design, Tata McGraw-Hill, 2002.
4. S. Brown and Z. Vranesic, Fundamentals of Digital Logic - With VHDL Design, Tata McGraw-Hill, 2002 .
5. J. P Uyemura, A First Course in Digital System Design - An Integrated Approach, Vikas Publishing House, 2001.

CS271	Optimization techniques	3–0–0–6	MA

Linear programming: Introduction and Problem formulation, Concept from Geometry, Geometrical aspects of LPP, Graphical solutions, Linear programming in standard form, Simplex, Big M and Two Phase Methods, Revised simplex method, Special cases of LPP.

Duality theory: Dual simplex method, Sensitivity analysis of LP problem, Transportation, Assignment and travelling salesman problem.

Integer programming problems: Branch and bound method, Gomory cutting plane method for all integers and for mixed integer LPP.

Theory of games: saddle point, linear programming formulation of matrix games, two-person zero-sum games with and without saddle-points, pure and mixed strategies, graphical method of solution of a game, solution of an game by simplex method. Computational complexity of the Simplex algorithm, Karmarkar's algorithm for LPP. Acquaintance to softwares like TORA and MATLAB.

Text Books:

1. Hamdy A. Taha, Operations Research: An Introduction, Eighth edition, PHI, New Delhi (2007).

2. S.Chandra, Jayadeva, AparnaMehra, Numerical Optimization with Applications, Narosa Publishing House (2009).

3. A. Ravindran, D.T. Phillips, J.J. Solberg, Operation Research, John Wiley and Sons, New York (2005).

4. M. S. Bazaraa, J. J. Jarvis and H. D. Sherali, Linear Programming and Network Flows, 3rd Edition, Wiley (2004).

Reference Books:

1. D. G. Luenberger, Linear and Nonlinear Programming, 2nd Edition, Kluwer, (2003).

2. S. A. Zenios (editor), Financial Optimization, Cambridge University Press (2002).

3. F. S. Hiller, G. J. Lieberman, Introduction to Operations Research, Eighth edition, McGraw Hill (2006).

CS230	Software Lab/Tools	0–0–3-3	CS

Bash shell programming – basic concepts, expressions, decision making selections, repetition, special parameters - positional parameters, shift, argument validation, script examples.

Android Basics: Getting started with Android development, project folder structure, simple programming, running project, generating build/APK of the app from Android Studio

First application: Creating Android Project, Android Virtual Device Creation, set up debugging environment, Workspace set up for development, launching emulator, debugging on mobile devices. Basic UI design: Basics about Views, Layouts, Drawable Resources, input controls, Input Events etc. understand the app idea and design user interface/wireframes of mobile app

Set up the mobile app development environment

Semester IV

HS2XX	**HSS Elective-II**	**3-0-0-6**	**HSS**

MA225	**Prob. Theory and Random Processes**	**3-0-0-6**	**MA**

Algebra of sets, probability spaces, random variables, cumulative distribution functions, mathematical expectations, conditional probability and expectation, moments and inequalities, special discrete and continuous probability distributions, function of a random variable, random vectors and their distributions, convolutions, joint, marginal and conditional distributions, product moments, independence of random variables, bivariate distributions and properties, order statistics and their distributions, sampling distributions, Central Limit Theorem, strong law of large numbers, sequence of random variables, modes of convergence, distributions of the sample mean and the sample variance for a normal population, chi-square, t and F distributions, method of moments and maximum likelihood estimation, concepts of unbiasedness, criteria for choosing estimators, consistency and efficiency of estimates, confidence intervals, pivotal quantities, confidence intervals for proportions, simple and composite hypothesis, null and alternative hypotheses, types of error, level and size of tests, the most powerful test and Neyman - Pearson Fundamental Lemma, tests for one- and two-sample problems for normal populations, tests for proportions, likelihood ratio tests, chi-square test for goodness of fit. discrete and continuous stochastic processes, markov chains, transition probability matrix, state spaces, classification of states, stationary distributions, ergodicity, Poisson process, birth and death process. Introduction to reliability analysis: Application of Bayes theorem in real life problem; Reliability analysis of simple system.

Serial, parallel and combined systems; First order uncertainty and reliability analysis (FORM), First order second mom (FOSM) and Advanced FOSM methods; Applications of risk and reliability analysis in engineering systems.

Text / Reference Books:

Scheaffer, R. L., Mulekar, M. S. and McClave, J. T., (2011): Probability and statistics for Engineers, Fifth Edition, Broo Cole, Cengage Learning.

Ang, A. H-S., and Tang, W. H., (2006): Probability Concepts in Engineering, Volumes 1. John Wiley and Sons.

Halder, A and Mahadevan, S., (2000): Probability, Reliability and Statistical Methods in Engineering Design, John Wiley Sons.

Rao, S.S., (1992): Reliability-Based Design, McGraw Hill, Inc.

Harr, M.E., (1987): Reliability-Based Design in Civil Engineering. McGraw Hill, Inc.

Ang, A. H-S, and Tang, W. H., (1975): Probability Concepts in Engineering Planning and Design, Volumes 2. John Wiley Sons

Benjamin, J., and Cornell. A., (1963): Probability, Statistics, and Decision for Civil Engineers. McGraw Hill.

CS209	Computer Architecture	3–0–0–6	CS

CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study - instruction sets of some common CPUs; Assembly language programming for some processor; Data representation: signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic; CPU control unit design: hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU; 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 policy; Peripheral devices and their characteristics: 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.

CS210	Computer Architecture Lab	0-0-3-3	CS

Familiarization with assembly language programming; Synthesis/design of simple data paths and controllers, processor design using HDL like verilog/vhdl; Interfacing - DAC, ADC, keyboard-display modules, etc. Development kits as well as Microprocessors/PCs may be used for the laboratory, along with design/simulation tools as and when necessary.

CS267	Theory of computation	3-0-0-6	CS

Regular Languages: Finite Automata-Deterministic and Nondeterministic, regular operations, Regular Expressions, Equivalence of DFA, NFA and Res, Nonregular Languages and pumping lemma

Context-Free Languages: Context-Free Grammars, Chomsky Normal Form, Pushdown Automata, Non Context-Free Languages and pumping lemma, Deterministic Context-Free Languages

Turing Machines: Definition of TM and its variants, Decidability, Reducibility.

Complexity Theory: Time complexity and Space Complexity.

Text Books:

1.Introduction to the Theory of Computation, by Michael Sipser

2. Computational Complexity, by Christos H. Papadimitriou, Addison-Wesley publishers.

3. Computational Complexity: A Modern Approach, by Sanjeev Arora and Boaz Barak.

CS259	Database	3-0-0-6	CS

Database system architecture: Data Abstraction, Data Independence, Data Definition and Data Manipulation Languages; Data models: Entity-relationship, network, relational and object oriented data models, integrity constraints and data manipulation operations; Relational query languages: Relational algebra, tuple and domain relational calculus, SQL and QBE; Relational database design: Domain and data dependency, Armstrong's axioms, normal forms, dependency preservation, lossless design; Query processing and optimization: Evaluation of relational algebra expressions, query equivalence, join strategies, query optimization algorithms; Storage strategies: Indices, B-trees, hashing; Transaction processing: Recovery and concurrency control, locking and timestamp based schedulers, multi-version and optimistic Concurrency Control schemes; Recent Trends: XML Data, XML Schema, JSON and "NoSQL Systems, etc.

Books:

Abraham Silberschatz, Henry Korth, and S. Sudarshan, Database System Concepts, McGraw-Hill.

Raghu Ramakrishnan, Database Management Systems, WCB/McGraw-Hill.

Bipin Desai, An Introduction to Database Systems, Galgotia.

J. D. Ullman, Principles of Database Systems, Galgotia.

R. Elmasri and S. Navathe, Fundamentals of Database Systems, Addison-Wesley.

Serge Abiteboul, Richard Hull and Victor Vianu, Foundations of Databases. Addison-Wesley

CS260	Database Lab	0-0-3-3	CS

Database schema design, database creation, SQL programming and report generation using a commercial RDBMS like ORACLE/SYBASE/DB2/SQL-Server/INFORMIX. Students are to be exposed to front end development tools, ODBC and CORBA calls from application Programs, internet based access to databases and database administration.

Semester V

XX3XX	Open Elective-II	3-0-0-6	--

CS358	Computer Network	3-0-0-6	CS

Evolution of computer networks; Physical Layer: Theoretical basis for data communication, transmission media and impairments, switching systems Medium Access Control Sublayer: Channel allocation Problem, multiple access protocols, Ethernet Data link layer: Framing, HDLC, PPP, sliding window protocols, error detection and correction Network Layer: Internet addressing, IP, ARP, ICMP, CIDR, routing algorithms (RIP, OSPF, BGP); Transport Layer: UDP, TCP, flow control, congestion control; Introduction to quality of service; Application Layer: DNS, Web, email, authentication, encryption.

Books:

Peterson & Davie, Computer Networks, A Systems Approach: 5th Edition

William Stallings Data and Computer Communication, Prentice Hall of India.

Behrouz A. Forouzan, Data Communication and Networking, McGraw-Hill.

Andrew S. Tanenbaum, Computer Networks, Prentice Hall.

Douglas Comer, Internetworking with TCP/IP, Volume 1, Prentice Hall of India.

W. Richard Stevens, TCP/IP Illustrated, Volume 1, Addison-Wesley.

CS359	Computer Network Lab	0-0-3-3	CS

Simulation experiments for protocol performance, configuring, testing and measuring network devices and parameters/policies; network management experiments; Exercises in network programming.

CS341	Operating Systems	3-0-0-6	CS

Process Management: process; thread; scheduling. Concurrency: mutual exclusion; synchronization; semaphores; monitors; Deadlocks: characterization; prevention; avoidance; detection. Memory Management: allocation; hardware sup- port; paging; segmentation. Virtual Memory: demand paging; replacement; allocation; thrashing. File Systems and Implementation. Secondary Storage: disk structure; disk scheduling; disk management. (Linux will be used as a running example, while examples will draw also from Windows NT/7/8.); Advanced Topics: Distributed Systems. Security. Real-Time Systems.

Books:

A. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, 8th Ed, John Wiley & Sons, 2010.

A. S. Tenenbaum, Modern Operating Systems, 2nd Ed, Prentice Hall of India, 2001.

H. M. Deitel, P. J. Deitel and D. R. Choffness, Operating Systems, 3rd Ed, Prentice Hall, 2004.

W. Stallings, Operating Systems: Internal and Design Principles, 5th Ed, Prentice Hall, 2005.

M. J. Bach, The Design of the UNIX Operating System, Prentice Hall of India, 1994.

M. K. McKusick et al, The Design and Implementation of the 4.4 BSD Operating System, Addison Wesley, 1996.

CS340	Operating Systems Lab	0–0–3-3	CS

Programming assignments to build different parts of an OS kernel.

CS304	Algorithm-II	3–0–0-6	CS

Models of computation: RAM model and its logarithmic cost. Formal introduction to algorithmic paradigms: divide and conquer, recursion, dynamic programming, greedy, branch and bound, etc.
Advanced data structures: Fibonacci heap, union-find, splay trees. Amortized complexity analysis
Randomized algorithms: Randomized algorithms to be introduced a bit early, i.e. before NP-completeness to highlight randomization as an algorithmic technique.

Application areas: Geometric algorithms: convex hulls, nearest neighbour, Voronoi diagram, etc.
Algebraic and number-theoretic algorithms: FFT, primality testing, etc. Graph algorithms: network flows, matching, etc. Optimization techniques: linear programming

Reducibility between problems and NP-completeness: discussion of different NP-complete problems like satisfiability, clique, vertex cover, independent set, Hamiltonian cycle, TSP, knapsack, set cover, bin packing, etc. Backtracking, branch and bound. Approximation algorithms: Constant ratio approximation algorithms. Miscellaneous: Introduction to external memory algorithms, parallel algorithms.

Special topics: Geometric algorithms (range searching, convex hulls, segment intersections, etc.)

References:

Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press.

Allan Borodin, Ran El-Yaniv, Online Computation and Competitive Analysis, Cambridge University Press.

Nancy Lynch, Distributed Algorithms, Morgan Kaufmann.

Robert Endre Tarjan, Data Structures and Network Algorithms, SIAM.
L. Grotchel, L. Lovasz, and A. Schrijver, Geometric algorithms and Combinatorial Optimization, Springer.
M. Kearns and U. Vazirani, An Introduction to Computational Learning Theory. MIT Press.
N. Alon and J. H. Spencer, The Probabilistic Method, John Wiley.
Vijay Vazirani, Approximation Algorithms, Springer.
Fan Chung, Spectral Graph Theory, American Mathematical Society.

CS389	Innovative Design Lab	0-0-3-3	CS

The objective of this lab would be to encourage and provide support to students for some innovative work. The work may focus on inventing a practical solution for a pure Computer Science or multidisciplinary problems. Depending on the nature of the work, it may be carried out in a group or individual mode.

Semester VI

HS3XX	HSS Elective-III	3-0-0-6	HSS

CS3XX	CS Elective-I	3-0-0-6	CS

CS351	PPL + Compiler	3-0-0-6	CS

Introduction: History of Programming Languages; Evolution of the Major Programming Languages; Art of Programming Language Design; Properties and Success of Programming Languages.

Programming Language-Paradigms: Imperative (e.g. C, Pascal, Fortran); Functional (e.g. LISP, HASKELL, OCaml); Object Oriented (e.g. JAVA, C++, Scala); Logic-based (e.g. Prolog); Multiparadigm programming languages (e.g. Python).

Programming Language Concepts: Values and Data Types; Block Structure; Scope, Binding and Lifetime of Variables; Static vs. Dynamic Typing; Static vs. Dynamic Scoping; Memory Management; Procedural Abstraction; Data Abstraction; Concurrency; etc.

Programming Language Syntax and Semantics: Syntax vs. Semantics; Brief Overview of Regular and Context Free Languages, Formal Semantics: denotational, operational, axiomatic semantics.

Language Translation: Compiler vs. Interpreter; Various Phases of Compilers; Overview of Parsing Techniques; Syntax vs. Semantic Analysis; Intermediate Code Generation, Code Optimization Techniques; A Closer Look at Implementation - Building a Runnable Program.

Text Books:

1. Michael L. Scott, **"Programming Language Pragmatics"**, Morgan Kaufmann, 3rd Edition.

2. Harold Abelson, Gerald Jay Sussman, Julie Sussman, **"Structure and Interpretation of Computer Programs**", MIT Press, 2nd Edition.

3. Aho A., Sethi R., Ullman J.D., Compilers : Principles, Techniques and Tools, Addison Wesley, 1995

References:

1. Ravi Sethi, K.V. Vishwanatha, **"Programming Languages: Concepts and Constructs"**, 2/e, Pearson Education, 2007.

2. T.W. Pratt and M.V. Zelkowitz, "**Programming Languages – Design and Implementation**",

Prentice-Hall.

3. Robert W. Sebesta, "**Concepts of Programming Languages**", Addison-Wesley.

4. D. A. Watt, "**Programming Language Design Concepts**", John Wiley & Sons.

5. Kenneth C. Louden and Kennath A. Lambert, "**Programming Languages: Principles and Practice**", Cengage Learning.

6. Recent Research Papers relevant to the course.

CS352	PPL + Compiler Lab	0-0-3-3	CS

1. Hands-on experience with various parsers, such as ANTLR, Lark, Lex, Yacc, etc.;

2. Design your own programming language, write its grammar, and implement its parser;

3. Programming assignments to build a compiler for a subset of a C-like programming language;

4. Class assignments on functional and logic programming languages, such as LISP, Prolog.

Course No.:CS366	Name: Artificial Intelligence	Credits: 3-0-0-6	Prerequisites: Nil

Syllabus:
Introduction to the Course

Search: Uninformed, Informed and Local Search

Symbolic AI: Knowledge Representation and Reasoning, Propositional Logic, First Order Logic

Planning: Plan generation and causal-link planning, Planning under uncertainty
Supervised Learning: Learning from examples, naïve Bayes, Decision Tree, Logistic Regression, Support Vector Machine

Graphical Models: Hidden Markov Model; Maximum Entropy Markov Model

Neural Networks and Deep Learning: Feed-forward NN, Recurrent Neural Networks

Current Topics- Explainable AI, Ethics in AI, Standardizing AI

References:

1. S. Russel and P. Norvig. Artificial Intelligence: A Modern Approach (Third Edition), Prentice Hall, 2009
2. E. Rich and K. Knight, Artificial Intelligence, Addison Wesley, 1990
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learnng, MIT Press, 2016
4. Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
5. Sutton and Barto. Reinforcement Learning: An Introduction. Available free online.
6. Hastie, Tibshirani, and Friedman. The elements of statistical learning. Available free online.

Journals and Conference Proceedings:

Artificial Intelligence, Machine Learning, AAAI, IJCAI, ACL Anthology, COLING, ICML, ECML, Proceedings of Uncertainty in AI, ICCV, ICLR etc.

CS367	Artificial Intelligence Lab	0-0-3-3	CS

Small projects based on the concepts and tools taught in AI class.

CS309	Machine Learning and Data Science	3-0-0-6	CS

Introduction: machine learning, supervised, unsupervised, semi-supervised techniques; evaluation methods

Introduction to data, data science, features, normalization methods, different types of features, importance of features, examples.

Supervised learning: classification and regression; Linear regression, regularization, overfitting, underfitting.

Classification: Logistic regression, decision trees, nearest neighbor classifiers, generative classifiers like naive Bayes, minimum error rate classifier, maximum margin classifier, Support vector Machines, basic of neural network (perceptron, backpropagation).

Concepts regarding Classification: Bias, variance.

Feature selection techniques: wrapper and filter approaches, sequential feature selection

algorithms

Feature extraction techniques: Principle Component Analysis, Linear Discriminant Analysis

Unsupervised learning: K-means, hierarchical, Expectation Maximization, K-medoid, DB-Scan, cluster validity indices, similarity measures, some modern techniques of clustering;

Introduction to Reinforcement Learning, ethics in machine learning.

Some case-studies in Natural language processing and Healthcare

Primary books

1. Pattern recognition and machine learning by Christopher Bishop, Springer Verlag, 2006.

2. Hastie, Tibshirani, Friedman *The elements of Statistical Learning* Springer Verlag

3. T. Mitchell. *Machine Learning*. McGraw-Hill, 1997.

Supplementary books

1. Probability, Random Variables and Stochastic processes by Papoulis and Pillai, 4th Edition, Tata McGraw Hill Edition.

2. Linear Algebra and Its Applications by Gilbert Strand. Thompson Books.

3. Data Mining: Concepts and Techniques by Jiawei Han, MichelineKamber, Morgan Kaufmann Publishers.

4. A. K. Jain and R. C. Dubes. *Algorithms for Clustering Data*. Prentice Hall, 1988.

CS397	Capstone Project-I	0-0-3-3	CS

The objective of this project would be to encourage and provide support to students for some innovative work. The work may focus on inventing a practical solution for a CS or multidisciplinary problems. Depending on the nature of the work, it may be carried out in a group or individual mode.

DEPARTMENTAL ELECTIVES:

CS372	Computer Graphics	3-0-0-6	CS

Introduction to Computer graphics: Graphics imaging pipeline, Rasterization, Display devices, CRT displays, Random scan display, Raster scan display, Raster Scan Basics.

How to develop/model objects for imaging scences: 2D transformations, 3D transformations, Parallel projection, Perspective projection, Vanishing points, Viewing Transformation. Coding sessions in class using C++, Python.

How to transfer the modeled objects into mobile/television screens for display: Drawing Algorithms, Bresenham's algorithms, polygon filling, Windowing and Clipping, problems of aliasing. Coding sessions in class using C++, Python.

How to detect and draw overlapping objects/human in a scene: Back face removal, Z-Buffer Algorithm, Scan-line algorithm for VSD, Painters algorithm, BSP trees. Coding sessions in class using C++, Python.

How to model solid objects: Graph based models, B-REP model, Constructive Solid Geometry (CSG), Octree based representation, Quadtree based representation.

How to model curved objects: Parametric representation of curves, parametric cubic curves, Bezier curves, continuity of curves, modeling of surfaces.

How to apply appropriate color and shading to the objects for realistic imaging: Reflectance properties of surfaces, Ambient, Specular and Diffuse reflections, Atmospheric attenuation, Phong's Illumination model. Coding sessions in class using C++, Python.

Suggested Readings:

1. P. Shirley, M. Ashikhmin and S. Marschner, Fundamentals of Computer Graphics, 3rd Edition, CRC Press, 2009.
2. E. Angel and D. Shreiner, Interactive Computer Graphics, A top-down approach with OpenGL, 6th Edition, Addison Wesley, 2012.
3. J. D. Foley, A. van Dam, S. Feiner, and J. F. Hughes, Computer Graphics: Principles and Practice, 2nd Ed, Addison-Wesley, 1996.
4. D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, 2nd Edition, McGraw-Hill International Edition, 1990.

CS547	Foundation of Computer Security	3-0-0-6	CS

Syllabus:

Introduction to Computer Security and Privacy : security and privacy; types of threats and attacks; methods of defense Program Security: Secure programs; nonmalicious program errors; malicious code; controls against program threats Operating System Security: Methods of protection; access control; user authentication Network Security: Network threats; firewalls, intrusion detection systems Internet Application Security and Privacy: Basics of cryptography; security and privacy for Internet applications (email, instant messaging, web browsing); privacy-enhancing technologies Database Security and Privacy: Security and privacy requirements; reliability, integrity, and privacy; inference;

Note: Familiarity with CS 341 Operating Systems and CS 101 Programming in C, is desirable

References:

1. Security in Computing, 4thedition. Charles P. Pfleeger and Shari Lawrence Pfleeger Prentice-Hall, 2007. Or later
2. Introduction to Computer Security Matt Bishop, Addison-Wesley 2005

Published papers in this area will be discussed and uploaded in the course-web

CS503	Advances in Algorithms	3-0-0-6	CS

Syllabus:

Algorithmic paradigms: Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis; Graph Algorithms: Shortest paths, Flow networks; NP-completeness; Approximation algorithms; Randomized algorithms; Online algorithms; Streaming algorithms; Linear programming;

Special topics: Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid's algorithm, modular exponentiation, primality testing, cryptographic computations), Internet algorithms (text pattern matching, tries, information retrieval, data compression, Web caching).

References:

1.T. H. Cormen, C. L. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, 2nd edition, Prentice-hall Of India Pvt.. Ltd, (2007)

2.J. Kleinberg and E. Tardos, Algorithm Design, Addison-Wesley, (2008)

3.Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, (1995)

4.Vijay Vazirani, Approximation Algorithms, Springer, (2004)

5.Soumen Chakrabarti, Mining the Web: Discovering Knowledge from Hypertext Data, Elsevier India Private Limited, (2005)

6.Technical papers from major reputed journals in the area of algorithms design

CS505	Advanced Graph Theory	3-0-0-6	CS

Syllabus:

Basic Concepts: Graphs and digraphs, incidence and adjacency matrices, isomorphism, the automorphism group;

Trees: Equivalent definitions of trees and forests, Cayleys formula, the Matrix-Tree theorem,

minimum spanning trees;

Connectivity: Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger s theorem;

Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, girth, circumference, the Chinese Postman Problem, the Travelling Salesman problem, diameter and maximum degree, shortest paths;

Matchings: Berges Theorem, perfect matchings, Halls theorem, Tuttes theorem, Konigs theorem, Petersens theorem, algorithms for matching and weighted matching (in both bipartitie and general graphs), factors of graphs (decompositions of the complete graph), Tuttes f-factor theorem;

Extremal problems: Independent sets and covering numbers, Turans theorem, Ramsey theorems; Colorings: Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizings theorem; Graphs on surfaces: Planar graphs, duality, Eulers formula, Kuratowskis theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces;

Directed graphs: Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, branchings;

Networks and flows: Flow cuts, Max flow min cut theorems, perfect square;

Selected topics: Dominating sets, the reconstruction problem, intersection graphs, perfect graphs, random graphs.

References

1.D.B.West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009

2.J.A.Bondy and U.S.R.Murty: Graph Theory, Springer, 2008.

3.R.Diestel: Graph Theory, Springer(low price edition) 2000.

4.F.Harary: Graph Theory, Narosa, (1988)

5.C. Berge: Graphs and Hypergraphs, North Holland/Elsevier, (1973)

List of Other Approved Electives:

- CS561: Artificial Intelligence
- CS544: Introduction to Network Science
- CS542: Software Testing
- CS543: Distributed Systems
- CS528: CAD for VLSI
- CS548: Wireless Networks
- CS549: Computer and Network Security

- CS508: Formal methods for analysis and verification
- CS743: Advanced topics on Database
- CS502: Pattern Recognition
- CS563: Natural Language Processing
- CS564: Foundations of Machine Learning

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