राष्ट्रीय प्रौद्योगिकी संस्थान मिजोरम

NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

(An Institute of National Importance under Ministry of Education, Govt. of India)
CHALTLANG, AIZAWL, MIZORAM – 796012

Course Structure & Syllabus for B.Tech Programme in
Mathematics and Computing
Batch: 2023-24 onwards

Department of Basic Sciences & Humanities and Social Sciences

Classification of Credit Points:

1 Hr Lecture (L) per week	1.0 Credit
1 Hr Tutorial (T) per week	1.0 Credit
1 Hr Laboratory (P) per week	0.5 Credit
AUDIT Course	No Credit

Course Credits – Semester-wise

SEMESTER	I	II	III	IV	V	VI	VII	VIII	TOTAL
CREDITS	20.5	21.5	22.5	22	19.5	18	17	19	160

SEMESTER I					
Code	**Course Name**	**L**	**T**	**P**	**C**
HUL 1101	Communicative English	2	0	0	2
MAL 1101	Engineering Mathematics I	3	1	0	4
CHL 1101	Engineering Chemistry	3	0	0	3
EEL 1101	Basic Electrical Engineering	3	0	0	3
MEL 1101	Engineering Mechanics	3	0	0	3
Laboratory					
EEP 1101	Basic Electrical Engineering Laboratory	0	0	3	1.5
CHP 1101	Engineering Chemistry Laboratory	0	0	3	1.5
MEP 1101	Engineering Mechanics Laboratory	0	0	3	1.5
HUP 1101	Language Laboratory	0	0	2	1
		Total 14-1-11			**20.5**

SEMESTER II					
Code	**Course Name**	**L**	**T**	**P**	**C**
ECL 1201	Basic Electronics Engineering	3	0	0	3
HUL 1202	Social Science	2	0	0	2
MAL 1202	Engineering Mathematics II	3	1	0	4
PHL 1201	Engineering Physics	3	0	0	3
CSL 1201	Introduction to Computer Programming	3	0	0	3
Laboratory					
MEP 1201	Engineering Drawing	0	0	4	2
CSP 1201	Introduction to Computer Programming Laboratory	0	0	3	1.5
PHP 1201	Physics Laboratory	0	0	3	1.5
MEP 1202	Workshop	0	0	3	1.5
ECA 1201	Extracurricular Activity	0	0	0	AUDIT
			Total 14-1-13		**21.5**

SEMESTER III					
Code	**Course Name**	**L**	**T**	**P**	**C**
CSL 1301	Data Structures	3	0	0	3
MAL 1305	Real Analysis	3	0	0	3
MAL 1303	Probability and Statistics	3	0	0	3
MAL 1307	Operations Research	3	0	0	3
MAL 1308	Scientific Computing	3	0	0	3
MAL 1302	Linear Algebra & Applications	3	0	0	3
Laboratory					
CSP 1301	Data Structures Lab	0	0	3	1.5
MAP 1307	Operations Research Laboratory using C/C++	0	0	3	1.5
MAP 1308	Scientific Computing Laboratory	0	0	3	1.5
		Total 18-0-6			**22.5**

SEMESTER IV					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL1406	Differential Equations & Integral Transforms	3	1	0	4
MAL 1407	Abstract Algebra	3	0	0	3
CSL 1403	Database Management System	3	0	0	3
CSL 1404	Discrete Mathematics	3	0	0	3
MAL 1408	Complex Analysis	3	0	0	3
MAL1409	Nonlinear Optimization	3	0	0	3
Laboratory					
CSP 1403	Database Management System Laboratory	0	0	3	1.5
MAP1409	Nonlinear Optimization Laboratory using R	0	0	3	1.5
			Total 18-0-3		**22**

SEMESTER V					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL 1501	Fluid Dynamics	3	0	0	3
MAL 1504	Stochastic Calculus	3	0	0	3
MAL 1505	Functional Analysis	3	0	0	3
CSL 1506	Artificial Intelligence	3	0	0	3
MAL 1502	Theory of Computation	3	0	0	3
MEL 1710	Neural Networks	3	0	0	3
Laboratory					
MAP 1501	Artificial Intelligence Laboratory	0	0	3	1.5
				Credits	**19.5**

SEMESTER VI					
Code	**Course Name**	**L**	**T**	**P**	**C**
CSL 1605	Machine Learning	3	0	0	3
CSL 1601	Design and Analysis of Algorithms	3	0	0	3
MAL 1603	Multivariate Statistical Methods	3	0	0	3
MAL 1XXX	Elective I (Core Math)	3	0	0	3

HUL 1604	Managerial Economics	3	0	0	3
Laboratory					
CSP 1605	Machine Learning Laboratory	0	0	3	1.5
MAP 1603	Statistical Methods Laboratory	0	0	3	1.5
				Credits	**18**

SEMESTER VII					
Code	**Course Name**	**L**	**T**	**P**	**C**
CSL/ECL 1XXX	Elective II (CSE/ECE)	3	0	0	3
MAL 1XXX	Elective III (Core Math)	3	0	0	3
MAL 1XXX	Elective IV (Stats)	3	0	0	3
MAL 1XXX	Elective V (Core Math)	3	0	0	3
MAD 1701	Project – I	0	0	5	5
				Credits	**17**

SEMESTER VIII					
Code	**Course Name**	**L**	**T**	**P**	**C**
MEL 1805	Environmental Science & Energy	2	0	0	AUDIT
MAL 1XXX	Elective VI (Core Math)	3	0	0	3
CSL 1XXX	Elective VII (CSE)	3	0	0	3
HUL 1XXX	Elective VIII	3	0	0	3
MAD 1801	Project II	0	0	10	10
				Credits	**19**

List of Electives

Elective – I					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL 1601	Mathematical Biology	3	0	0	3
MAL 1602	Topology	3	0	0	3
MAL 1604	Measure and Integration	3	0	0	3
MAL 1605	Numerical Optimization	3	0	0	3
MAL 1606	Applied Graph Theory	3	0	0	3
MAL 1608	Randomized Algorithms	3	0	0	3
MAL 1609	Advanced Abstract Algebra	3	0	0	3
MAL 1610	Integral Equations & Calculus of Variations	3	0	0	3
Elective – II					
Code	**Course Name**	**L**	**T**	**P**	**C**
CSL 1XXX	Advanced Data Structures	3	0	0	3
CSL 1303	Object Oriented Programming	3	0	0	3
CSL 1XXX	Data Mining and Data Warehousing	3	0	0	3
ECL 1302	Digital Logic Design	3	0	0	3
CSL 1401	Computer Organization and Architecture	3	0	0	3
CSL 1502	Operating Systems	3	0	0	3
ECL 1303	Signals and Systems	3	0	0	3
Elective – III & V					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL 1701	Stochastic Differential Equations	3	0	0	3

MAL 1702	Combinatorics and Number Theory	3	0	0	3
MAL 1703	Advanced Matrix Theory	3	0	0	3
MAL 1704	Wavelets and Applications	3	0	0	3
MEL 1810	Fuzzy Systems and Genetic Algorithms	3	0	0	3
MAL 1705	Computational Fluid Dynamics	3	0	0	3
MAL 1706	Nonlinear Partial Differential Equations	3	0	0	3
MAL 1707	Introduction to Uncertain Optimization	3	0	0	3
Elective – IV					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL 1708	Statistical Simulation and Data Analysis	3	0	0	3
MAL 1709	Applied Time Series Analysis	3	0	0	3
MAL 1710	Empirical Processes	3	0	0	3
MAL 1711	Inferences	3	0	0	3
MAL 1712	Statistical and AI Techniques in Data Mining	3	0	0	3
Elective – VI					
Code	**Course Name**	**L**	**T**	**P**	**C**
MAL 1801	An Introduction to Mathematical Modelling	3	0	0	3
MAL 1802	Finite Element Method	3	0	0	3
MAL 1803	Fields and Galois Theory	3	0	0	3
MAL 1804	Differential Geometry and Tensor Analysis	3	0	0	3
MAL 1805	Spectral Methods	3	0	0	3
Elective - VII					
Code	**Course Name**	**L**	**T**	**P**	**C**
CSL 1XXX	Computer Networks	3	0	0	3
CSL 1XXX	Digital Image Processing and Applications	3	0	0	3
CSL 1XXX	Natural Language Processing	3	0	0	3
CSL 1XXX	Security and Its Application	3	0	0	3
CSL 1XXX	Quantum Computing	3	0	0	3
Elective – VIII					
Code	**Course Name**	**L**	**T**	**P**	**C**
HUL 1601	Macroeconomics & Business Environment	3	0	0	3
HUL 1801	Globalization, International Finance And Monetary System And Indian Economy	3	0	0	3
HUL 1802	Financial Engineering	3	0	0	3

In the curriculum of B.Tech. in Mathematics and Computing, the distribution of various components are as follows.

- Basic Sciences = 17 credits which is 10.63%,
- Basic Engineering = 20 credits which is 12.5%,
- Humanities and Social Sciences = 11 credits which is 6.88%,
- Major Discipline = 112 credits which is 70%.

In this major discipline component,

Mathematics and computing courses = 67 credits which is 41.86%,
CSE/ECE/ME courses = 30 credits which is 19.81%,
Project Courses = 15 credits which is 9.34%.

SEMESTER - I

Subject: Communicative English Code: HUL1101 L-T-P: 2-0-0
Credit: 2

Language: Organs of Speech, Sounds, Pronunciation, Consonant, Long Vowels, Short Vowels, Syllable, Diphthongs. (4 Hrs)

Comprehension: Reading and Writing, Précis, Essay & Paragraph Writing. (4 Hrs)

Communication Skills: Communication Skills- Tips for conversation, Reading, Developing Reading Skills, Communication: Definition, types and Objective of Communication, Channels of Communication, Barriers of Communication, Group Discussion, Presentation Skills, Public Speaking. (7 Hrs)

Writing Skills: Business Correspondence, Applying for a job, Designing Curriculum Vitae, Résumé and Covering Letter, Letter Writing, Report writing, Notices, Email & E Correspondence. (6 Hrs)

Literature: Selected Reading: Lectures: 03
Science Fiction: A Very Short Introduction by David Seed.
Frankenstein by Marry Shelley.
The Time Machine by H.G. Wells
Of Studies by Francis Bacon

Total Lectures: 24

Suggested Reading:

1. Ellis, Rod. *English for Engineers and Technologists: A Skills Approach. Book 1*.
2. Jones, Daniel. *An outline of English Phonetics*. New Delhi: Kalyani Publishers.
3. Hornby, A S. *Guide to Patterns and Usage in English*. OUP.
4. Nesfield, J. C. *Manual of English Grammar, and Composition*. CUP.
5. Wells, H. G. *The Time Machine*.
6. Seed, David. *Science Fiction: A very Short Introduction. Oxford University Press*.
7. Shelley, Marry. *Frankenstein.* Maple Press.
8. Farhathulla, T. M. *Communication Skills for Technical Students*. Orient Blackswan, 2002.
9. Sharma R. C. and Krishna Mohan. *Business Correspondence & Report Writing*. Tata McGraw Hill, 2011.
10. Konar, Nira. *English Language Laboratories. A Comprehensive Manual* –, PH1 Learning Private Limited. New Delhi, 2011.
11. Bacon, Francis. *Selected Essays*.

Subject: Language Laboratory Code: HUP 1101 (L-T-P: 0-0-2)
Credit: 1

LIST OF PRACICALS

1. Self-Introduction
2. Basic Phrases
3. Story and Action: Dialogues & Narration

4. Conversational skills
5. Describing Objects
6. Expressing opinions
7. Showing agreement and disagreement
8. Extempore
9. JAM Sessions
10. Group Discussions
11. Debates
12. Interviews
13. Formal Presentation
14. Newspaper Reading and discussion of interesting Information
15. Role Play
16. Comprehension of audio material
17. Learning correct Pronunciation

The lab shall have two parts:

Computer Assisted Language Learning Lab- it requires a spacious room equipped by English Language Learning software for students. The students will be guided and monitored by the instructor.

Interactive Communication Lab- it requires a spacious room with movable chairs and audio-visual aids with a Public-Address System, a LCD and a
projector etc.

Subject: ENGINEERING MATHEMATICS-I Code: MAL 1101 L-T-P:3-1-0 Credit: 4

Differential Calculus:
Functions of single variable: Limit, continuity, and differentiability. Indeterminate forms. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with remainders. Curve tracing: Concavity, asymptotes, multiple points. Curvature: Intrinsic, Cartesian, and polar coordinate forms. (14 Hrs)

Integral Calculus:
Riemann Integration, Fundamental theorem of Integral calculus, mean value theorem. Application of definite integrals to area, length, volumes, and surfaces of solids of revolution. Improper integrals: Beta and Gamma functions, differentiation under integral sign. (10 Hrs)

Infinite series:
Sequences and series: Cauchy criterion, tests of convergence, absolute and conditional convergence, uniform convergence, power series, radius of convergence. (8 Hrs)

Matrices:
Rank of matrix, Echelon form, consistency, and solution of a system of linear equations, linear dependence and independence, linear and orthogonal transformations, Eigenvalues and eigenvectors, Cayley Hamilton theorem, reduction to diagonal form, Symmetric and

skew symmetric matrices, Hermitian and skew Hermitian matrices, Quadratic forms. (10Hrs)

Textbooks:

1. E. Kreyszig: Advanced Engineering Mathematics, 8th ed., John Wiley & Sons, 2007.
2. G. B Thomas and R. L. Finney: Calculus and Analytic Geometry 9th ed., Addison Wesley Longman, Inc; 1998.
3. R. K. Jain and S.R.K. Iyengar: Advanced Engineering Mathematics, Narosa Publishers, 2002.

Reference Books:

1. R. G. Bartle, D. R. Sherbert: Introduction to Real Analysis, 3rd ed., 2007.
2. G. Strang: Introduction to Linear Algebra, 4th ed., Cengage Learning, 2006.
3. D. Poole: Linear Algebra; A Modern Introduction, Cengage Learning, 2010.

Subject: Engineering Chemistry Code: CHL 1101 (L-T-P: 3-0-0)
Credit: 3

UNIT - I

Chemical Thermodynamics: Second law of thermodynamics, entropy and its physical significance, entropy change of ideal gases, free energy (Gibbs and Helmholtz), thermodynamic properties for reversible and irreversible processes, equilibrium constant from thermodynamic considerations, Maxwell's relationships, Gibbs-Helmholtz equation, Clapeyron-Clausius equation, concept of chemical potential with examples, Van't Hoff reaction isotherm, third law of thermodynamics and its applications.

Fundamentals of Instrumental analysis: UV-VIS, IR, NMR, Mass and Fluorescence spectrophotometry. (10 Hrs)

UNIT - II

Electrochemistry: Behavior of strong electrolytes with concentration, electrochemical cells, EMF and applications of EMF measurements, commercially important cells, and corrosion (its chemistry and remedial methods).

Chemical Kinetics: General discussion on the reactions of different orders including their rate laws with examples, problems based on first and second order reactions, pseudo-uniorder reactions, theories of reaction rates (collision and transition state theories), activation energy and catalytic reactions. Lasers in chemistry and its applications. (10 Hrs)

UNIT - III

Coordination Chemistry: Structure of coordination compounds corresponding to coordination no. up to 6, types of ligands, EAN, isomerisms, bonding in coordination compounds (VBT and MOT), Application of organometallic chemistry and coordination compounds in biology (Vitamin B12 and Haemoglobin).

Chemistry of materials: Preparation, properties, and applications. (8 Hrs)

UNIT - IV

Organic Chemistry: Stereochemistry of carbon compounds, E-Z and R-S systems of nomenclature of organic molecules, conformation analysis for certain organic systems,

pericyclic reactions, organic photochemistry, structures, and functions of biologically important molecules (carbohydrates, amino acids, proteins, and nucleic acids).

Polymers: Classification and structures of polymers, commercially important polymers: natural and synthetic rubber, biodegradable polymers, and composite polymeric materials. (8 Hrs)

Textbooks:

1. Engineering Chemistry by B. Sivasankar, Tata Mcgraw Hill
2. Engineering Chemistry by A. Mallick, Viva Books, 2008.
3. Organic Chemistry by J. Clayden, Nick Greeves, S. Warren, Oxford Press 2012.
4. Levine, Physical Chemistry, 5/e (7th reprint), Tata McGraw Hill, 2006.
5. Inorganic Chemistry, Principle, structure, and reactivity, J.E. Huheey, E.A. Keitler, R.L. Keita, O.K. Medhi, Pearson Education, 4th Ed.
6. Chemistry, J.E. Mcmerry and R.C. Fay, 5th Ed., Pearson Education, 2008

Reference Books:

1. Shriver, Atkins and Langford, Inorganic Chemistry, 2/e, ELBS, 1994.
2. S.H. Pine, Organic Chemistry, 5/e (special Indian ed.), TMH, 2007.
3. Banwell and McCash, Fundamentals of Molecular Spectroscopy, 4/e, Tata Mc-Graw Hill, 1962.
4. Cotton, Wilkinson and Gaus, Basic Inorganic Chemistry, 3/e, John Wiley & Sons, Inc., 1996.
5. I. L. Finar, A Textbook of Organic Chemistry, 6/e, Vol. I & II, ELBS, 2006
6. Textbook of Polymer Science, F.W. Billmeyer, Wiley-India Publications

Subject: Engineering Chemistry Laboratory Code: CHP 1101 (L-T-P: 0-0-3) Credit: 1.5

Exp. No. 1: Determination of viscosity by Redwood viscometer.
Exp. No. 2: Determination of critical micelle concentration (cmc) of commercial soaps by surface tension/conductance method.
Exp. No. 3: Verification of Beer-Lambert's law and determination of concentration of unknown solution by spectrophotometer.
Exp. No. 4: To study the adsorption of acetic acid on activated charcoal.
Exp. No. 5: Determination of dissociation constant of weak acid using a pH meter.
Exp. No. 6: Determination of cloud point of polymers and the effect of additives.
Exp. No. 7: To determine the rate constant of acid catalyzed hydrolysis of methyl acetate conductometrically.
Exp. No. 8: To find the strength of unknown supplied acid by conductometric titration (strong acid vs. strong base).
Exp. No. 9: Estimation of hardness of water by complexometry.
Exp. No. 10: Synthesise and characterization of metal(acetylacetonate): Mn (III)/Fe (III).
Exp. No. 11: Estimation of Fe2+ by permanganometry.
Exp. No. 12: Preparation of drug molecule: Paracetamol/Aspirin.
Exp. No. 13: Isolation of natural products like Caffein/Lactose.
Exp. No. 14: Preparation of nylon 6,6.
Exp. No. 15: Find out number of components in organic mixture and determination of Rf of each component using thin layer chromatography.
Exp. No. 16: Find out the m.p. of a binary mixture of organic compounds by varying the composition and determine the composition of the unknown mixture.

NOTE: Any ten experiments from the above shall be performed

Text/Reference Books:

1. Practicals in Physical Chemistry, P.S. Sindhu, Macmillian 2006.
2. Vogel's textbook of quantitative inorganic analysis, including elementary instrumental analysis, A.I. Vogel, 5th Edition, Addison-Wesley Longman, Incorporated, 1989.
3. Comprehensive Practical Organic Chemistry Preparation and quantitative Analysis, V.K. Ahluwalia, Renu Aggarwal, University Press India LTD, 2000.
4. J.R. Mohrig, T.C. Morril, C.N. Hammond and D.C. Neckers, Experimental organic chemistry, W.H. Freeman and Co., 1998.
5. N.K. Vishnoi, Advanced Practical organic chemistry, Vikash publishing housing Pvt. LTD., 1996.
6. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell, Vogels textbooks of practical organic chemistry, 5th Ed., ELBS longman, 1994.

Subject: BASIC ELECTRICAL ENGINEERING EEL 1101 (L-T-P: 3-0-0)
Credits: 3

1. Introduction: Introduction to electrical equipment, circuit components, Electrical Elements, and their classification, KCL, KVL equation, nodal, mesh analysis, voltage method, D.C. circuits steady state analysis with independent and dependent sources, Series and parallel circuits, star delta conversion, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer Theorem. (10 Hrs)

2. A.C. circuits: Common signals and their waveform, RMS and Average value, form factor and peak factor of sinusoidal wave, Impedance of series and parallel circuits, Phasor diagram, Power, Power factor, Power Triangle, coupled circuits, Resonance and Q-factor. (7 Hrs)

3. Magnetic circuits: Introduction, Series & Parallel magnetic circuits, Analysis of Linear and non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy current and hysteresis losses. (5 Hrs)

4. Three Phase Balanced Supply & Power Measurement: Star-delta connection, Power measurement. (2 Hrs)

5. Introduction of Electrical Machines: Transformer, DC machines, Induction Machines. (7 Hrs)

6. Introduction of Electrical Measurement: MI & MC types of meter, Energy meter, Wattmeter. (5 Hrs)

Textbooks:

1. R.J. Smith and R.C. Dorf: Circuits, Devices and Systems; John Wiley & Sons, 1992.
2. V. Del Toro: Electrical Engineering Fundamentals; PHI, 1994.

Reference Books *:*

1. Fundamentals of Electrical Engg. By Leonard S. Bobrow, Oxford
2. Fundamentals of Electrical Engineering by R. Prasad, PHI Publication

3. J. Nagrath and D. P. Kothari, 'Electric Machines', Tata McGraw Hill, 1985

Subject: BASIC ELECTRICAL ENGINEERING LAB EEP1101 (L-T-P: 0-0-3)
Credit : 1.5

1. Study of Network Theorems (KCL & KVL, Thevenin's, Norton's, Maximum Power transfer Theorem).
2. Familiarization of Voltmeter, Ammeter & Wattmeter
3. Study of RL & RLC circuit.
4. Study of calibration of Energy Meter.
5. Study of characteristic Fluorescent lamp connection.
6. Study of characteristic of carbon tungsten lamp.
7. Study of RL, RC and RLC series and parallel circuit.

Textbooks:

1. R.J. Smith and R.C. Dorf: Circuits, Devices and Systems; John Wiley & Sons, 1992.
2. V. Del Toro: Electrical Engineering Fundamentals; PHI, 1994.

Subject: ENGINEERING MECHANICS Code: MEL 1101 (L-T-P:3-0-0)
Credits: 3

Introduction: Engineering Mechanics: Idealization of Bodies, concept of Rigid Body, External Forces, moments, couples, Laws of Mechanics.

Force Systems And Equilibrium: Concurrent forces in a plane, Parallel forces in a plane, Free Body Diagram, Equation of equilibrium and their applications to various systems of forces. Friction: Concepts of friction, Dry friction, Laws of friction and their applications to wedge, ladder, screw, belt-pulley system, Rolling friction.

Distributed Forces and Moment of Inertia: Centroid of Composite figures, Area Moment of Inertia, Polar Moment of Inertia, Parallel axis theorem, Perpendicular axis theorem, Principal Moment of Inertia, Mass Moment of Inertia of circular ring, disc, cylinder, sphere, and cone about their axis of symmetry.

Beams: Different support & load conditions, Shear Force and Bending Moment Diagrams for point load, uniformly distributed load, uniformly varying load.

Analysis of Plane Trusses: Engineering structures, Perfect Truss, Determination of axial forces in the members, Method of Joints, Method of Section.

Kinematics of Rigid Body: Plain motion of rigid body, Velocity, and acceleration under translation and rotational motion, Absolute motion, Relative motion.

Kinetics of Rigid Body: Force, Mass and Acceleration, Work, Power and Energy, Impulse and Momentum, D' Alembert's Principle and dynamic equilibrium.

Text & Reference Books:

1. Timoshenko, Young and Rao: Engineering Mechanics: Tata McGraw-Hill Education.

2. I.H. Shames: Engineering Mechanics: Prentice Hall of India Pvt. Ltd.
3. F.P. Beer & E.R. Johnston: Mechanics for Engineers – (Statics & Dynamics): TMH New Delhi
4. J.L. Marriam & L.G. Kraig: Engineering Mechanics – Statics & Dynamics: John Wiley & Sons Ltd.
5. R.C Hibbler: Engineering Mechanics – Statics & Dynamics: Pearson

Subject: ENGINEERING MECHANICS LABORATORY Code: MEP 1101 (L-T-P:0-0-3) Credits: 1.5

List of Experiments

1. Study of functioning of gear trains.
2. Deflection of simply supported beam and verification of theoretical values.
3. To determine the modulus of rigidity of rod with the help of torsion testing machine.
4. To study functioning of belt pulley systems.
5. To find the mechanical advantages, velocity ratio and efficiency of worm and worm wheel.
6. To find the coefficient of friction between the surface of a given wood slide bar and an inclined plane.
7. To find the coefficient of friction between belt and pulley using belt pulley system.
8. To find reaction at the supports of a simply supported beam with different types of loading.
9. To find moment of inertia of a fly wheel about the axis of rotation using electronic counter machine.
10. To find centre of gravity of different geometrical objects.
11. To find forces in members of a truss for different load conditions.
12. To study conversion of momentum.
13. To verify the law of conservation of energy.
14. To verify law of polygon of forces.
15. To verify law of parallelogram of forces.
16. Demonstration for centrifugal forces.

Note: - Any 6-7 Experiments out of the list may be chosen.

SEMESTER - II

Subject: ENGINEERING MATHEMATICS--II Code: MAL 1202 L-T-P:3-1-0
Credit: 4

Function of Several variables:
Limit, continuity, and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Tangent plane, and normal line. Euler's theorem on homogeneous functions, Total differentiation, chain rules, Jacobian, Inverse function theorem and implicit function theorem (statement only). Taylor's formula, maxima and minima, Lagrange's method of undetermined multipliers. (12Hrs)

Multiple Integrals:
Double and triple integrals, change of order of integration, change of variables, application to area, volume, mass, centre of gravity and moment of inertia. (9Hrs)

Vector Calculus:
Vector Differentiation: Scalar and vector fields, gradient of scalar point function, directional derivatives, divergence, and curl of vector point function, solenoidal and irrotational vectors.
Vector Integration: line, surface and volume integral, theorem, Green's theorem, Stokes' theorem and Gauss divergence theorem (without proof). (10Hrs)

Ordinary Differential Equations:
Formation of differential equations: its order and degree. First order differential equations: Exact equation, integrating factors, Reducible to exact differential equations, linear and Bernoulli's form. Solution of first order and higher degree differential equations.
Second order differential equations: Solutions of second and higher order linear equation with constant coefficients, Linear independence, and dependence of solutions, Wronskian. Method of variation of parameters, solution of Cauchy's equation, simultaneous linear differential equations. (12Hrs)

Textbooks:

1. E. Kreyszig: Advanced Engineering Mathematics, 8th ed., John Wiley&Sons,2007.
2. G. B. Thomas and R. L. Finney: Calculus and Analytic Geometry 9th ed., Addison Wesley Longman, Inc; 1998.
3. W. E. Boyce and R. C. DiPrima: Elementary Differential Equations. 8th ed., John Wiley & Sons, Inc., New York,2005.

Reference Books:

1. Tom M. Apostol: Calculus, Volume 11,2nded., Wiley,2007.
2. R. K. Jain and S.R.K. Iyengar: Advanced Engineering Mathematics, Narosa Publishers, 2002.
3. S. L. Ross: Introduction to Ordinary Differential Equations, 4th ed.,Wiley,1989.

Subject: Engineering Physics Code : PHL 1201 (L-T-P: 3-0-0) Credits - 3

Wave and Oscillations: Overview of vibrations with emphasis on damped and forced oscillations, Resonance, Coupled oscillations, Simple Harmonic Motion. (05 Hrs)

Optics: Interference- Conditions for interference, types, Methods for producing Interference pattern of light, Fresnel's bi-prism, Newton's ring. Diffraction- Types of Diffraction, Diffraction by a single slit, double slit, diffraction by a N parallel slit: Diffraction grating. Polarization- Types of polarized light, Brewster's law, Nicol prism. (10hrs)

Wave Mechanics: Planck's theory of black body radiation, Photoelectric effect, Compton effect, Wave particle duality, de-Broglie matter waves, Davisson and Germer's experiment, Physical interpretation of wave function, Schrodinger's wave equation and its application particle in a box. (10 Hrs)

Solid State Physics: Free electron theory, Band theory of solids- Classification of materials based on band theory of solid, Semiconductor, Fermi level in an intrinsic and extrinsic semiconductor, Hall effect. (06 Hrs)

Lasers and Fibre optics: Lasers, Einstein's A and B coefficients, Population inversion, Optical pumping, Optical Resonators, Characteristics of lasers, Ruby laser, He-Ne laser, Semiconductor laser.

Introduction to fibre optics, Construction, types, Principle of wave propagation, Numerical aperture, Fibre losses, Applications of optical fibre. (10 Hrs)

Textbooks:

1. Concept of Modern Physics; Arthur Beiser: Tata Mc Graw Hills, 6th edition, 2009.
2. Applied Physics for Engineers; Neeraj Mehta: PHI Publication, 1st edition, 2011.
3. Fundamental of Physics Extended Volume; Resnick Halliday and Walker: John Wiley & Sons , 8th Asian Edition, 2008.

Reference books:

1. Quantum Mechanics; L. I. Schiff: TataMc Graw Hills, 3rd edition, 2010.
2. Optics; Ajoy Ghatak: Tata McGraw Hills, 4th edition, 2009.

Paper : Engineering Physics Laboratory Code : PHP 1201 (L-T-P: 0-0-2) Credits-1

Minimum eight experiments are required to be performed in a semester:

1. List of the Experiments:
2. Hall Effect experiment.
3. CRO experiment.

4. Semiconductor diode characteristics.
5. Characteristics of a solar cell.
6. Series and Parallel resonant circuits experiment.
7. He-Ne Laser experiment.
8. Diffraction grating experiment by using semiconductor diode laser.
9. Newton's Ring experiment.
10. Dispersion of prism experiment by using spectrometer.
11. To determine the wavelength of sodium light by using plane transmission grating.
12. Fresnel's biprism experiment.

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Note: Department may add or delete any experiment subject to availability.

Subject: Social Sciences **Code: HUL1202** **(L-T-P: 2-0-0)**
Credits: 2

Introduction: Meaning, Scope and general utility of Social Science to Engineers; Different Subjects in Social Sciences; Applied Humanities and Human Engineering. (4 Hrs)

Fundamental Concepts in Social Sciences: Types, Characteristics and Problems; Social Structure and Social System; Social Stratification, Social Change and Social Control. Types, Characteristics, Difference between Culture and Civilization; Family and Marriage Institution in India. (5 Hrs)

Industrialization & Society: Industrial Psychology and Industrial Democracy; Environment in Industry, Motivation, Selection and Training of Workers; Fatigue of Workers. (4 Hrs)

Political Orientation: Indian Constitution; Federal System, Directive Principles, Legislative measures for Labour Welfare; Bureaucracy in India.

Political Orientation: Indian Constitution; Federal System, Directive Principles, Legislative measures for Labour Welfare; Bureaucracy in India. (5 Hrs)

Major Social Problems in India: (6 Hrs)

1. Illiteracy
2. Poverty
3. Population
4. Slums
5. Family Disorganization
6. Corruption

Total Lectures: 24

Textbooks:

1. Asudani. V.H. An Easy Approach to Social Science.
2. Shabbir. S. A.M. Sheikh and Jaya Dwadashiwar. New Look Into Social Science.

Reference Books:

1. Zoya, Hasan. And E. Sridharan (eds.). India's Living Constitution: Ideas, Practices,
2. Controversies –Delhi: Permanent Black, 2002.
3. P. M Bakshi. The Constitution of India -Delhi: Universal Law Publishing, 2002.
4. Kozlowaski. Steve W. J. The oxford handbook of organizational psychology.
5. Ahuja. Ram. Social Problems in India.

Subject: INTRODUCTION TO COMPUTER PROGRAMMING Code: CSL 1201
Credits: 3 (L-T-P: 3-0-0)

Computer Basics: Introduction, Characteristics of a Computer, Criteria for Using Computers, History of Computers, Generations of Computer, Classification of Computers, Applications of Computer, Basic Components of PC, Computer Architecture. Computer Hardware, Computer Software, Internet. (3 Hrs)

Number System: Binary number, Octal number, Hexadecimal number system and their conversion among them. Programming basics: Assembly language, High level language, Compiler, and assembler. (4 Hrs)

Keyword & Identifiers: History & Importance of C, Basic structure of C programs, C fundamentals: The C character set identifier, Constants and keywords, Data types & size, Variable names declaration statement, C token, symbolic constant. (4 Hrs)

Operators and Expression: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment & Decrement operators, Condition Operators, Bitwise Operators, Special operators, precedence of arithmetic operators. Managing Input & output operations: using of printf() & scanf( ). (4 Hrs)

Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the ? operator, goto statement. (4 Hrs)

Decision making & branching: while statement, do- while statement, for statement. (2 Hrs)

Array, String & pointer: One-dimension array, Two-dimension array and multi dimension array. String: Operation on String without using library function and using library function. Pointer: Declaration of pointer variables, accessing the variable by using pointer, pointer increment and decrement operator, pointer, and array. **Functions**: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by value and Call by reference, Recursive function. Pointer to function. (9 Hrs)

Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure. Nested structure, structure & functions, Pointer & structure, Unions. (4 Hrs)

File management system: Advantage of using files, Open, close, read. Write in the files, Operation on files. (4 Hrs)

Dynamic memory Allocation: use of Malloc, calloc, realloc, free library functions, linked list concept, the preprocessor: macro statements. (3 Hrs)

Introduction to programming paradigm (1 Hr)

Textbooks:

1. Balaguruswamy," Programming with 'C'".
2. Kerninghan and Ritchie," The 'C' programming language".

Reference Book:

1. Govil, Agrawal, Mathur & Pathak, "Computer Fundamentals and Programming in C". Sinha & Sinha," Foundations of Computing", BPB.

Subject: Introduction to Computer Programming Code: CSP 1201 (L-T-P: 0-0-3) Credits: 1.5

Programming Lab will be set in consonance with the material covered in CSL1201.

Subject: Basic Electronics Engineering Code: CSL 1201 (L-T-P: 3-0-0) Credits: 3

Semiconductors and diodes: Lectures: 09

Introduction, Insulators, semiconductors and metals, Intrinsic and extrinsic semiconductors, PV cells, PN junction diode - Characteristics and analysis, Avalanche and Zener breakdown (zener diode).

Diode applications: Lectures: 06

Rectifiers and filter circuit: Half wave rectifier, Full wave rectifier, bridge rectifier and their analysis, passive filters (RC; low pass, high pass filter), Series and shunt diode clippers, Clipping at two independent levels, Clamping operation, Clamping circuit, Basic regulator supply using Zener diode.

Other diodes: Lectures: 03

Photodiode, LED, Varactor, tunnel diode and PV Cell.

Transistors: Lectures: 05

Construction and characteristics of BJT, Transistor configuration: CB, CE, CC configuration and their input output characteristics.

Field effect transistor: Lectures: 06

Construction of JFET, pinch-off voltage, volt-ampere characteristics, transfer characteristics, types of MOSFET (enhancement and depletion) construction and characteristics.

Amplifiers and oscillators: Lectures: 04

Classification of amplifiers, concept of feedback, Characteristics of feedback amplifiers, basics of oscillator, barkhausen criterion, introduction to Op-Amp.

Basic Digital Logic: Lectures: 03

Boolean Algebra, Basic Logic Gates, Number System

Textbooks:

1. Integrated Devices & Circuits by Millman & Halkias.
2. Electronics Devices and Circuit Theory by R. Boylestad.
3. Electronics: Fundamental and Applications, 15th eds by D. Chattopadhyay and P C Rakshit.
4. Digital Circuits Vol.I (Combinational Circuits) by Diptiman Ray Chauduri

Reference Books:

1. Electronics Devices and Circuits-II by A.P.Godre & U.A. Bakshi.
2. Electronics Devices and Circuit by G.K. Mithal.
3. Microelectronic Circuits by Sedra Smith, Oxford University Press.

Subject: Engineering Drawing Code: MEP 1201 (L-T-P: 0-0-4) Credits: 2

Introduction: Introduction to drawing instruments, sheet layout, types of lines and their uses, lettering, types of dimensioning, application of symbols and conventions in drawing practice, geometrical construction. Concepts of scales in drawing and their types.

Theory of projections: Introduction of projections, Orthographic & Pictorial projection.

Orthographic projection: Projection of points, lines, planes, and solids. Section of solids.

Isometric projection: Concepts of isometric and perspective views. Conversion of pictorial views to orthographic views and vice versa. Development of surfaces & Computer Aided Drawing using Auto CAD.

Text & Reference Books:

1. Bhatt N.D., Panchal V.M: Engineering Drawing: Charothar Publishing, Gujarat.
2. B. Agrawal: Engineering Drawing: Tata Mc Graw Hill.
3. Dhananjay A. Jolie: Engineering Drawing: Tata Mc Graw Hill
4. Luzadder Warren J., Duff John M: Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production: Practice-Hall of India Pvt. Ltd, New Delhi.
5. Singh Ajit: Machine Drawing: Tata McGraw Hill, New Delhi.

Subject: Workshop Code: MEP 1202 (L-T-P: 0-0-3) Credits: 1.5

General safety precautions in workshop and introduction.

Carpentry Shop:
Safety precaution, Kinds of wood and timber, Application of timber as per their classification, Carpentry hand tools and machines, Demonstration of wood working machine like, band saw, circular saw, etc. Exercise: Different types of carpentry joint.

Welding Shop:
Safety precaution in welding shop, Introduction to gas and arc welding, Soldering, and brazing etc. Welding equipment and welding material. Exercise: A simple job on welding.

Fitting Shop:
Safety precaution, Introduction to fitting shop tools, equipment, Operation, and their uses, Marking and measuring practice. Exercise: A simple job using fitting tools and equipment's.

Sheet Metal:
Safety precautions, Demonstration and working principles of some of the general machines, General idea of cutting tools and sheet metal works.

Exercise: A simple job on sheet metal.

SEMESTER - III

Subject: Data Structures Code: CSL 1301 (L-T-P: 3-0-0)
Credits: 3

Introduction: Basic Terminology, Elementary Data Organization, Structure operations, Algorithm Complexity and Time-Space trade- off Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors. (4 Hrs)

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, and Application of stack: Conversion of infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack. Recursion: Recursive definition and processes, recursion, example of recursion, Tower of Hanoi Problem, simulating recursion, Backtracking, recursive algorithms. (5 Hrs)

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D- queues and Priority Queues. (5 Hrs)

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Garbage Collection and Compaction. (6 Hrs)

Trees: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, path length algorithm. Huffman Algorithm. Binary Search Trees: Binary Search Tree (BST), insertion and Deletion in BST, Complexity of Search Algorithm. (5 Hrs)

Searching and Hashing: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation. Sorting: insertion Sort, Bubble Sort, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys. (5 Hrs)

File Structures: Physical Storage Media File Organization, Organization of records into Blocks, Sequential Files, Indexing and Hashing, Primary indices, Secondary indices, Introduction to index Files. (5 Hrs)

Textbooks:

1. Data Structures & Program Design in C: Robert Kruse, G. L. Tondo and B. Leung PHI-EEE.
2. R .Sedgewick, Algorithms in C++ parts 5' 3rd Ed. Pearson Education,2002
3. Data Structures By E. Horowitz and S. Sahni, Galgotri Publication

Reference Books:

1. Data Management & File Structures, 2e, by Mary E.S. Loomis, PHI
2. Data Structures by Lipschutz & Pai, Tata McGraw Hill.
3. C and Data Structures by P.S. Despande, Wiley India

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

Subject: Data Structures Laboratory Code: CSP 1301 (L-T-P: 0-0-3) Credits: 1.5

Programming Lab will be set in consonance with the material covered in CSL1301. This will include assignment in programming language like C++/JAVA.

Subject: Real Analysis Code: MAL 1305 (L-T-P: 3-0-0) Credits: 3

Unit I - Metric spaces

Review of the real number system, Basic concepts/ definitions and examples, continuous functions, completeness, Baire category theorem, contraction mapping theorem, connectedness, compactness, HeineBorel theorem. (14 Hrs)

Unit II - The Riemann-Stieltjes integral

The Riemann-Stieltjes integral and its properties, integrals of continuous and monotone functions, fundamental theorems of calculus, integration by parts, change of variables formula. (13 Hrs)

Unit III - Uniform convergence

Sequences and series of functions, Weierstrass M-test, uniform convergence and its relation to continuity, differentiation and integration, Weierstrass approximation theorem, equicontinuity, Arzela-Ascoli theorem. (13 Hrs)

Textbooks:

1. W. Rudin - Principles of mathematical analysis, McGraw-Hill 1976.
2. Terence Tao - Analysis I and II, with Chapter 11 from volume I and Chapters 1,2 and 3 from Volume II, trim series 37 and 38, Hindustan Book Agency.

Reference Books:

1. C. C. Pugh, Real Mathematical Analysis, Springer, 2002.
2. T. M. Apostol, Mathematical Analysis, Addison-Wesley, 1974.
3. G. F. Simmons, Topology and Modern Analysis, Kreiger, 2003.

Subject: Probability & Statistics Code: MAL 1303 (L-T-P: 3-0-0) Credits: 3

Random variables: Review of probability; Probability distributions with discrete and continuous random variables - Joint probability mass function, Marginal distribution function, Joint density function – Independent random variables – Mathematical Expectation – Moment generating function - Chebyshev's inequality - Weak law of large numbers - Bernoulli trials

Theoretical Probability Distributions: Binomial, Negative Binomial, Geometric, Poisson, Normal, Rectangular, Exponential, Gaussian, Beta and Gamma distributions and their moment generating functions; Fit of a given theoretical model to an empirical data.

Sampling and Testing of Hypothesis: Introduction to testing of hypothesis - Tests of significance for large samples – t, F and Chi-square tests; ANOVA - one-way and two-way classifications.

Theory of estimation: Characteristics of estimation - Minimum variance unbiased estimator - Method of maximum likelihood estimation.

Correlation and Regression: Scatter diagram - Linear and polynomial fitting by the method of least squares - Linear correlation and linear regression - Rank correlation - Correlation of bivariate frequency distribution.

Textbooks:

1. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapur, S.Chand & Sons, New Delhi, 2008
2. An Introduction to Probability theory and Mathematical Sciences, V.K. Rohatgi and A.K. Md. Ehsanes Saleh, Wiley, 2001

References:

1. Miller & Freund's Probability and Statistics for Engineers, Richard A. Johnson, Pearson, 2018, Ninth Edition

Subject: Operations Research Code: MAL 1307 (L-T-P: 3-0-0) Credits: 3

Linear Programming: Lines and hyperplanes - convex sets, convex hull - Formulation of a Linear Programming Problem - Theorems dealing with vertices of feasible regions and optimality - Graphical solution - Simplex method (including Big-M method and two-phase method) - Revised simplex method - Dual problem - Duality theory - Dual simplex method - Sensitivity analysis.

Transportation Problem: Existence of solution - Degeneracy - MODI method (including the theory). Assignment problem, Travelling Salesman Problem.

Integer Programming: Gomory's cutting plane method for an integer linear programming problem and a mixed integer linear programming problem.

Dynamic Programming: Multistage decision process - Concept of sub optimization - Principle of optimality - Computational procedure in dynamic programming – Application to problems involving discrete variables, continuous variables and constraints involving equations and inequations.

Textbooks:

1. Operations Research: An Introduction, H.A. Taha, Prentice Hall of India, 2019
2. Operations Research, Kanti Swarup, Manmohan and P.K. Gupta, Sultan Chand and Co., 2006

3. Introduction to Operations Research, J.C. Pant, Jain Brothers, 2008

Reference Books:

1. Mathematical Programming Techniques, N.S. Kambo, East-West Pub., Delhi, 1999.
2. Principles of Operations Research, H.M. Wagner, Prentice Hall of India, 1980

Subject: Operations Research Lab using C/C++ Code: MAP 1307 (L-T-P: 0-0-3) Credits: 1.5

Simple programs dealing with fundamentals of C/C++ language for

1. Simplex method
2. Big-M method
3. Two phase method
4. Revised simplex method
5. Dual simplex method
6. Solution of a transportation problem by northwest corner rule
7. Initial basic feasible solution for a transportation problem by Vogel's approximation method
8. Assignment problem

Subject: Scientific Computing Code: MAL 1308 (L-T-P: 3-0-0) Credits: 3

Errors, Numerical methods for solving scalar nonlinear equations; Interpolation and approximations, spline interpolations; Numerical integration based on interpolation, quadrature methods, Gaussian quadrature; Initial value problems for ordinary differential equations - Euler method, Runge-Kutta methods, multi-step methods, predictor-corrector method, stability and convergence analysis; Finite difference schemes for partial differential equations - explicit and implicit schemes; Consistency, stability and convergence; Stability analysis (matrix method and von Neumann method), Lax equivalence theorem; Finite difference schemes for initial and boundary value problems (FTCS, backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendroff method, upwind scheme).

Textbooks:

1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.
2. G. D. Smith, Numerical Solutions of Partial Differential Equations, 3rd Ed., Calrendorn Press, 1985.

Reference Books:

1. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.
2. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.
3. R. Mitchell and S. D. F. Griffiths, The Finite Difference Methods in Partial Differential Equations, Wiley, 1980.
4. Richard L. Burden and J. Douglas Faires, Numerical analysis, Brooks/Cole, 2001.

Subject: Scientific Computing Lab Code: MAP 1308 (L-T-P: 0-0-3)
Credits: 1.5

Problem will be set in consonance with the material covered in MAL 1501.

Subject: Linear Algebra & Applications Code: MAL 1302 (L-T-P: 3-0-0)
Credits: 3

Review of system of linear equations- matrices and elementary row operations, uniqueness of echelon forms. Moore-Penrose Generalized inverse. (6 Hrs)

Vector spaces, subspaces, basis and dimension, coordinates. Linear transformations: its algebra and representation by matrices. Algebra of polynomials, determinant functions, permutation, and uniqueness of determinants, additional properties. (11 Hrs)

Elementary canonical forms, characteristic values, and characteristic vectors, Cayley-Hamilton theorem, annihilating polynomial and invariant subspaces. Simultaneous triangularization, simultaneous diagonalization-Jordan form. (11 Hrs)

Inner product spaces, unitary and normal operators, bilinear forms. (4 Hrs)

Textbooks:

1. K. Hoffman and R. Kunze: Linear Algebra, PHI, New Delhi, 1986
2. G. Strang: Introduction to linear algebra, 4th ed., Cengage learning, 2006
3. K. B. Datta: Matrix and Linear Algebra, PHI, New Delhi, 2009.

Reference Books:

1. V. Krishnamoorthy, V. P. Mainra and J. L. Arora: An Introduction to Linear Algebra, Affi. ted East-West Press, New Delhi, 1976.

SEMESTER - IV

Subject: Differential Equations & Integral Transforms **Code: MAL 1406**
(L-T-P: 3-0-0) **Credits: 3**

Applications of Ordinary Differential Equations: **First Order:** Geometrical; tangent, normal of curves, orthogonal trajectories of curves. Growth and Decay. **Higher Order**: Applications- Mass spring Mechanical System -Free, damped, undammed & forced Oscillations. RLC circuits. Simple Pendulum. (6 Hrs)

Partial Differential Equations and Applications: Basic Concepts-Formation PDEs, Order, Linearity & Homogeneity of PDE, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients, Equations reducible to Homogeneous linear form, Non-Homogeneous Linear PDE, Classification of second order linear PDEs. Method Separation of variables. Applications - One Dimensional Wave equation, One Dimensional Heat equation, Two-Dimensional Laplace equation. (11 Hrs)

Laplace Transforms: Definition, existence, linearity property, first and second shifting properties, change of scale property, transforms of derivatives and integrals, Laplace transform of periodic functions, unit step function and Dirac delta function. Evaluation of integrals by Laplace transforms. Inverse Laplace transforms-properties, convolution theorem. Applications of Laplace transform to solve ODEs and PDEs. (10 Hrs)

Fourier Series and Fourier Transforms: Fourier series, half range sine and cosine series, exponential form of Fourier series. Fourier integral, Fourier transform, Fourier sine and cosine transforms, linearity, scaling, frequency shifting and time shifting properties, convolution theorem. Applications to solutions of ODEs and PDEs. (12 Hrs)

Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of difference equations. (5 Hrs)

Textbooks & References:

1. E. Kreyszig: Advanced Engineering Mathematics, 8th ed., John Wiley& Sons, 2007.
2. R.K. Jain and S.R.K. Iyengar: Advanced Engineering Mathematics, Narosa Publishers, 2002.
3. Sudhakar Nair, Advanced Topics in Applied Mathematics for Engg. & Physical Science
4. Gilbert Strang, Introduction to Applied Mathematics.
5. J. Spanier and K. B. Oldham, Fractional Calculus Theory and Applications of Differentiation and Integration to Arbitrary Order
6. M. Abramowitz & I. Stegun , Handbook of Mathematical Functions.
7. E. Rukumangadachari, Differential Equations, Pearson.
8. B V Ramana, HigerAngineering Mathematics, Tata McGraw-Hill.
9. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley
10. Gerald B Folland, Introduction to Partial Differential Equations, 2nd edition, Prentice – Hall of India (2001)

Subject: Abstract Algebra Code: MAL 1407 (L-T-P: 3-0-0) Credits: 3

Group theory: Definition and some examples of groups, some preliminary lemmas, subgroups, a counting principle, normal subgroups and Quotient groups. (12 Hrs)

Homomorphisms, automorphisms, Cayley's theorem, permutation groups, Sylow's theorems. (11 Hrs)

Ring theory: Definition and examples of Rings, some special classes of Rings, homomorphisms, Ideal and Quotient rings, Maximal Ideal, Integral domain, Principal Ideal domain, unique factorization domain. (11 Hrs)

Definition of field and some examples, the field of Quotients of an Integral domain, Euclidean rings, polynomial rings. (8 Hrs)

Texts & References:

1. Herstein, I. N., "Topics in Algebra", 2nd Ed., John Wiley & Sons, 2004.
2. Fraleigh, J. B., "A First Course in Abstract Algebra", 7th Ed., Pearson Education, 2003.
3. Dummit, D. S. and Foote, R. M., "Abstract Algebra", 3rd Ed., John Wiley & Sons, 2004.
4. Artin M., "Algebra", 2nd Ed., Prentice Hall India, 2011.
5. Gallian J. A., "Contemporary Abstract Algebra", 8th Ed., Cengage Learning, 2013.

Subject: Database Management Systems Code: CSL 1403 (L-T-P: 3-0-0) Credits: 3

Introduction : Introduction to database system, Database model, Database management system, Types and Examples (RDBMS, OODBMS, etc), Three-schema architecture of a database, Design Challenges, Components. (5 Hrs)

Entity-Relationship Model: Conceptual data modeling - motivation, Entities, Attributes, Relationships, E-R diagram, Examples: Concept of relations, Schema, Instances, Integrity constraints and Keys, EER. (5 Hrs)

Relational algebra: Selection, Projection, Cross product, Joins, Division, Example queries, Tuple relation calculus, Domain relational calculus, Converting the database specification in ER notation to the relational schema and vice versa. (4 Hrs)

SQL: Introduction, Data definition, Table, key and foreign key, Update behaviors, SQL Query-basic queries, semantics, and Nested queries. (6 Hrs)

Dependencies and Normal forms: schema design, Importance, and problems with bad designs, normalforms, dependency theory – functional dependencies, Armstrong's axioms, Closure set, Minimal covers, 1NF, 2NF, 3NF and BCNF, Decomposition, Multi-valued dependencies, Join dependencies, Introduction to 4NF and 5NF. (8 Hrs)

File organization: Indexing, Index structures, Hashing, Dynamic hashing techniques, Multi-level indexing, B+ trees and its variances. (6 Hrs)

Transaction processing and Error recovery: Concepts of transaction processing, ACID properties, Concurrency control, Locking protocols, Error recovery, backups. (4 Hrs)

Query Optimizations. (2 Hrs)

Textbooks:

1. Database System Concepts, by A. Silberschatz, H. F. Korth, & S. Sudharshan, McGraw Hill.

Reference Books:

1. Fundamental of Database Systems, by Elmasri, Navathe, Somayajulu, and Gupta, Pearson Education
2. Introduction to Database Management system by ISRD Group, Tata McGraw Hill
3. An Introduction to database system by C.J. Date, A. Kanana, S. Swamynathan, Pearson Education

Subject: Database Management Systems Lab Code: CSP 1403 (L-T-P: 0-0-3) Credits: 1.5

Problem will be set in consonance with the material covered in CSL 1403.

Subject: Discrete Mathematics Code: MAL 1408 (L-T-P: 3-0-0) Credits: 3

Set Theory: Definition of sets, countable and uncountable sets, Venn Diagrams, proofs of some general identities on sets. **Relation:** Definition, types of relation, composition of relations, Pictorial representation of relation, equivalence relation, partial ordering relation. **Function:** Definition, type of functions, one to one, into and onto function, inverse function, composition of functions, recursively defined functions. Theorem proving Techniques: mathematical induction (simple and strong), pigeonhole principle, prove by contradiction. (10 Hrs)

Algebraic Structures: Definition, Properties, types: Semi Groups, monoid, Groups, abelian group, properties of groups, Subgroup, cyclic groups, cosets, factor group, Permutation groups, normal subgroup, Homomorphism and isomorphism of Groups, example and standard results, Rings and Fields: definition and standard results. (8 Hrs)

Posets, Hasse Diagram and Lattices: Introduction, ordered set, hasse diagram of partially, ordered set, isomorphic ordered set, well ordered set, properties of Lattices, bounded and complemented lattices. (8 Hrs)

Propositional Logic: Proposition, First order logic, Basic logical operation, truth tables, tautologies, Contradictions, Algebra of Proposition, logical implications, logical equivalence, predicates, universal and existential quantifiers. (6 Hrs)

Graphs: Graphs, Sub graphs, some basic properties, various example of graphs & their sub graphs, walks, trails, path & circuits, connected graphs, disconnected graphs and component, various operation on graphs, Euler graphs, Hamiltonian paths and circuits, the

traveling salesman problem, directed graphs, some types of directed graphs, directed paths and connectedness, Hamiltonian, and Euler digraphs. Trees and fundamental circuits, distance diameters, radius, and pendent vertices, rooted and binary trees, on counting trees, spanning trees, fundamental circuits, finding all spanning trees of a graph and a weighted graph, trees with directed edges, fundamental circuits in digraph. (8 Hrs)

Textbooks:

1. Liptschutz, Seymour, "Discrete Mathematics", McGraw Hill.
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics: A computer Oriented Approach, Tata-McGraw Hill,
3. Deo, N: Graph theory, PHI

Reference Books:

1. Discrete Mathematical Structures: Theory & Applications by D.S Malik & M.K. Sen, Thomson India Edition
2. Trembley, J.P & R. Manohar, "Discrete Mathematical Structure with Application to Computer Science", McGraw Hill, Reprint 2010
3. Bondy and Murthy: Graph theory and application. Addison Wesley

Subject: Complex Analysis Code: MAL 1408 (L-T-P: 3-0-0) Credits: 3

Functions of Complex Variables: Complex variable - Functions of a complex variable - Continuity - Differentiability – Analytic functions. (9 Hrs)

Complex Integration: Cauchy's theorem - Cauchy's integral formula - Morera's theorem - Cauchy's inequality - Liouville's theorem. (9 Hrs)

Series Expansions: Taylor's theorem - Laurent's theorem - Zeros of an analytic function - Singularities. (7 Hrs)

Contour Integration: Residue - Cauchy's residue theorem – contour integration – the fundamental theorem of algebra - Poisson's integral formula. Analytic continuation – branches of a many-valued function - Riemann surface. (7 Hrs)

Conformal Mapping: The maximum modulus theorem - mean values of f(z) - Conformal representation – Bilinear transformation - Transformation by elementary functions - uniqueness of conformal transformation - representation of any region on a circle. (10 Hrs)

Textbooks:

1. Complex Variables and Applications, R.V. Churchill and J.W. Brown, McGraw Hill, Tokyo, 2009, Eighth Edition.
2. Theory of Complex Variables, E.T. Copson, Oxford University Press, New Delhi, 1974.

Reference Books:

1. Complex Variables with Applications, S. Ponnusamy & Herb Silverman, Birkhauser, Boston, 2006, First Edition

2. Complex Variable, Murray Spiegel, Seymour Lipschutz, John Schiller and Dennis Spellman, Schaum's Outlines Series, McGraw Hill, 2017, Revised Second Edition.

Subject: Nonlinear Optimization: Theory & Algorithms **Code: MAL 1409**
(L-T-P: 3-0-0) **Credits: 3**

Recap of real analysis and linear algebra: Sets, functions, sequences, continuity, differentiability, gradients, Taylor series expansion. Vectors, matrices, norms, symmetric matrices, eigenvalue decomposition, positive semidefinite and positive definite matrices. (3 Hrs)

Convex sets and functions: Convex sets, examples and properties. Convex functions, strict and strong convexity, examples, and convexity preserving operations. Equivalent definitions of convexity under differentiability assumptions. (8 Hrs)

Unconstrained optimization: Maxima, minima, stationary point, saddle point, local and global maximum/minimum. First order and second order conditions for optimality. Linear, quadratic and convex optimization problems, examples. Benefits of convexity. (9 Hrs)

Constrained optimization: Constrained optimization problem, feasible set. Lagrangian, KKT conditions Linear and quadratic optimization Duality for convex optimization — theorem of alternatives, Farka's lemma. (9 Hrs)

Algorithms for optimization: Gradient descent with fixed step size, line search and Armijo-Goldstein rule. Newton method and variations. Conjugate gradient and Quasi-newton methods. Algorithms for constrained optimization: Projected gradient descent, dual ascent, alternating direction method of multipliers. (10 Hrs)

Applications: Applications in statistics, machine learning and computer science. (3 Hrs)

Textbooks:

1. Boyd, Stephen, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
2. Luenberger, David G., and Yinyu Ye. Linear and nonlinear programming. 4th edition. Springer, 2015.

Reference Books:

1. Bertsekas, Dimitri P. Nonlinear programming. Belmont: Athena scientific, 1999.
2. Nocedal, Jorge and Wright, Stephen. Numerical optimization. Springer, 1999

Subject: Nonlinear Optimization: Theory & Algorithms Lab using R
Code: MAP 1409 **(L-T-P: 0-0-3)** **Credits: 1.5**

Problem will be set in consonance with the material covered in MAL 1409.

SEMESTER – V

Subject: Fluid Dynamics **Code: MAL 1501** **(L-T-P: 3-0-0)**
Credits: 3

Kinematics of fluids in motion: Real fluids and ideal fluids – Velocity of a fluid at a point– Streamlines and path lines – Steady and unsteady flows – The velocity potential – The velocity vector – Local and particle rates of change – The equation of continuity – Acceleration of fluid – Conditions at a rigid boundary.

Equations of motion of fluid: Euler's equations of motion – Bernoulli's equation – Some flows involving axial symmetry – Some special two-dimensional flows. Some three-dimensional flows: Introduction – Sources, sinks and doublets – Axisymmetric flows – Stokes' stream function. The Milne-Thomson circle theorem – The theorem of Blasius – Applications.

Viscous flows: Stress analysis in fluid motion – Relations between stress and rate of strain – The coefficient of viscosity and laminar flow – the Navier-Stokes' equations of motion of viscous fluid – Steady motion between parallel planes, Through tube of uniform cross section and flow between concentric rotating cylinders. Steady viscous flow in tubes of uniform cross section – A uniqueness theorem – Tube having uniform elliptic cross section – Tube having equilateral triangular cross section – Steady flow past a fixed sphere.

Textbooks:

1. Fluid Dynamics, Frank Chorlton, CBS Publishers, Delhi, 2004
2. Theoretical Hydrodynamics, L. M. Milne Thomson, Macmillan Company, New York, 1960

Reference Books:

1. Fluid Mechanics: An Introduction to the Theory of Fluid Flow, Franz Durst, Springer Verlag Berlin Heidelberg, 2008
2. Introduction to Fluid Mechanics, Stephen Whitaker, Ed-Tech Press, 2018.

Subject: Stochastic Calculus **Code: MAL 1504** **(L-T-P: 3-0-0)**
Credits: 3

Understand the following mathematical concepts with their properties: sigma-algebra, expectation with respect to sigma algebra, martingale, Wiener process, Ito's stochastic integral.

Be able to formulate and apply in simple context the following theorems: Ito's lemma, Girsanov's theorem.

Understand the Black and Scholes model: price simple European options using martingale approach, price exotic European options using simulations in open-source software like R, python or Julia.

Textbooks:

1. Brzezniak, Zdzislaw and Tomasz Zastawniak (2000). Basic stochastic processes: a course through exercises. Springer Science and Business Media.
2. S. Shreve, Stochastic Calculus for Finance, Vol.2, Springer India, 2004.
3. M. Baxter and A. Rennie, Financial Calculus, Cambridge University Press, 1996.

Reference Books:

1. Shreve, Steven (2012). Stochastic calculus for finance I: the binomial asset pricing model. Springer Science and Business Media.
2. Steele, J Michael (2012). Stochastic calculus and financial applications. Vol. 45. Springer Science and Business Media.
3. I. Karatzas and S. E. Shreve, Brownian motion and stochastic calculus, 2nd ed., Graduate Texts in Mathematics, vol. 113, Springer-Verlag, New York, 1991.

Subject: Functional Analysis Code: MAL 1505 (L-T-P: 3-0-0) Credits: 3

Normed linear spaces, Banach spaces; Classical examples: C([0,1]), l_p, c, c_0, c_{00}, $L_p[0,1]$; Continuity and boundedness of linear operator; Quotient spaces; Finite dimensional normed spaces; Riesz lemma, (non)compactness of unit ball; Separability with examples. (14 Hrs)

Hahn Banach extension theorem, Open mapping theorem, Closed graph theorem, Uniform boundedness principle. (10 Hrs)

Hilbert spaces, Projection theorem; Orthonormal basis, Bessel inequality, Parseval equality; Dual, Duals of classical spaces-c_0, l_p, $L_p[0,1]$; Riesz representation theorem, Adjoint of an operator; Double dual, Weak and weak* convergence. (16 Hrs)

Textbooks:

1. M. Fabian, P. Habala, P. Hajek, V. M. Santalucia, J. Pelant and V. Zizler, Functional analysis and infinite-dimensional geometry. (Canadian Math. Soc, Springer 2001).
2. M. T. Nair, Functional analysis. (PHI-Learning, New Delhi, Fourth Print 2014).

Reference Books:

1. B. Bollobas, Linear analysis (Cambridge Univ. Press 1999).
2. J. Conway, A course in functional analysis. (Springer 2007).
3. C. Goffman and G. Pedrick, A first course in functional analysis, (Prentice-Hall 1974).
4. P. D. Lax, Functional analysis (Willey Interscience 2002).
5. B.V Limaye, Functional analysis (New Age International 1996).
6. M. Reed and B. Simon, Methods of Modern Mathematical Physics, Vol I. (Academic press, 1980).

Subject: Artificial Intelligence Code: CSL 1506 (L-T-P: 3-0-0) Credits: 3

Introduction: Introduction and techniques of AI, Importance of AI, Intelligent agent, LISP, Prolog for AI. (3 Hrs)

Search strategies: Search space, Uninformed Search technique- Bread First Search, Depth first search, Informed Search- Heuristic Search technique, constraint satisfaction problems,

stochastic search methods, Hill climbing, backtracking, graph search, Properties of A* algorithm, monotone restriction– Specialized production systems - AO* algorithm. (12 Hrs)

Searching game trees: MINIMAX procedure, alpha-beta pruning. (3 Hrs)

Knowledge representation: Knowledge representation and reasoning, Propositional logic, First order logic, Situation calculus. Theorem Proving in First Order Logic, STRIPS robot problem solving system, Structured representations of knowledge (Semantic Nets, Frames, Scripts). (10 Hrs)

Uncertain Knowledge and Reasoning: Non monotonic & monotonic reasoning, Confidence factors, Bayes theorem, Dempster & Shafer's Theory of evidence, Probabilistic inference, Fuzzy reasoning. (6 Hrs)

Natural Language Processing: An Introduction to Natural language Understanding, Perception, Learning. (4 Hrs)

Applications: AI in E-commerce, E-tourism, Industry, Medicine, etc. (2 Hrs)

Textbooks:

1. Artificial Intelligence by Rich & Knight, Tata McGraw Hills
2. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvik, Pearson Education

Reference Books:

1. Introduction to Artificial Intelligence by Eugene Charniak, Pearson Education
2. Artificial Intelligence by G.LUGER, W.A. STUBBLEFIELD, Addison- Wesley Longman, 1998
3. Artificial Intelligence application programming by M. Tim Jones, Dreamtech Press Programming Lab (AI) Implementation in all algorithms in LISP/Prolog

Introduction to Artificial Intelligence by Rajendra Akerkar, PHI

Subject: Artificial Intelligence Lab Code: CSP 1506 (L-T-P: 0-0-3) Credits: 1.5

Problem will be set in consonance with the material covered in CSL 1506.

Subject: Theory of Computation Code: MAL 1502 (L-T-P: 3-0-0) Credits: 3

Introduction: Alphabets, strings, languages, and grammar. (2 Hrs)

Finite automata: Introduction to finite automata, deterministic and non-deterministic finite automata, application offinite automata, equivalence, and minimization of automata (6 Hrs)

Regular Expression: Regular expression, finite automata and regular expressions, applications of regular expressions, Arden's Theorem, algebraic laws of regular expressions. (6 Hrs)

Properties of Regular Language: Pumping lemma, closure properties. (4 Hrs)

Context-free Grammars and Languages: Parse trees, Applications of context free grammars, Ambiguity. (3 Hrs)

Pushdown Automata: Pushdown automation (PDA), the language of PDA, equivalence of PDA's and CFG's, deterministic pushdown automata. (4 Hrs)

Properties of Context-Free Languages: Normal forms, pumping lemma, closure properties. (5 Hrs)

Turing Machine: Definition, variants, recursively enumerable (r.e.) sets, recursive sets, programming techniques for Turing machine, restricted Turing Machines, Turing machines and Computers, decidability and undecidability, Halting Problem, reductions, Undecidable Problem about Turing Machine, Post's Correspondence Problem. (7 Hrs)

Intractable Problem: The Classes P&NP, NP-Complete Problem, Example of P& NP Problem. (3 Hrs)

Textbooks:

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

Reference Books:

1. Introduction to languages and the theory of computation, Martin John, TMH
2. Theory of Computer Science (Automata, Languages and Computation), K. L. P. Mishra and N. Chandrasekharan, PHI

Subject: Neural Networks Code: MEL 1710 (L-T-P: 3-0-0) Credits: 3

Fundamentals of Neural Networks: What is Neural Network, Model of Artificial Neuron, Learning rules and various activation functions.

Neural Network Architecture: Single layer Feed-forward networks. Multilayer Feed-forward networks. Recurrent Networks.

Back propagation Networks: Back Propagation networks, Architecture of Back-propagation(BP) Networks, Back-propagation Learning, Variation of Standard Back propagation algorithms.

Associative Memory: Autocorrelators, Heterocorrelators, Wang et al.'s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real coded pattern pairs, Applications.

Adaptive Resonance Theory: Cluster Structure, Vector Quantization, Classical ART Network, Simplified ART Architecture, ART1 and ART Architecture and algorithms, Applications, Sensitivities of ordering of data.

Text & Reference Books:

1. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press. 1995
2. S. Rajasekaran & G.A.V. Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI, 2003.
3. J.S.R. Jang, C.T. Sun and E. Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 2004.

SEMESTER - VI

Subject: Machine Learning Code: CSL 1605 (L-T-P: 3-0-0) Credits: 3

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. (3 Hrs)

Linear regression, Decision trees, overfitting. (4 Hrs)

Instance based learning, Feature reduction, Collaborative filtering based recommendation. (4 Hrs)

Probability and Bayes learning. (5 Hrs)

Logistic Regression, Support Vector Machines, Kernel function and Kernel SVM. (8 Hrs)

Neural networks: Perceptron, multilayer network, backpropagation, introduction to deep neural network (DNN). (8 Hrs)

Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning. (6 Hrs)

Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture models (GMM). (5 Hrs)

Textbooks:

Machine Learning by Mitchell Tom M., Mcgraw Hills.
J. Shavlik and T. Dietterich (Ed), Readings in Machine Learning, Morgan Kaufmann, 1990.
P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

Subject: Machine Learning Lab Code: CSP 1605 (L-T-P: 0-0-3) Credits: 1.5

Problem will be set in consonance with the material covered in CSL 1605.

Subject: Design & Analysis of Algorithms Code: CSL 1601 (L-T-P: 3-0-0) Credits: 3

Introduction: Definition, Asymptotic notations, and complexity analysis (best, worst, and average case), notions of optimality, Medians, and order statistics, Minimum and maximum, selection in expected linear time, Selection in worst-case linear time. (5 Hrs)

Algorithm design techniques: Greedy Algorithm: Introduction Set of Intervals, Fractional Knapsack and 0-1knapsack problems, Huffman coding**,** Divide and Conquer: Introduction, Sorting, Median Finding**,** Dynamic Programming: combinatorial Search, 0-1 knapsack, longest common subsequence, matrix chain multiplication, optimal search trees, scheduling problem. (12 Hrs)

Miscellaneous algorithms: Integer, matrix and polynomial multiplication, convex hull, closest pairs, stringmatching, FFT, extended Euclid's algorithm. (5 Hrs)

Graphs and graph algorithms: Definition, Representations of graphs, Depth first search, Breadth firstsearch. Kruskal‟s and Prim's algorithm for minimum spanning tree, single source shortest path algorithm, all-pairs shortest path algorithms**.** (10 Hrs)

Computational complexity: The classes P and NP, Introduction to NP completeness-Matching, search/Decision examples of NP complete problems , Polynomial Reduction, NP Hard and NP Complete Problems, Introduction to branch-and-bound, backtracking, and approximation algorithms. (8 Hrs)

Textbooks:

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein : Introduction to algorithms -, PHI,2002
2. Fundamentals of Algorithm-by Horowitz & Sahani, 2nd Edition, Universities Press.

Reference Books:

1. Algorithms By Sanjay Dasgupta, Umesh Vazirani – McGraw-Hill Education
2. Algorithms – Berman, Cengage Learning

Subject: Multivariate Statistical Methods Code: MAL 1603 (L-T-P: 3-0-0) Credits: 3

Data driven decision making is the state of the art today. It spreads across all sectors of human civilization. Engineers today gather huge data and seek meaningful knowledge out of these for interpreting the process behavior. Scientists do experiments under controlled environment and analyze them to confirm or reject hypotheses. Managers and administrators use the results out of data analysis for day-to-day decision making. Data collection and storage is an easy task today. Data-driven decision making now is the way of life. The aim of this course is therefore to build confidence in the students in analyzing and interpreting multivariate data. The course will help the students by: (i) Providing guidelines to identify and describe real life problems so that relevant data can be collected, (ii) Linking data generation process with statistical distributions, especially in the multivariate domain, (iii) Linking the relationship among the variables (of a process or system) with multivariate statistical models, (iv) Providing step by step procedure for estimating parameters of a model developed, (v) Analyzing errors along with computing overall fit of the models, (vi) Interpreting model results in real life problem solving, and (vii) Providing procedures for model validation.

Textbooks:

1. Applied multivariate statistical analysis by R A Johnson and D W Wichern, Sixth Edition, PHI, 2012.

2. Multivariate data analysis by Joseph F. Hair Jr, Rolph E. Anderson, Ronald L Tatham, and William C. Black, Fifth Edition, Pearson Education, 1998.

Subject: Multivariate Statistical Methods Lab Code: MAP 1603 (L-T-P: 3-0-0) Credits: 3

Problem will be set in consonance with the material covered in MAL 1603.

Subject: Managerial Economics Code: HUL 1604 (L-T-P: 3-0-0) Credits: 3

Introduction to Economics: Definition, Economic Problems, Production Possibility Frontier, Microeconomics and Macroeconomics. (2 Hrs)

Demand: Definition, Law of Demand, Demand Function, Demand Curve, Change in Demand, Shift in Demand. (3 Hrs)

Supply: Law of Supply, Supply function, Supply Curve, Change in Supply, Shift in Supply, Market Equilibrium, Consumer and Producer Surplus, Government intervention, Deadweight Loss. (3 Hrs)

Indifference Curve Analysis, Budget Line, Equilibrium of the Consumer, Substitution Effect, Income Effect. (4 Hrs)

Elasticity: Definition, Types of Elasticity, Methods for measuring Elasticity, Relationship between Price, Revenue and Elasticity; Pragmatic approach to Demand, Analysis of Demand pattern demand forecasting. (6 Hrs)

Production: Production Function, Isoquant, Types of Isoquant, Isocost line, Returns to Scale, Law of Variable Proportions/ Diminishing Returns, Expansion path. (3 Hrs)

Introduction to Costs: Types of Costs fixed, sunk, variable, Short-run and Long-run Costs, Opportunity cost, Total revenue, average revenue, marginal revenue, Break-even analysis, Economies of Scale and Scope. (5 Hrs)

Introduction to Market: Market Structure, Perfect Competition: Short-run and Long-run Equilibrium, Monopoly: Short-run and Long-run Equilibrium, Price Discrimination, Monopolistic Competition: Short-run and Long-run Equilibrium. (8 Hrs)

Game theory: Introduction to Game theory, Prisone -operative game, Non-Cooperative game, Zero Sum game, Non-zero sum game, Nash Equilibrium. (8 Hrs)

Textbooks:

1. Robert S. Pindyck, D Rubinfeld & P. L. Mehta, Microeconomics, 2009 edition, Prentice Hall.
2. A. Koutsoyiannis, Modern Microeconomics, 2nd edition, Macmillan.
3. Das, Satya P, Microeconomics for Business, Sage Publications.

References:

1. Samuelson, Paul A and William D Nordhaus, Economics, 19th Edition, 2010, Indian Adaptation by Sudip Chaudhuri and Anindya Sen, Tata McGraw Hill.
2. Mankiw, N Gregory, Principles of Economics, Cengage Learning.
3. Salvatore, Dominick, Principles of Microeconomics, 5th Edition, 2009, Oxford International Student Edition.

LIST OF ELECTIVES

ELECTIVE - I

Subject: Mathematical Biology **Code: MAL 1601** **(L-T-P: 3-0-0)**
Credits: 3

Review of Linear Systems of ODEs and Qualitative Analysis of Autonomous Systems; Bifurcations and chaos: Saddle-node, Transcritical, Pitchfork, Hopf; Population dynamics, single species, interacting species; Infectious disease, SIR epidemics, SIS endemics; Spatially structured models, pattern formation, Turing instability, Turing bifurcations, tumor modeling; Stochastic birth and death processes, Branching processes.

Textbooks:

1. William E. Boyce, Richard C. DiPrima, and Douglas B. Meade, Elementary Differential Equations, John Wiley & Sons, 2017.
2. Nicholas F. Britton, Essential Mathematical Biology, Springer Science & Business Media, 2012
3. Mark Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001.

Subject: Topology **Code: MAL 1602** **(L-T-P: 3-0-0)**
Credits: 3

Topological Spaces: open sets, closed sets, neighbourhoods, bases, subbases, limit points, closures, interiors, continuous functions, homeomorphisms.

Examples of topological spaces: subspace topology, product topology, metric topology, order topology, topological groups.

Quotient topology, examples of quotient topology: construction of cylinder, cone, suspension, Moebius band, torus, orbit spaces.

Connectedness and Compactness: Connected spaces, Components, Local connectedness, Compact spaces, Local compactness, Tychnoff Theorem. Separation Axioms, Urysohn lemma, Urysohn Metrization theorem,Tietze Extension theorem, One-point compactification, paracompactness and partition of unity.

Textbooks:

1. J. Dugundji, Topology, UBS, 1999.
2. M. A. Armstrong, Basic Topology, Springer, 2005.

Reference Books:

1. J. R. Munkres, Topology: A First Course, Prentice Hall, 1975.
2. G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw-Hill, 1963.

Subject: Measure and Integration **Code: MAL 1604** **(L-T-P: 3-0-0)**

Credits: 3

Riemann integral to Abstract measure: Function theoretic view of Riemann integral, Outer measure induced by the length, the Caratheodary condition, Lebesgue measurable sets in R, Non-measurable sets in R, Abstract Measurable space, Borel σalgebra,Measure, Continuity properties of a measure, Monotone class theorem, Uniqueness of the extension, Completion of a measure space, Completeness of Lebesgue σ-algebra. (14 Hrs)

Measurable functions, convergence and integration: Measurable functions, Convergence of measurable functions (almost everywhere, in measure, in mean, almost uniform), Egorov's theorem, Lusin's theorem, Integral of nonnegative measurable function, Monotone convergence theorem, Fatou's lemma, Lebesgue Integrable functions, Dominated convergence theorem, Generalized dominated convergence theorem, Scheffe's lemma, Completeness of L'(μ), L1 [a, b] as the completion of R[a, b], Bounded variation, Absolute continuity, Fundamental theorem for Lebesgue integrable functions. (21 Hrs)

Product measure: Product measure, Fubini's theorem. (5 Hrs)

Textbooks:

1. G. de Barra, Measure and Integration, Wiley Eastern, 1981.
2. K. Rana, An Introduction to Measure and Integration, Second Edition, Narosa, 2005.

Reference Books:

1. H. L. Royden, Real Analysis, Third edition, Prentice-Hall of India, 1995.
2. Terence Tao, An Introduction to Measure Theory, Graduate Studies in Mathematics, AMS, 2011
3. G. Folland, Real Analysis: Modern Techniques and Their Applications.
4. W. Rudin, Real and Complex Analysis, Third edition, McGraw-Hill, International Editions, 1987

Subject: Numerical Optimization Code: MAL 1605 (L-T-P: 3-0-0)
Credits: 3

Introduction (1 lecture), Background and Classification of optimisation problems (1 lecture), Unconstrained optimisation (2 lectures), Line Search methods (3 lectures), Trust region methods (3 lectures), Gradient descent (2 lecture), Exact and Quasi-Newton Methods (5 lectures), Non-linear least squares (1 lecture), Nonlinear equations (2 lectures), Constrained optimization (3 lectures), Linear programming: Simplex method (2 lectures); Nonlinear constrained optimization (1 lecture), Farkas' lemma (1 lecture), Karushâ-Kuhnâ-Tucker (KKT) conditions (2 lectures), Quadratic programming (2 lectures), Penalty, Barrier and Augmented Lagrangian methods (4 lectures), Sequential Quadratic Programming (2 lectures), Large scale optimization: Algorithms and Softwares (4 lectures).

Textbooks:

1. Jorge Nocedal & Stephen J. Wright, Numerical Optimization, Publisher : Springer
2. R. Fletcher, Practical Methods of Optimization, Publisher: Wiley
3. D. Bertsekas, Nonlinear Programming, Athena Scientific.

Reference Books:

1. P. E. Gill, W. Murray and M. H. Wright, Numerical Methods for Linear Algebra and Optimization: Volume 1, Addison-Wesley.
2. P. E. Gill and W. Murray, Numerical Methods for Constrained Optimization, Academic Press.
3. P. E. Gill, W. Murray, and M. H. Wright, Practical Optimization, Academic Press.

Subject: Applied Graph Theory Code: MAL 1606 (L-T-P: 3-0-0) Credits: 3

Fundamental concepts: basic definitions, operations, properties, proof styles. (5 Hrs)

Trees: properties, distances, and centroids, spanning trees, enumeration. (5 Hrs)

Matchings: bipartite graphs, general graphs, weighted matching . (4 Hrs)

Connectivity: vertex and edge connectivity, cuts, blocks, k-connected graphs, network flows. (6 Hrs)
Traversibility: Eulerian tours, Hamiltonian cycles); Coloring (vertex and edge coloring, chromatic number, chordal graphs. (8 Hrs)

Planarity: duality, Euler's formula, characterization, 4-color theorem. (4 Hrs)

Advanced topics: Perfect graphs, matroids, Ramsay theory, extremal graphs, random graphs, and Applications. (8 Hrs)

Textbooks:

1. Douglas B. West, “Introduction to Graph Theory”, Prentice Hall of India
2. Narsingh Deo, “Graph Theory with Applications to Engineering and Computer Science”, Prentice-Hall.

Reference Books:

1. West, Introduction to Graph Theory, 2nd ed., Prentice Hall
2. Nisan/Roughgarden/Tardos/Vazirani (eds), Algorithmic Game Theory, Cambridge University, 2007 (available for free from here).
3. Game Theory by Michael Maschler, Eilon Solan, and Shmuel Zamir.
4. Game Theory and Mechanism Design by Y. Narahari

Subject: Randomized Algorithms Code: MAL 1608 (L-T-P: 3-0-0) Credits: 3

Moments and Deviations, Tail Inequalities, Probabilistic Method, Markov Chains and Random Walks, Polynomial Identity Testing, Perfect Matchings, Interactive Proof Systems, Randomized Data Structures: Skip Lists, Hash tables, Universal hash functions and their applications. Randomization in Geometric Algorithms. Randomized Algorithms for Minimum Spanning Tree, Min-Cut and All-pairs Shortest Paths. Approximate Counting: Counting Perfect Marching in bipartite graphs. Randomized Parallel and Distributed

Algorithms: Maximal Independent Set. Number Theory: Randomized Primality Testing.

Textbooks:

1. Rajeev Motwani, Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press.
2. R.M. Karp, An introduction to randomized algorithms, Discrete Applied Mathematics, 34, pp. 165-201, 1991.
3. D.B. Dubhashi, A. Panconesi, Concentration of Measure for the Analysis of Randomized Algorithms, Cambridge University Press, 2009.

Subject: Integral Equations & Calculus of Variations Code: MAL 1610 (L-T-P: 3-0-0) Credits: 3

Preliminary Concepts: Definition and classification of linear integral equations. Conversion of initial and boundary value problems into integral equations. Conversion of integral equations into differential equations. Integro-differential equations. (4 Hrs)

Fredholm Integral Equations: Solution of integral equations with separable kernels, Eigenvalues and Eigenfunctions. Solution by the successive approximations, Numann series and resolvent kernel. Solution of integral equations with symmetric kernels, Hilbert-Schmidt theorem, Green's function approach. (8 Hrs)

Classical Fredholm Theory: Fredholm method of solution and Fredholm theorems. (4 Hrs)

Volterra Integral Equations: Successive approximations, Neumann series and resolvent kernel. Equations with convolution type kernels. (4 Hrs)

Solution of integral equations by transform methods: Singular integral equations, Hilbert-transform, Cauchy type integral equations. (6 Hrs)

Calculus of Variations: Basic concepts of the calculus of variations such as functionals, extremum, variations, function spaces, the brachistochrone problem. Necessary condition for an extremum, Euler`s equation with the cases of one variable and several variables, Variational derivative. Invariance of Euler`s equations. Variational problem in parametric form. (10 Hs)

General Variation: Functionals dependent on one or two functions, Derivation of basic formula, Variational problems with moving boundaries, Broken extremals: Weierstrass – Erdmann conditions. (6 Hrs)

Textbooks/Reference Books:

1. Jerry, Abdul J., Introduction to Integral Equations with applications, Clarkson University Wiley Publishers (II Edition), 1999.
2. Chambers, Ll. G., Integral Equations: A short Course, International Text Book Company Ltd., 1976.
3. Kanwal R. P., Linear Integral Equations, Birkhäuser Bosten, II Edition, 1997.
4. Harry Hochstadt, Integral Equations, John Wiley & Sons, 1989.
5. Gelfand, I. M., Fomin, S. V., Calculus of Vaiations, Dover Books, 2000.

6. Weinstock Robert, Calculus of Variations With Applications to Physics and Enginering, Dover Publications, INC., 1974.

ELECTIVE – II

Subject: Advanced Data Structures Code: CSL 1XXX (L-T-P: 3-0-0) Credits: 3

Basic Concepts of OOPs, Templates Function and class templates, Algorithms: performance analysis, time complexity and space complexity, ADT, List (Singly, Doubly and Circular), Array, Pointer, Cursor. (4 Hrs)

Stacks and Queues, ADT, Trees: Binary Tree, Binary Search Tree, AVL, Tries, Red Black trees, Splay tree, B Trees, Skip List, Fibonacci Heap, Augmented data structures. (10 Hrs)

Set, Implementation, Operations on Set, Priority Queue, Graphs: Directed Graphs, Shortest Path Problem, Undirected Graph, Spanning Trees, Graph Traversals: hash table representation, hash functions, collision resolution, separate chaining, open addressing, linear probing, quadratic probing, double hashing, rehashing. (8 Hrs)

Equal Sized Blocks, Garbage Collection Algorithms, Storage Allocation with Mixed Sizes object, Buddy Systems, Storage Compaction. (4 Hrs)

Searching Techniques, Internal sorting: Quick sort, Heap sort, Bin sort, Radix sort, External Sorting: Multiway Merge Sort, Polyphase Sorting, Design Techniques, Divide and Conquer, Dynamic Programming, Greedy Algorithm, Backtracking, Local Search Algorithms. (14 Hrs)

Textbooks:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education.
2. Aho Hopcroft Ullman, "Data Structures and Algorithms", Pearson Education.
3. T.H. Cormen, C.E. Leiserson,R.L. Rivest, C.Stein "Introduction to algorithms", PHI.

Reference Books:

1. Horowitz Sahni, Rajasekaran, "Computer Algorithms", Galgotia.
2. Tanenbaum A.S, Langram Y, Augestien M.J, "Data Structures using C & C++", Prentice Hall of India,
3. S.Sahni, "Data structures, Algorithms and Applications in C++", University Press (India) Pvt.Ltd, Universities Press Orient Longman Pvt. Ltd.
4. Michael T.Goodrich, R.Tamassia and Mount, "Data structures and Algorithms in C++", Wiley student edition, John Wiley and Sons.
5. Langsam, Augenstein and Tanenbaum, "Data structures using C and C++", PHI.

Subject: OBJECT ORIENTED PROGRAMMING Code: CSL 1303 (L-T-P: 3-0-0) Credits: 3

Object Modelling: Objects and classes, links and association, generalization and inheritance, aggregation, abstract class, multiple inheritance, meta data, candidate keys,

constraints. Dynamic Modeling: Events and states, operations, nested state diagrams and concurrency, advanced dynamic modeling concepts, a sample dynamic model. (10 Hrs)

Functional Modelling: Data flow diagram, specifying operations, constraints, a sample functional model. OMT (object modeling techniques) methodologies, Introduction to UML, examples and case studies to demonstrate methodologies, comparisons of methodologies, SA/SD, JSD. (8 Hrs)

Java Programming: Introduction, Operator, Data types, Variables, Methods & Classes, Multithread Programming, I/O, Java Apple. (8 Hrs)

Java Library: String Handling, input/output exploring Java.io, Networking, Exception Handling, Event Handling, Introduction to AWT, Working with window, Graphics, AWT Controls, Layout Manager and Menus, Images. (8 Hrs)

Software Development using Java: Java Swing, Application of java, JDBC. Characteristic of Different object oriented language. (6 Hrs)

Textbooks:

1. Herbert Schieldt, "The Complete Reference: Java", TMH, 7th Edition
2. James Rumbaugh et al., "Object Oriented Modeling and Design", PHI

Reference Books:

1. Nino," An Introduction to Programming and Object Oriented Design using Java, w/CD", Wiley India
2. Horstmann, Big Java, Wiley India

Subject: OBJECT ORIENTED PROGRAMMING LABORATORY Code: CSP 1303 (L-T-P: 0-0-3) Credits:1.5

Programming Lab will be set in consonance with the material covered in CSL1303.This will include assignment in programming language like JAVA.

Subject: Data Mining & Warehousing Code: CSL 1XXX (L-T-P: 3-0-0) Credits: 3

Data Mining: Data Mining definition, tools and applications, Data Mining Functionalities, Classification of Data Mining Systems, data mining query languages and Architectures of Data Mining Systems., Data Mining issues. (5 Hrs)

Data warehousing: Definition, usage, and trends, , Data Warehouse Architecture, Data Warehouse Implementation, Development of Data cube technology, Data Warehousing to Data Mining. (6 Hrs)

Architecture: OLTP vs. OLAP, ROLAP vs. MOLAP, types of OLAP, servers, 3-Tier data warehouse architecture, distributed and virtual data warehouses, data warehouse manager. (6 Hrs)

Implementation: Data warehouse implementation, computation of data cubes, modeling OLAP data, OLAP queries manager, data warehouse back end tools, complex aggregation at multiple granularities, tuning and testing of data warehouse. (5 Hrs)

Mining Association rules: Data mining techniques, Association rules, Mining single-dimensional Boolean Association rules from transaction databases, Mining multi-level Association rules from transaction databases, Mining multidimensional Association rules from relational databases and Data warehouses, Association Mining to correlation analysis, Constraint based association mining. (10 Hrs)

Cluster Analysis What is cluster analysis, Types of data in cluster analysis, A categorization of major clustering methods, Partitioning methods, Hierarchical Methods, Density based methods, Grid based methods, Modal based clustering methods. (8 Hrs)

Applications in Data Mining Data mining in market analysis, medical etc. (2 Hrs)

Textbooks:

1. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Elesevier
2. Alex Berson, "Data Warehousing, Data Mining and OLTP", McGraw Hill

Reference Books:

1. Mallach, Data warehousing System McGraw Hill
2. Sam Anahory & Dennis Murray, "Data Warehousing in the Real World", Pearson
3. W.H. Inman, "Building the Data Warehouse", John Wiley & Sons
4. Richard J. Roiger, Michael W. Geatz, "Data Mining: A tutorial-based Primer", Pearson Education

Subject: Digital Logic Design Code: ECL 1302 (L-T-P: 3-0-0) Credits: 3

Introduction to Boolean Algebra and Logic Gates: (8 Hrs)
Signed binary number, Binary arithmetic, Codes – BCD, Gray, Excess-3, Error detection & Correcting code-Hamming code, Logic Gates, Universal gates, Boolean Algebra, Basic theorems & properties of Boolean Algebra, De-Morgan's theorem, Min terms & Max terms, K-map representation, Q-M Method, simplification, and realization with logic gates.

Combinational Circuits: (6 Hrs)
Code Converters, Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator, BCD Adder), Subtractor (Half and Full subtractor), decoders and Encoders, Priority Encoder, Multiplexer and De-multiplexer, Parity generator/checkers.

Sequential Logic: (8 Hrs)
Latches, Flip-Flops (SR, D, JK, T and Master Slave JK, Edge Triggered), Conversion of FlipFlops, Glitches, Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (ripple and synchronous, Ring and Johnson Counters).

Memory: (4 Hrs)
Memory concepts, RAM, ROM, UV-EPROM, EEROM, Flash memory, Optical memory.

Programmable Logic Devices: (2 Hrs)
PAL, PLA, PROM, CPLD, FPGA and Programmable ASIC.

Finite State Machine (FSM): (4 Hrs)
Brief introduction to finite automata theory; Moore, Mealy and Turing machine; state diagram, state variable, state table and state minimization. Design of state machines using combinational logic circuits and memories.

Introduction to Logic Families: (4 Hrs)
Standard logic families (TTL, ECL, CMOS).

D/A and A/D: (4 Hrs)
Sample and Hold Circuits, Digital to Analog converter (Binary weighted resister network & R-2R ladder network), Analog to Digital converter (Flash type, Counter type, Dual Slope & Successive approximation type).

Textbooks:
1. Digital Logic and Computer Design, M. Morris Mano, PHI, 2008.
2. Digital design- Principles and Practices, J. F. Wakerly, 4th Edition, Pearson, 2006.
3. Digital Integrated Electronics, Herbert Taub (Author), Donald Schilling (Author)
4. Digital Principles and Applications, Leach, Malvino, Saha

Reference Books:
1. Digital Fundamentals, Thomas L.Floyd, 10th Edition, Pearson, 2011.
2. Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, 5th ed, TMH, 1995.
3. Switching & Finite Automata Theory, Zovi Kohavi , 2nd Edition , TMH.,2008.
4. Fundamentals of Digital Logic, Anand Kumar, 2nd Edition, PHI, 2008.
5. Fundamentals of Logic Design, Charles H. Roth Jr, 4th Ed, Jaico publishers, 2002.

Subject: Digital Logic Design Laboratory Code: ECP 1302 (L-T-P: 0-0-3) Credits: 1.5

Experiment List:
1. Verification of truth-table of different logic gates: To Study and verify Truth Table of different logic gates.
2. Implementation of various logic gates using universal gates: To Implement various logic gates using universal gates.
3. Implementation of XOR & XNOR using universal gates: To Implement XOR & XNOR using universal gates.
4. Implementation of half adder & full adder using universal gates: To Implement half adder & full adder using universal gates.
5. Implementation of half subtractor & full subtractor using universal gates: To Implement half subtractor & full subtractor using universal gates.
6. Implementation of 8x1 MUX using 4x1 MUX and to realize the given Boolean expression: To Implement 8x1 MUX using 4x1 MUX and to realize the given Boolean expression.
7. Design of 4-bit binary-to-gray code converter: To Design a 4-bit binary-to-gray code converter.

8. Design of 4-bit gray-to-binary code converter: To Design a 4-bit gray-to-binary code converter.
9. Design of 4-bit BCD-to-excess-3 code converter: To Design a 4-bit BCD-to-excess3 code converter.
10. Implementation of half adder & half subtractor using 2-line to 4-line decoder: To Implement a half adder & half subtractor using 2-line to 4-line decoder.
11. Design of T-flip flop using SR flip flop: To Design a T-flip flop using SR flip flop.
12. Design of a clocked flip flop using 3 input NAND gate and verify the truth table: To Design a clocked flip flop using 3 input NAND gate and verify the truth table.
13. Design a 3-bit binary counter using J-K flip flop: To Design a 3-bit binary counter using JK-flip flop.
14. Design of a Ring Counter & Johnson Counter: To Design a Ring Counter & Johnson Counter.
15. Design of Asynchronous counter & Synchronous Counter: To Design an Asynchronous counter & Synchronous Counter.
16. Realization of Shift Registers: To Design and Realize a given Shift Register.
17. Realization of Encoders: To Design and Realize a given Encoder.

Subject: Computer Organization & Architecture Code: CSL 1401 (L-T-P: 3-0-0) Credits: 3

Introduction: Computer architecture, Vonneuman architecture Register Transfer Language, Bus and MemoryTransfers, Bus Architecture, Bus Arbitration, Arithmetic Logic, Shift Microoperation, Arithmetic Logic Shift Unit, Design of Fast address, Arithmetic Algorithms (addition, subtraction, Booth Multiplication), IEEE standard for Floating point numbers. (3 Hrs)

Processor Design: Processor Organization: General register organization, Stack organization, Addressingmode, Instruction format, Data transfer & manipulations, Program Control, Reduced Instruction Set Computer. (5 Hrs)

Control Design: Hardwired & Micro Programmed (Control Unit): Fundamental Concepts (Register Transfers, performing of arithmetic or logical operations, fetching a word from memory, Storing a word in memory), Execution of a complete instruction, Multiple- Bus organization, Hardwired Control, Micro programmed control(Microinstruction, Micro program sequencing, Wide- Branch addressing, Microinstruction with Next-address field, Prefetching Microinstruction). (8 Hrs)

Memory Organization:
Memory Hierarchy, Main Memory (RAM and ROM Chips), organization of CacheMemory, Auxiliary memory, Cache memory, Virtual Memory. (8 Hrs)

Input-Output: I/O Organization: I/O Interface, Modes of transfer, Interrupts& Interrupt handling, DirectMemory access, Input-Output processor, Serial Communication, introduction to storage. (8 Hrs)

Parallel Processing, Pipelining- Arithmetic Pipelining, Instruction Pipelining, RISC Pipelining, Vector Processing, Array Processor. Multiprocessor: Characteristic of Multiprocessor, Interconnection Structure, Interprocessor Arbitration, Cache Coherence. (8 Hrs)

Textbooks:

1. V. C. Hamacher, Z. G. Veranesic, and S. G. Zaky, Computer Organization, Tata McGraw Hill, 5th Ed, 2002.
2. Computer Organization & Design: A hardware/software interface by David A Patterson and John L. Hennessy, Morgan Kaufmann Publishers
3. Computer Architecture: A Quantitative Approach by John L. Hennessy, Morgan Kaufmann Publishers

Reference Books:

1. M. M. Mano, Computer System Architecture, Pearson, 3rd Ed, 2004.
2. W. Stallings, Computer Organization and Architecture –Designing for Performance, Prentice Hall

Subject: Operating Systems Code: CSL 1502 (L-T-P: 3-0-0) Credits: 3

Introduction: Introduction and history of Operating systems, structure, and operations; processes and files. (6 Hrs)

Process management: process, process states, synchronization, mutual exclusion, semaphores, inter process communication, scheduling algorithms, critical sections, threads, multithreading. (7 Hrs)

Memory management: contiguous memory allocation, dynamic partitioning management, virtual memory, paging, page table, demand fetching, place, and replacement policies, thrashing, segmentation. (8 Hrs)

Concurrency Control: Shared resources, resource allocation and scheduling, resource graph models, deadlock Detection, deadlock avoidance, deadlock prevention algorithms. (8 Hrs)

Device management: devices and their characteristics, device drivers, device handling, disk scheduling algorithms, scan, c-scan, c-look , storage RAID. (5 Hrs)

File management: file concept, types and structures, directory structure, access methods and matrices, file security, user authentication. (6 Hrs)

UNIX operating system as a case study. (2 Hrs)

Textbooks:

1. Tanenbaum A, “Modern Operating Systems”, PHI
2. Silberchatz & Galvin, “Operating System Concepts”, Addison Wesley

Reference Books:

1. Dhamdhere, “Systems Programming and Operating System”, Tata Mc Graw Hill
2. Operating Systems by Stalling, Pearson

Subject: Signals & Systems Code: ECL 1303 (L-T-P: 0-0-3) Credits: 1.5

Introduction to Signals & Systems Classification of signals, useful signal operations, Exponential and sinusoidal signals, Unit step and unit step functions, Basic system properties. (5 Hrs)

Time-domain analysis of continuous time systems & discrete-time systems Zero-input and zero-state response, unit impulse response, convolution, Graphical method for convolution, stability of systems, Response time and Rise time of system. (5 Hrs)

Fourier series representation of periodic signals Linear time invariant systems to complex exponential signals, Fourier series representation of continuous time periodic signals, Convergence and properties of continuous-time Fourier series, Discrete time Fourier series and its properties. (7 Hrs)

Continuous-time Fourier transform Representation of aperiodic signal, Fourier transform and its properties, Fourier transform of some useful signals, Generalized Fourier series: signals vs vectors, Modulation, System characterization. (5 Hrs)

Discrete-time Fourier transform Representation of aperiodic signal, Discrete-time Fourier transform and its properties, Sampling, Duality in discrete-time Fourier series. (5 Hrs)

Laplace transform, ROC, Inverse Laplace transform, Filter design by placements of poles and zeros of system functions, properties of Laplace transform, analysis and characterization of LTI systems using Laplace transform, unilateral Laplace transform. (5 Hrs)

Z- transform, properties of z- transform, Frequency response from pole-zero location, analysis, and characterization of LTI systems using z-transform, unilateral z-transform. (4 Hrs)

References:

A. V. Oppenheim A. S. Willsky and S. H. Nawab, ``Signals and Systems'', New Delhi: Prentice Hall of India, 2004
B. P. Lathi, ``Principle of Linear Systems and Signals``, Oxford, University Press, 2010

ELECTIVES – III & V

Subject: Stochastic Differential Equations Code: MAL 1701 (L-T-P: 3-0-0) Credits: 3

Introduction: Stochastic analogs of classical differential equations. Mathematica; preliminaries: Probability space, random variable, stochastic process, Brownian motion. Ito Integral: Definition, Properties, extensions. Ito formula and Martingale representation Theorem: One-dimensional Ito formula, Multi-dimensional Ito formula, Martingle representation Theorem. Stochastic differential equations: Examples and some solution methods, Existence and Uniqueness result, weak and strong solutions. Applications: Boundary value problems, filtering, optimal stopping, stochastic control, mathematical finance.

Textbooks:

1. B. K. Oksendal, Stochastic Differential Equations: An Introduction with Applications, 6th edition, Apringer, 2010.

References:

1. I. Karatzas and S. E. Shreve, Brownian Motion and Stochastic Calxulus, SPringer, 1991.
2. P. Protter, Stochastic Integration and Diferential Equations, Springer, 2nd edition. 2010.
3. I. Karatzas and S.E. Shreve, Methods of Mathematical Finance, Springer, 2010.
4. S. Watanabe and N. Ikeda, Stochastic Differential Equations and Diffusion Processes, North-Holland, 1981.

Subject: Combinatorics and Number Theory Code: MAL 1702 (L-T-P: 3-0-0) Credits: 3

Combinatorics: Numbers and counting, partitions and permutations, principle of inclusion and exclusion, pigeon hole principle, recurrence relations, generating Functions.

Number Theory: Primes, divisibility and the fundamental theorem of arithmetic, prime number theorem, Euclidean algorithm, congruences, ring of integers mod n, Chinese remainder theorem, arithmetic functions, Fermat's last theorem, Mobius inversion formula, quadratic residues, quadratic reciprocity law, binary quadratic forms, continued fractions, Pell's equation, Diophantine equations.

Textbooks:

1. J. L. Mott, A. Kandel, and T. P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, PHI Learning, 2003.
2. I. Niven, H.S. Zuckerman, and H.L. Montgomery. An Introduction to the Theory of Numbers, Wiley, 1991.

References:

1. T. Koshy, Discrete Mathematics with Applications, Elsevier, 2004.
2. K.F. Ireland and M.I. Rosen, A Classical Introduction to Modern Number Theory, Springer, 1990.

Subject: Advanced Matrix Theory Code: MAL 1703 (L-T-P: 3-0-0) Credits: 3

Eigenvalues, eigenvectors and similarity, Unitary equivalence and normal matrices, Schur's theorem, Spectral theorems for normal and Hermitian matrices; Jordan canonical form, Application of Jordan canonical form, Minimal polynomial, Companion matrices, Functions of matrices; Variational characterizations of eigenvalues of Hermitian matrices, Rayleigh-Ritz theorem, Courant-Fischer theorem, Weyl theorem, Cauchy interlacing theorem, Inertia and congruence, Sylvester's law of inertia; Matrix norms, Location and perturbation of eigenvalues Gerschgorin disk theorem; Positive semi definiteness, Singular value decomposition, Polar decomposition, Schur and Kronecker products; Positive and nonnegative matrices, Irreducible nonnegative matrices.

Textbooks:

1. Horn R. A. and Johnson C. R. Matrix Analysis, CUP

Reference Books:

1. Lancaster P. and Tismenetsky M. The Theory of Matrices, Academic Press
2. GantmacherF. R. The Theory of Matrices, Vol-I, Chelsea
3. R. Bhatia. Matrix analysis. vol. 169 of Graduate Texts in Mathematics, Springer, 1997.

Subject: Wavelets and Applications Code: MAL 1704 (L-T-P: 3-0-0) Credits: 3

Basic Fourier Analysis: Fourier Series, convergence of Fourier series, Riesz Fischer theorem, Fourier transform of square integrable functions, Plancheral formula, Poisson Summation formula, Shannon sampling theorem, Heisenberg Uncertainty principle. Continuous Wavelet transform, Plancherel formula, Inversion formulas. Frames, Riesz Systems, discrete wavelet transform, Numerical algorithms. Orthogonal bases of wavelets, multi resolution analysis, smoothness of wavelets, compactly supported wavelets, cardinal spline wavelets. Tensor products of wavelets, Decomposition and reconstruction algorithms for wavelets, wavelet packets, recent development, and applications.

Textbooks:

1. J. S. Byrnes, Jennifer L. Byrnes, Kathryn A. Hargreaves, Karl Berry, Wavelets and Their Applications, Nato Science Series C, SPRINGER, 1994.

Subject: Fuzzy Systems and Genetic Algorithms Code: MEL 1810 (L-T-P: 3-0-0) Credits: 3

Different faces of imprecision – inexactness, ambiguity, un decidability, Fuzziness and certainty, Fuzzy sets and crisp sets. Intersection of Fuzzy sets, Union of Fuzzy sets - the complement of Fuzzy sets-Fuzzy reasoning. Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference - Methods of decompositions and defuzzification. Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts,

Applications– Fuzzy controllers - Control and Estimation. Genetic Algorithms- basic structure-coding steps of GA, convergence characteristics, applications.

Text & Reference Books:

1. Timothy J.Ross: Fuzzy Logic with Engineering Applications: McGraw-Hill 1997.
2. Goldberg, Genetic Algorithms, Pearson Education India, 2008
3. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic -Theory and Applications, Pearson Education India, 2008.

Subject: Computational Fluid Dynamics Code: MAL 1705 (L-T-P: 3-0-0) Credits: 3

Review of the governing equations of Incompressible viscous flows, Stream function - vorticity approach, upwind schemes, Primitive variables, Staggered grid, Artificial compressibility, pressure correction and vortex methods; Compressible inviscid flows, central schemes with combined and independent space time discretization, Compressible viscous flows, Explicit, implicit and PISO methods; Grid generation: Structured and unstructured grid generation methods; Finite volume method: Finite volume method to convection-diffusion equations.

Textbooks:

1. P Wessling, Principles of Computational Fluid Dynamics, Springer, 1991.
2. John D Anderson, Jr., Computational Fluid Dynamics, The Basics with Applications, McGraw-Hill, 1995.

Subject: Nonlinear Partial Differential Equations Code: MAL 1706 (L-T-P: 3-0-0) Credits: 3

Review of first order equations and characteristics, Weak solutions to hyperbolic equations- discontinuous solutions, shock formation, a formal approach to weak solutions, asymptotic behaviour of shocks, Diffusion Processes-Similarity methods, Fisher's equation, Burgers' equation, asymptotic solutions to Burgers' equations, Reaction diffusion equations-traveling wave solutions, existence of solutions, maximum principles and comparison theorem, asymptotic behaviour, Elliptic equations-Basic results for elliptic operators, eigenvalue problems, stability and bifurcation, Hyperbolic system.

Textbooks:

1. J David Logan, An introduction to nonlinear partial differential equations, John Wiley and Sons, Inc., 1994

Subject: Introduction to Uncertain Optimization Code: MAL 1707 (L-T-P: 3-0-0) Credits: 3

Modeling. Basic stochastic programming modeling concepts. Formulating and solving the extensive form of stochastic programs with recourse. Some statistics: value of stochastic solution and expected value of perfect information. Risk measures.

Algorithms. Basic theory and properties of two-stage stochastic linear programs with recourse. Algorithms: Benders (L-Shaped) method (single and multi-cut), trust-region methods, level-method, progressive hedging.

Sampling and Monte Carlo Methods. Review of statistics. Sample average approximation (SAA). Statistical inference on lower bounds, upper bounds, and optimality gaps.

Robust Optimization. Tractable (convex) optimization problems. Robust counterparts of uncertain LPs: basic theory, duality in robust optimization, choice of uncertainty sets.

Uncertainty in Constraints (time permitting). Basic theory of chance constraints and solvable cases. Analytic (and tractable) approximations of chance constraints. Sampling methods. Integer programming approaches to solving finite support problems.

Textbooks:

1. Lectures on Stochastic Programming – Modeling and Theory, SIAM, Shapiro, Dentcheva, and Ruszczyn´ski, 2009.
2. Introduction to Stochastic Programming, Springer-Verlag, Birge and Louveaux, 2011.
3. Stochastic Programming, Wiley, Kall and Wallace, 1994.
4. Robust Optimization, Princeton University Press, Ben-Tal, El Ghaoui, and Nemirovski, 2009.

ELECTIVE - IV

Subject: Statistical Simulation and Data Analysis Code: MAL 1708 (L-T-P: 3-0-0) Credits: 3

Simulation of random variables from discrete, continuous, multivariate distributions and stochastic processes, Computer Intensive Inference Methods - Jack-Knife, Bootstrap, cross validation, Monte-Carlo methods. Regression analysis, scatter plot, residual analysis. Computer Intensive Inference Methods - Jack-Knife, Bootstrap, cross validation, Monte Carlo methods and permutation tests. Graphical representation of multivariate data, Cluster analysis, Principal component analysis for dimension reduction, Dimension reduction using LASSO, E.M. Algorithm, Markov Chain Monte Carlo.

Textbooks & References:

1. "Simulation" by Sheldon M. Ross (Academic Press, Fourth Edition), 2006.
2. Bootstrap from "An Introduction to the Bootstrap" by B. Efron and R.J. Tibshirani (Chapman and Hall), 1994.
3. Jackknife from "An Introduction to the Bootstrap" by B. Efron and R.J. Tibshirani (Chapman and Hall), 1994.
4. Cluster Analysis from "Cluster Analysis" by B.S. Everitt, S. Landau, M. Leese, D. Stahl, (Wiley), 2011.
5. E.M. Algorithm from "The EM Algorithm and. Extensions" by G. M. McLachlan and T. Krishnan, (Wiley), 1997.
6. LASSO from "Statistical Learning with Spharsity- The Lasso and Generalizations" by T. Hastie, R. Tibshirani and M. Wainwright, (CRC), 2015.

Subject: Applied Time Series Analysis Code: MAL 1709 (L-T-P: 3-0-0) Credits: 3

Harmonic Analysis of stationary random processes; spectral representation of the process; stationary process; stationary processes with spectral densities.

Linear extrapolation, filtering, and interpolation of stationary processes.

Stationary moving average autoregressive ARMA and ARIMA process; estimation of parameters; verification identification, Maximum and mean likelihood estimation. Box Jenkins modeling application in economics and business, Consistent estimation of autospectrum and cross spectrum. Choice of spectral window. Use of Digital filters. Kalman filter, FFT

Transfer function model estimation; Closed loop models.

Alternative to box Jenkins approach , ARUA models.

Textbooks & References:

1. Yu. A. Rozano (1967), Stationary Random Processes, Holden-Day.
2. G.M. Jenkins and D.G. Watts (1968), Spectral Analysis and its Applications, Holden-Day
3. G.E.P. Box and G.M. Jenkins (1970), Time Series Analysis, Forecasting and Control, Holden Day.
4. O.D Anderson (1978), The Statistical analysis of Time Series Wiley.
5. O.D. Anderson and M.R. Perryman Eds. (1981), Time Series Analysis, North-Holland.

Subject: Empirical Processes Code: MAL 1710 (L-T-P: 3-0-0) Credits: 3

Preliminaries: Different Modes of Convergence, Law of Large Numbers, Motivations. (6 Hrs)

Function classes and their complexities, Glivenko-Cantelli class of functions. (8 Hrs)

Symmetrization, Concentration Bounds. (4 Hrs)

Vapnik-Cervonenkis (VC) classes of functions, Covering and Bracketing numbers, Examples: M-estimators. (8 Hrs)

Donsker class, Uniform Central Limit Theorem, Examples. (6 Hrs)

Arg-min continuous mapping theorem, Applications in Statistics: M-estimators, Lasso, Bootstrap consistency etc. (6 Hrs)

More on Concentration Bounds/ Weak Convergence on Polish Spaces. (4 Hrs)

Textbooks & References:

1. W. van der Vaart and Jon A. Wellner. (1996). Weak Convergence and Empirical Processes, with Applications to Statistics. Springer Series in Statistics.
2. Michael R. Kosorok. (2008). Introduction to Empirical Processes and Semiparametric Inference. Springer Series in Statistics.
3. Sara van de Geer. (2009). Empirical Processes in M-Estimation. Cambridge Series in Statistical and Probabilistic Mathematics.
4. Richard M. Dudley (2014). Uniform Central Limit Theorems. Cambridge Studies in Advanced Mathematics.
5. G´abor Lugosi, Pascal Massart, and St´ephane Boucheron (2014). Concentration Inequalities: A Nonasymptotic Theory of Independence. Oxford University Press.
6. Zhengyan Lin and Zhidong Bai. (2010). Probability Inequalities. Springer.

Subject: Inferences Code: MAL 1711 (L-T-P: 3-0-0) Credits: 3

Exponential families-introduction, canonical form, full rank; Sufficient statistic-sufficiency, Neyman Fisher factorization criterion, minimal sufficiency; Ancillary statistic; Completeness-completeness of family of distributions, completeness of statistic; Basu's theorem and its uses; Rao-Blackwell theorem and its implications; Unbiasedness-basic concepts, locally minimum variance unbiased estimator, uniformly minimum variance unbiased estimator, Lehmann- Scheffe's theorem and its importance; Methods for finding UMVUE-method of solving, Rao-Blackwellization; Non-parametric families and Hoeffding's U-statistic; Information inequality and lower bounds- Hammersley-Chapman-Robbins inequality, Fisher information, Cramer-Rao lower bond; Information inequality for multi-parameter case-information matrix, s-parameter exponential family, Bhattacharya system of lower bounds; Methods of estimation-MLE, MOME, MinMSE; Basic concepts in statistical hypotheses testing-simple and composite hypothesis, critical regions, Type-I and Type-II errors, size and power of a test; Neyman-Pearson lemma and its applications; Type of optimum tests and their construction using NP lemma- Most powerful test, uniformly most powerful test, unbiased test and uniformly most unbiased test; Monotone Likelihood ratio and testing with MLR property; Testing in one-parameter exponential families-one sided hypothesis, UMP and UMPU tests for different two-sided hypothesis; Testing in multi-parameter exponential families-tests with Neyman structure, UMP and UMPU similar size-tests; Likelihood Ratio test; Confidence intervals-pivotal functions, shortest expected length confidence interval, UMA and UMAU confidence intervals.

Textbooks & References:

1. John Rice: Mathematical Statistics and Data Analysis, 3rd edition
2. Jun Shao: Mathematical Statistics, 2nd edition
3. George Casella and Roger Berger: Statistical Inference, 2nd edition

Subject: Statistical and AI Techniques in Data Mining Code: MAL 1712
(L-T-P: 3-0-0) Credits: 3

Introduction to Data Mining; supervised and un-supervised data mining, virtuous cycle. Dimension Reduction and Visualization Techniques; Chernoff faces, principal component analysis. Feature extraction; multidimensional scaling. Measures of similarity/ dissimilarity. Cluster Analysis: hierarchical and non-hierarchical techniques. Classification

and Discriminant Analysis Tools; classification based on Fisher's discriminant functions, Bayes classifier, TPM and ECM minimizing classification rules, logistic discrimination rules, perceptron learning and Support Vector Machines. Density estimation techniques; parametric and Kernel density estimation approaches. Statistical Modelling; design, estimation and inferential aspects of multiple regression, Kernel regression techniques. Tree based methods; Classification and Regression Trees. Neural Networks; multi-layer perceptron, feed-forward and recurrent networks, supervised ANN model building using back-propagation algorithm, ANN model for classification. Genetic algorithms, neuro-genetic models. Self-organizing Maps.

Textbooks & References:

1. T. Hastie, R. Tibshirani and J, Friedman: The elements of statistical learning: Data Mining, Inference and Prediction; Springer Series in Statistics, Springer, 2013.
2. R. A. Johnson and D.W. Wichern: Applied multivariate statistical analysis, Pearson, 2013.
3. A. R. Webb: Statistical Pattern Recognition, John Wiley & Sons, 2002.
4. S. S. Haykin: Neural Networks: A comprehensive foundation; Prentice Hall, 1998.
5. C. J. Hand, H. Mannila and P. Smith: Principles of Data Mining, MIT Press, Cambridge, 2001.

ELECTIVE - VI

Subject: An Introduction to Mathematical Modelling **Code: MAL 1801**
(L-T-P: 3-0-0) **Credits: 3**

Introduction to model and mathematical modelling, Role of Mathematics in problem solving; Transformation of Physical model to Mathematical model with some illustrations of real world problems; Mathematical formulation, Dimensional analysis, Scaling, Sensitivity analysis, Validation, Simulation, Some case studies with analysis (such as exponential growth and decay models, population models, Traffic flow models, Optimization models).

Textbooks & References:

1. D. N. P. Murthy, N. W. Page and E. Y. Rodin: Mathematical Modelling: A Tool for Problem Solving in Engineering, Physical, Biological and Social Sciences, Pergamon 1990.
2. Clive L. Dyne: Principles of Mathematical Modeling, Academic Press, 2004.
3. R. llner, C. Sean Bohun, S. McCollum and T. van Roode: Mathematical Modeling: A case study approach, AMS 2004.

Subject: Finite Element Method **Code: MAL 1802** **(L-T-P: 3-0-0)**
Credits: 3

Calculus of Variations: Introduction, Euler's Equation, Euler Lagrange Equations, Ostrogradsky equation.

Variational formulation: Variational Formulation for a boundary value problem with homogeneous and non-homogeneous boundary conditions, Rayleigh- Ritz minimization, Weighted residuals - Collocation, Least squares method, Galerkin, Petrov-Galerkin methods

for boundary value problems.

One dimensional problem: Solution of one-dimensional boundary value problems by linear, quadratic and cubic shape functions.

Two dimensional problems: Solution of two-dimensional boundary value problems by linear, quadratic and cubic rectangular, serendipity and triangular shape functions.

Time Dependent Problems: One-dimensional heat and wave equations.

Textbooks:

1. An introduction to the Finite Element Method, J. N. Reddy, McGraw Hill, 4th Edition, 2020
2. Finite Element Analysis in Fluid Dynamics, I. J. Chung, McGraw-Hill International Book Company, 2007, Digitized Version.

Reference Books:

1. Finite Elements and Approximation, O. C. Zienkiewiez and K. Morgan, John Wiley, 1983
2. The Finite Element Method – Principles and Applications, P. E. Lewis and J. P. Ward, Addison Wesley, 1991.

Subject: Fields and Galois Theory Code: MAL 1803 (L-T-P: 3-0-0) Credits: 3

Fields: Definition and examples, Irreducibility Criterions, Prime Subfield, Algebraic and transcendental elements, and extensions, Splitting field of a polynomial. Existence and uniqueness of algebraic closure. Finite fields, Normal and separable extensions, Inseparable and purely inseparable extensions. Simple extensions and the theorem of primitive elements, Perfect fields. Galois Extension and Galois groups. Fundamental theorem of Galois Theory. Applications of Galois Theory: Roots of unity and cyclotomic polynomials, Wedderburn's and Dirichlet's theorem. Cyclic and abelian extensions, Fundamental Theorem of Algebra, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions. Traces and norms, Hilbert's theorem-90, Dedekind's theorem of Linear Independence of Characters. Inverse Galois Problem.(Time permitting: Simple transcendental extension and Luroth's theorem. Infinite Galois Extension and Krull's theorem.)

Textbooks & References:

1. S. Lang: Algebra.
2. M. Artin: Algebra.
3. C. S. Dummit and R.M. Foote: Abstract Algebra.
4. Patrick Morandi: Field and Galois Theory, GTM 167, Springer-Verlag.
5. M. P. Murthy, K. G. Ramanathan, C. S. Seshadri, U. Shukla and R. Sridharan: Galois Theory.

Subject: Differential Geometry and Tensor Analysis Code: MAL 1804 (L-T-P: 3-0-0) Credits: 3

Differential Geometry:
Local curve theory: Serret-Frenet formulation, Fundamental existence theorem of space curves.

Plane curves and their global theory: Rotation index, Convex curves, Isoperimetric inequality, Four vertex theorem.

Local surface theory: First fundamental form and arc length, Normal curvature, Geodesic curvature and Gauss formulae, Geodesics, Parallel vector fields along a curve and parallelism, the second fundamental form and the Weingarten map, Principal, Gaussian, Mean and normal curvatures, Riemannian curvature and Gauss's theorem Egregium, Isometrics and fundamental theorem of surfaces.

Global theory of surfaces: Geodesic coordinate patches, Gauss-Bonnet formula and Euler characteristic, Index of a vector field, Surfaces of constant curvature.

Tensor Analysis: N-dimensional space, Covariant and contravariant vectors, Contraction, Second & higher order tensors, Quotient law, Fundamental tensor, Associate tensor, Angle between the vectors, Principal directions, Christoffel symbols, Covariant and intrinsic derivatives.

Textbooks:
1. Elements of Differential Geometry, R. S. Millman and G. D. Parker, Prentice Hall Inc., 1977.
2. Differential and Riemannian Geometry, D. Laugwitz, Academic Press, 2014.
3. Tensor Calculus, Barry Spain, Dover Publications, 2003.

Reference Books:
1. A Course in Differential Geometry and Lie Groups, S. Kumaresan, Texts and Readings in Mathematics, 22, Hindustan Book Agency, New Delhi, 2002.
2. The Use of Integral Transforms, I. N. Snedden, Tata McGraw-Hill, 1974.
3. Mathematical Methods in Physics & Engineering, John W. Dettman, Dover Publications, 2013.

Subject: Spectral Methods **Code: MAL 1805** **(L-T-P: 3-0-0)**
Credits: 3
Basics of Matlab: Introduction to Matlab, Programming in Matlab, Branching and looping, Built-in functions and user defined functions.

Spectral Methods: Historical background, Introduction to spectral methods via orthogonal functions, some examples of spectral methods, Spectral differentiation versus Finite differences, MATLAB as a tool in problem solving, Basic layout of spectral methods.

Fourier Spectral Differentiation: Fourier approximation, Fourier spectral differentiation via differentiation matrices, Smoothness and accuracy, Aliasing and aliasing removal, MATLAB demonstrations.

Chebyshev Spectral Differentiation: Polynomial approximation, Jacobi polynomials, Chebyshev spectral differentiation via Differentiation matrices, Smoothness, and accuracy, MATLAB demonstrations.

Initial Value Problems: Spectral method treatment of problems with mixed initial/boundary conditions, Semi-implicit methods, Case studies and MATLAB demonstrations.

Boundary Value Problems: Spectral method treatment of problems Dirichlet/Neumann/Robin type boundary conditions, Eigen boundary value problems, Boundary value problems in Polar coordinates, Differential eigen problems, Case studies and MATLAB demonstrations.

Textbooks:

1. Numerical Computing with MATLAB, Cleve Moler, SIAM, 2004.
2. Spectral Methods in Matlab, L. N. Trefethen, SIAM, 2000.
3. Spectral Methods: Fundamentals in Single Domain, C. Canuto, M.Y. Hussaini, A. Quarteroni and T. A. Zang, Springer Verlag, 2006, First Edition.

Reference Books:

1. Numerical Analysis of Spectral Methods: Theory and Applications, D. Gottlieb and S. A. Orszag, CBMS-NSF 26, Philadelphia: SIAM, 1987.
2. Spectral Methods in Fluid Dynamics, C. Canuto, M.Y. Hussaini, A. Quarteroni and T.A. Zang, Springer-Verlag Berlin Heidelberg, 1988, First Edition.

ELECTIVE - VII

Subject: Computer Networks **Code: CSL 1XXX**
(L-T-P: 3-0-0) **Credits: 3**

Review of Computer Network Architecture and the Subnet layers. (2 Hrs)

Physical Layer: Data communication basics, guided transmission media, wireless transmission, communication satellites, public switched telephone network. Data link layer: Framing, HDLC, PPP, sliding window protocols, medium access control, Token Ring, Wireless LAN Virtual circuit switching: Frame relay, ATM. (8 Hrs)

Network Layer: Network layer and its functionalities, Subnets, Circuit Switching, Packet Switching, Virtual Circuit, datagram, Routing, IP, ARP, RARP, DHCP, ICMP, Queuing Disciplines, RIP, OSPF, Subnetting, CIDR, Interdomain routing –BGP, IPv6, Multicasting, Congestion avoidance in Network layer. (10 Hrs)

Data Transport: Connection management, Quality of Service, TCP/IP Protocol, UDP, TCP, Congestion Control, Flow Control, Congestion Avoidance, QoS. (7 Hrs)

Network security: Message Security and Authentication Techniques, Encryption algorithms, PGP, SSH, Firewall. (7 Hrs)

Applications: HTTP, E-mail (SMTP, MIME, IMAP, POP3), DNS, Remote login (Telnet, SSH), File transfer (FTP), Network file system, Overlay Networks, P2P Networks, Network management (SNMP). UNIX network programming with TCP/IP. (8 Hrs)

Textbooks:

1. "Computer Networks", Tanenbaum A. S., PHI
2. "Computer Networks", Peterson, Davie, Elsevier

Reference Books:

1. "Data Communication and Network", Farouzan, Mc Graw Hill
2. "Communication Systems", Simon Haykin, John Wiley
3. "Computer Networks and Internets", Douglas Comer, Addison Wesley
4. "Computer Networks: A Systems Approach", Peterson, Simon, Pearson Education, Asia

Subject: Digital Image Processing and Applications **Code: CSL 1XXX**
(L-T-P: 3-0-0) **Credits: 3**

Introduction: basic concepts of image signal capture, relation of pixels to physical luminance. (3 Hrs)

Display modeling: concept of dynamic range, color correction, modeling of a conventional display, modeling of modern Led-backlit displays, applications. (6 Hrs)

Image processing and Machine Learning: similarities and differences between traditional and ML based models, augmenting traditional image processing with ML. (6 Hrs)

Sparse models for image processing: dictionary learning, modeling of natural image patches, applications of sparse modeling (denoising, inpainting, super resolution). (7 Hrs)

Image inpainting: use-case scenarios, analytical methods (PDE, SVD, dictionary learning etc.) for inpainting, exemplar-based inpainting, content-aware filling in Adobe Photoshop CS5, semantic inpainting using machine learning. (10 Hrs)

Image saliency: bottom-up and top-down mechanisms, saliency due to color and texture, automatic saliency prediction using traditional and ML based approaches, applications of saliency. (6 Hrs)

Perceptual image processing: masking, contrast sensitivity, angular frequency and viewing Distance. (4 Hrs)

Textbooks & References:

1. Gonzalez, R.C. and Woods, R.E., (2018), Digital Image Processing, 4th Edition, Prentice Hall
2. Katsaggelos, A.K., Fundamentals of Image and Video Processing , Coursera, Northwestern University, https://www.coursera.org/learn/digital

Subject: Natural Language Processing **Code: CSL 1XXX**
(L-T-P: 3-0-0) **Credits: 3**

Introduction: Knowledge in speech and language processing – Ambiguity – Models and Algorithms – Language, Thought and Understanding. Regular Expressions and automata: Regular expressions – Finite-State automata. Morphology and Finite-State Transducers: Survey of English morphology – Finite-State Morphological parsing – Combining FST lexicon and rules – Lexicon-Free FSTs: The porter stammer – Human morphological processing. (8 Hrs)

Syntax: Word classes and part-of-speech tagging –Rule-based part-of-speech tagging – Stochastic part-of-speech tagging – Transformation-based tagging. Context-Free Grammars for English: Constituency – Context-Free rules and trees – Sentence-level constructions – The noun phrase – Coordination – Agreement – The verb phase and sub categorization – Auxiliaries – Spoken language syntax – Grammars equivalence and normal form – Finite-State and Context-Free grammars – Grammars and human processing. Parsing with Context-Free Grammars: Parsing as search – A Basic Top-Down parser – Problems with the basic Top-Down parser – The early algorithm – Finite-State parsing methods. (8 Hrs)

Advanced Features and Syntax, Features and Unification: Feature structures – Unification of feature structures – Features structures in the grammar – Implementing unification – Parsing with unification constraints – Types and Inheritance. Lexicalized and Probabilistic Parsing: Probabilistic context-free grammar – problems with PCFGs – Probabilistic lexicalized CFGs – Dependency Grammars – Human parsing. (8 Hrs)

Semantic: Representing Meaning: Computational desiderata for representations – Meaning structure of language – First order predicate calculus – Some linguistically relevant concepts – Related representational approaches – Alternative approaches to meaning. Semantic Analysis: Syntax-Driven semantic analysis – Attachments for a fragment of English – Integrating semantic analysis into the early parser – Idioms and compositionality – Robust semantic analysis. Lexical semantics: relational among lexemes and their senses – WorldNet: A database of lexical relations – The Internal structure of words – Creativity and the lexicon. (10 Hrs)

Applications: Word Sense Disambiguation and Information Retrieval: Selectional restriction-based disambiguation – Robust word sense disambiguation – Information retrieval – other information retrieval tasks. Natural Language Generation: Introduction to language generation – Architecture for generation – Surface realization – Discourse planning – Other issues. Machine Translation: Language similarities and differences – The transfer metaphor – The Interlingua idea: Using meaning – Direct translation – Using statistical techniques – Usability and system development. (6 Hrs)

Textbooks:

1. Daniel Jurafsky & James H.Martin, “Speech and Language Processing”, Pearson Education (Singapore) Pte.Ltd.
2. James Allen, “Natural Language Understanding”, Pearson Education.

Reference Book:

1. C. Manning and H. Schutze, “Foundation of statistical Natural Language Processing”

Subject: Security and Its Application **Code: CSL 1XXX**

(L-T-P: 3-0-0) **Credits: 3**

Introduction to Cryptography

Shannon's Approach to Cryptography: Measures of security, Perfect secrecy, Definition of entropy, One-time pad. (3 Hrs)

Symmetric Key Cryptography: The notion of a symmetric key cryptography, The Data Encryption Standard (DES) and differential cryptanalysis, The Advanced Encryption Standard (AES). (4 Hrs)

Cryptographic Hash Functions: Definition of hash functions and properties, Unkeyed hash functions, Keyed hash functions, Message Authentication Codes (MAC), The Random Oracle Model (ROM). (4 Hrs)

Authentication: Definition of authentication, A simple authentication protocol and possible attacks, Strong password protocols, BM Encrypted Key Exchange (EKE), Key Distribution Centers (KDC), Certification authorities and certificate revocation, KDC based authentication protocols. (3 Hrs)

Network Security

Public Key Cryptosystems: Fundamentals of Public-key Cryptography, Background on number theory, The RSA public key cryptosystem, The ElGamal public key cryptosystem and discrete logs Digital Signatures: An RSA based signature scheme, The ElGamal based signature scheme,The Schnorr signature scheme, The Digital Signature Algorithm (DSA). (6 Hrs)

Key Distribution and Key Agreement Protocols: Key Predistribution: Diffie-Hellman key Exchange, The MTI key Exchange. (4 Hrs)

Network Security: TCP/IP threats, The IPSEC protocol, The SSL and TLS protocols, Firewalls and Virtual Private Networks (VPNs), Electronic mail security, Worms, DDoS attacks, BGB and security considerations. (4 Hrs)

Cyber-physical security and Blockchain

(fractal 3) Cyber-physical security: IoT security, sensor actuator network security. (4 Hrs)

Block Chain: Introduction to Blockchain, Blockchain Architecture and Design, Consensus (Byzantine Fault, Proof of Work, Poof of Stake,), Permissioned Blockchains, Components of blockchain. (10 Hrs)

Textbooks:

1. Stallings, W. (2017). Cryptography and network security, 7/E. Pearson Education India
2. Douglas R. Stinson, Maura B. Paterson (2018). Cryptography: theory and practice. 4/E Chapman and Hall/CRC

Reference Books:

1. Mao, W. (2004). Modern cryptography: theory and practice. Pearson Education India.
2. Pfleeger, C. P., & Pfleeger, S. L. (2018). Security in computing. 5/E, Prentice Hall Professional Technical Reference

3. Goldreich, O. (2009). Foundations of cryptography: volume 2, basic applications. Cambridge university press
4. Forouzan, B. A. (2015). Cryptography & network security. 3/E, McGraw-Hill, Inc.

Subject: Quantum Computing **Code: CSL 1XXX**
(L-T-P: 3-0-0) **Credits: 3**

Mathematical Preliminaries: Quantum Mechanics, Matrix representations of quantum states and operators, Cauchy-Schwartz and Triangle Inequalities, Classical and Quantum Correlations. (6 Hrs)

Notions of Quantum Information: Classical and Quantum state Registers, Pure and Mixed states, Reduction and Purification of states, Quantum Channels, Completely Positive and trace Preserving Maps. (6 Hrs)

Entropy: Quantitative bounds on Shannon and relative Entropy, Von-Neumann and quantum relative entropy, Klein's inequality, Concavity and subadditivity of von Neumann entropy, Strong subadditivity of von Neumann entropy, Accessible Information, Holevo information. (8 Hrs)

Entanglement and Nonlocality: Separability Criteria, Classical, Separable and Entangled states, Local Operations and Classical Communications, Distillable entanglement and entanglement cost, Bound entanglement, Bell's Inequality and Nonlocality, Nonlocality in multiqubit Systems, Entanglement Measures. (12 Hrs)

Quantum Error Correction: Bit flip and phase flip codes, Quantum Hamming Bound, Calderbank-Shor-Steane codes, Gottesman-Knil theorem, Fault-tolerant quantum computation, quantum algorithms and cryptography. (10 Hrs)

Textbooks:

1. Nielsen, M. A. and Chuang, I. L., Quantum Computation and Quantum Information, Cambridge University Press, 2000.
2. Vedral, V., Introduction to Quantum Information Science, Oxford University Press, 2006.

Reference Books:

1. Griffiths, D. J., Introduction to Quantum Mechanics, Pearson Prentice Hall, 2006.
2. Bouwmeester, D., Ekert, A. and Zeilinger, A., The Physics of Quantum Information, Springer, 2000.

ELECTIVE – VIII

Subject: Macroeconomics & Business Environment **Code: HUL 1601**
(L-T-P: 3-0-0) **Credits: 3**

The meaning of Macroeconomics, Objectives of Macroeconomic Policy and Instruments, Importance of Macroeconomics, Circular Flow of Income;

Concepts of National income, Methods of Measuring GDP, Real GDP Vs Nominal GDP, Difficulties and Importance of Measuring National Income;

Classical theory of Output and Employment: Say's Law, Keynesian theory of Output and Employment: Consumption Function, Saving Function, Investment Function, Multiplier, Accelerator, Business Cycle;

Aggregate Demand and Aggregate Supply, Shift in AD and AS: 2-sector, 3-sector and 4-sector model;

Functions of Money, Demand for and Supply of Money, Determination of Interest rate, Hicks-Hansen Analysis: IS-LM model;

Unemployment: Definition, Types, Measures of Unemployment, Okun's Law;

Inflation: Definition, Measures of Inflation, Types of Inflation, Effects of Inflation;

Monetary and Fiscal Policy;

Open economy framework: Basics of Exchange rate, IS-LM in open economy, Balance of Trade Vs Balance of Payments, International Trade theories – Comparative Advantage and H-O theorem.

Textbooks:

1. Dornbusch, Rudiger, Stanley Fischer and Richard Startz, Macroeconomics, 9th ed., Tata McGraw Hill.
2. Bernanke, Ben S, Andrew B Abel and Dean Croushore, Macroeconomics, Pearson.

References:

1. Samuelson, Paul A and William D Nordhaus, Economics, 19th Edition, 2010, Indian Adaptation by Sudip Chaudhuri and Anindya Sen, Tata McGraw Hill.
2. Krugman, Paul R, International Economics, Pearson.
3. Froyen, Richard T, Macroeconomics: Theory and Policy, Pearson.

Subject: Globalization, International Finance And Monetary System And Indian Economy Code: HUL 1801 (L-T-P: 3-0-0) Credits: 3

Globalization: Introduction, Meaning and Nature, Globalization and Technology Intermediation, Development of Competitive capabilities: Role of Technology and Skills, FDI and Technology Transfer;

Exchange rate as an instrument of adjustment, Basic exchange rate concepts: spot, forward, real, nominal, fixed, flexible, etc. Models of exchange rate determination, current account and capital account models;

A historic perspective of International Monetary systems of the post-world war era, Bretton Woods system and the Managed Floating regime, Relative roles of gold;

Provision of short run and long run (development) finance by international agencies, Role of International Monetary Fund (IMF), and World Bank and DFIs in providing financial assistance to LDCs;

Growth perspective of the Indian Economy since Independence, Crisis of Indian economy in 1990s and initiation of economic reforms; Monetary and fiscal policies, Industrial policy, Foreign trade and exchange rate policies, Price and wage policies, Financial reforms since 1991;

A critique of Indian planning and policies in the light of select macroeconomic indicators such as: Growth rate(s), Inflation rate(s), Unemployment levels, Incidence of poverty and External payments position

Textbooks:

1. P. Hallwood, and R. MacDonald, International Money: Theory, Evidence and Institutions, Basil Blackwell, 1986.
2. F. L. Rivera-Batiz and L. Rivera-Batiz, International Finance and Open Economy Macroeconomics, Macmillan Pub. Co., 1985.
3. Joshi, V., & Little, I.M.D., India: Macroeconomics and Political Economy, 1964-1991, Oxford University Press, Delhi, 1994.

References:

1. P. Stoneman, The Economic Analysis of Technological Change, Oxford University Press, 1983.
2. Isher Judge Ahluwalia and I.M.D. Little (eds.), India's Economic Reforms and Development, Oxford University Press, Delhi, 1998.
3. Jeffrey D. Sachs, A. Varshney, and N. Bajpai (eds.), India in the Era of Economic Reforms, Oxford University Press, Delhi, 1999.
4. Chakravarty, S., Development Planning: The Indian Experience, Oxford, 1987.
5. Lucas, R.E.B., and Papanek, G.F. (eds.), The Indian Economy: Recent Developments and Future Prospects, Oxford University Press, Delhi, 1988.
6. M. Levi, International Finance, 2nd Edition, Tata McGraw-Hill, 1990.

Subject: Financial Engineering Code: HUL 1802 (L-T-P: 3-0-0) Credits: 3

Overview of financial engineering, financial markets and financial instruments; Interest rates, present and future values of cash flow streams; Riskfree assets, bonds and bond pricing, yield, duration and convexity, term structure of interest rates, spot and forward rates; Risky assets, risk-reward analysis, Markowitz's mean-variance portfolio optimization model and efficient frontier, CAPM; No-arbitrage principle; Derivative securities, forward and futures contracts and their pricing, hedging strategies using futures, interest rate and index futures, swaps; General properties of options, trading strategies involving options; Discrete time financial market model, Cox-Ross-Rubinstein binomial asset pricing model, pricing of European derivative securities by replication; Countable probability spaces, filtrations, conditional expectations and their properties, martingales, Markov processes; Risk-neutral pricing of European and American derivate securities.

Textbooks:

1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, 2nd Ed., Springer, 2010.

2. S. Shreve, Stochastic Calculus for Finance, Vol. I, Springer, 2004.

References:

1. J. C. Hull, Options, Futures and Other Derivatives, 10th Ed., Pearson, 2018.
2. J. Cvitanic and F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, Prentice-Hall of India, 2007.
3. S. Roman, Introduction to the Mathematics of Finance: From Risk Management to Options Pricing, Springer, 2004.
4. C. G. Luenberger, Investment Science, 2nd Ed., Oxford University Press, 2013.
5. N. J. Cutland and A. Roux, Derivative Pricing in Discrete Time, Springer, 2012.