B.Tech ECE Scheme

IIIT Nagpur

(2023 Batch Onwards)

IIIT Nagpur New Scheme for B.Tech ECE || 2023 Batch Onwards

Year	Semester	Course Code	Course Name	Type	L	T	P	Credits
FIRST YEAR								
1	1	MAL 103	Calculus for Engineers	BS	3	1	0	4
1	1	BEL 102	Elements of Electrical Engineering	ES	3	0	2	4
1	1	BEL 101	Mechanics & Graphics	ES	3	0	2	4
1	1	CSL 101	Computer Programming	DC	3	0	2	4
1	1	ECL 101	Electronic Devices and Circuits	DC	3	0	2	4
1	1	HUL 101	Communication Skills	HU	2	0	2	3
Sub Total					**17**	**1**	**10**	**23**
1	2	MAL 104	Matrices, Transform Techniques and Differential Equations	BS	3	1	0	4
1	2	ASL 101	Applied Sciences	BS	3	0	2	4
1	2	ECL 102	Digital Electronics	DC	3	0	2	4
1	2	CSL 102	Data Structures	DC	3	0	2	4
1	2	HUL 102	Environmental Studies	HU	2	0	0	2
1	2	CSL 103	Application Programming	DC	3	0	2	4
1	2	SAP 101	Health, Sports and Safety	HU	0	0	2	0
Sub Total					**17**	**1**	**10**	**22**
Total					**34**	**2**	**20**	**45**
SECOND YEAR								
2	3	MAL 201	Numerical Methods and Probability Theory	BS	3	1	0	4
2	3	ECL 201	Signals and Systems	DC	3	0	2	4
2	3	ECL 202	Microprocessors and Interfacing	DC	3	0	2	4
2	3	ECL 203	Analog ICs	DC	3	0	2	4
2	3	ECL 204	Network Theory	DC	3	0	2	4
2	3	CSP 201	IT Workshop- I	DC	0	0	4	2
Sub Total					**15**	**1**	**12**	**22**
2	4	ECL 205	Digital Signal Processing	DC	3	0	2	4
2	4	ECL 206	Analog Communication	DC	3	0	2	4
2	4	ECL 207	Control Systems	DC	3	0	0	3
2	4	ECL 208	Electromagnetics	DC	3	0	0	3

2	4	ECL 209	Computer Architecture and Organisation	DC	3	0	0	3
2	4	CSP 202	IT Workshop- II	DC	0	0	4	2
Sub Total					**15**	**0**	**8**	**19**
Total					**30**	**1**	**20**	**41**

Year	Semester	Course Code	Course Name	Type	L	T	P	Credits
THIRD YEAR								
3	5	ECL 303	Hardware Description Languages	DC	3	0	2	4
3	5	ECL 307	Waveguides and Antennas	DC	3	0	0	3
3	5	ECL 308	Embedded Systems	DC	3	0	2	4
3	5	ECL 320	Digital Communication	DC	3	0	2	4
3	5		Open Course - I	OC	3	0	0	3
Sub Total					**15**	**0**	**6**	**18**
3	6	ECL 311	Wireless Communication	DC	3	0	2	4
3	6	ECL 312	CMOS Design	DC	3	0	2	4
3	6	ECD 302	Mini Project	DC	0	0	2	1
3	6		Open Course - II	OC	3	0	0	3
3	6		Departmental Elective - I	DE	3	0	0	3
3	6		Departmental Elective - II	DE	3	0	2	4
Sub Total					**15**	**0**	**8**	**19**
Total					**30**	**0**	**14**	**37**
FINAL YEAR								
4th	7th		Departmental Elective - III	DE	3	0	0	3
4th	7th		Departmental Elective - IV	DE	3	0	0	3
4th	7th		Departmental Elective - V	DE	3	0	0/2	3/4
4th	7th		Departmental Elective - VI	DE	3	0	0/2	3/4
4th	7th		OPEN / MOOC course	OC	3	0	0	3
4th	7th	ECD 403	Project	DE	0	0	16	8
4th	7th	**OR**						
4th	7th	ECD 402	Internship	DE	0	0	16	8
Sub Total					**15/0**	**0**	**16(20)/16**	**23(25)/8**
4th	8th	ECD 402	Internship	DE	0	0	16	8
4th	8th	**OR**						
4th	8th	ECD 403/ECD 404	Project/ Internship-II	DE	0	0	16	8

	8th		Departmental Elective - III	DE	3	0	0	3
4th	8th		Departmental Elective - IV	DE	3	0	0	3
4th	8th		Departmental Elective - V	DE	3	0	0/2	3/4
4th	8th		Departmental Elective - VI	DE	3	0	0/2	3/4
4th	8th		OPEN / MOOC course	OC	3	0	0	3
Sub Total					**15/0**	**0**	**16(20)/16**	**23(25)/8**
Total								**31/33**
GRAND TOTAL								**154/156**

Sem	Credits
1	**23**
2	**22**
3	**22**
4	**19**
5	**18**
6	**19**
7&8	**31/33**
TOTAL	**154/156**

Type	Credits
BS	**16**
ES	**08**
HU	**05**
OC	**09**
DC	**81**
DE	**35/37**
TOTAL	**154/156**

B.Tech ECE Syllabus IIIT Nagpur

(2023 Batch Onwards)

First Year

Year and Semester: First Year, First Semester.
Course Title: Calculus for Engineers (MAL 103)

Course Code:	MAL 103	**Course Title:**	Calculus for Engineers			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	1	0	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Basic Science			

Course Outcomes:

1. To understand & apply differential calculus, infinite series and matrix theory.
2. To understand & apply Integral calculus
3. Applications of calculus infinite series and matrices.
4. Derivation and application of theorems of matrices.
5. Application of ODE to engineering problems

Course Contents:

Module- I:
Differential Calculus: Functions of single variable: Limit continuity and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with remainders, indeterminate forms, curvature, curve tracing.

Module- II:
Integral Calculus: Fundamental theorem of Integral calculus, mean value theorems, evaluation of definite integrals, Applications in Area, length, volumes and surface of solids of revolutions, Improper integrals: Beta and Gamma functions, differentiation under integral sign.

Module- III:
Matrices: Rank of matrix, consistency of a system of equations, linear dependence and independence, linear and orthogonal transformations, Eigen values and eigen vectors, Cayley – Hamilton theorem, reduction to diagonal form, Hermitian and skew Hermitian matrices, Quadratic forms.

Module IV:
Ordinary Differential Equations: First order differential equations: Exact equation, Integrating factors, Reducible to exact differential equations, Linear and Bernoulli's form, orthogonal trajectories, Existence and Uniqueness of solutions. Picard's theorem, Picard's iteration method of solution (Statements only).

Module V:
Solutions of second and higher order linear equation with constant coefficients, Linear independence and dependence, Method of variation of parameters, Solution of Cauchy's equation, simultaneous linear equations.

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2010.
2. Piskunov, N., Differential and Integral calculus, Mir publishers, (Vol. 1, Vol. 2)

Reference Books:

1. Thomas, G.B. and Finney, R.L, Calculus and Analytic Geometry, Addison Wesley Longman
2. Michael D. Greenberg, Advanced Engineering Mathematics, Pearson Education Pvt. Ltd.
3. Jain R.K., Iyengar S.R.K, Advanced Engineering Mathematics, Narosa Publishers

Year and Semester: First Year, First Semester.
Course Title: Elements of Electrical Engineering (BEL 102)

Course Code:	BEL 102	**Course Title:**	Elements of Electrical Engineering			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Basic Science			

Course Outcomes:

1. Demonstrate application of fundamental laws to analyze dc electric and magnetic circuits
2. Apply fundamental laws and phasor method to analyze ac circuits
3. Apply working principle of different electrical measuring instruments
4. Illustrate working principle, equations and determine transformer parameters, regulation and efficiency
5. Demonstrate working principle, equations and application of dc machines and induction motor.

Course Contents:

Module I:
Electrical Circuit: Circuit Elements Resistance, Inductance & Capacitance, Series, Parallel circuits, Star-Delta Transformation , Voltage, Current, Power, Energy , Voltage Source, Current Source, Practical Source, Voltage Division , Current Division, Kirchhoff's Laws Current and Voltage, source transformation, Mesh Analysis, Nodal Analysis, Super Mesh, Super Node, Superposition Theorem

Magnetic Circuit, Flux, MMF, Reluctance, Analogy with Electric Circuits, BH Curve Simple Calculations for Composite Magnetic Circuits

Module II:
AC Circuits: Periodic Function, Average & R.M.S., Values, Steady State Behavior With Sinusoidal Excitation, Phasor Representation, Reactance & Impedance, Series & Parallel Circuit, Power Factor, Principle of Generation of Single Phase & Three Phase Voltages,Star-Delta Transformation , Voltage Division , Current Division, Kirchhoff's Laws Current and Voltage, Source transformation, Mesh Analysis, Nodal Analysis, Super Mesh, Super Node, Superposition Theorem.
Three Phase Balanced Circuits, Three Phase Load, Star Connection, Delta Connection, Voltage and Current Relationship in Three Phase Systems Star and Delta, Power in Balanced Three Phase AC System

Module III:
Electrical Measurements: Definition, Indicating, Integrating & Recording Instruments, Deflecting Controlling & Damping Mechanisms, Ammeter & Voltmeters, P.M.M.C.

Type & Moving Iron Type, Electrodynamometer Type Wattmeters, Measurement of Single Phase and Three Phase Power for Balanced and Imbalanced load, Induction Type Single Phase Energy Meter,

Module IV:
Transformers : Introduction, Basic Principles, Construction, Phasor Diagram for Transformer under No Load Condition Transformer On Load, Balance of MMF on Sides, Phasor Diagram, Equivalent Circuit, Open Circuit & Short Circuit Test, Voltage Regulation and Efficiency

Power Systems : Elementary Idea about Power Generation, Transmission and Distribution

Module V:
Electric Machines :DC Shunt and Series Motor – Construction, Principle of Working, Characteristics, Speed Control and Applications
Induction Motors – Construction, Principle of Working of Single Phase and 3-Phase Motors. Torque Slip Characteristics

Text Books:

1. Hughes, Electrical Technology, Pearson Publishers , 2010.
2. Theraja B.L. and Theraja A. K., Electrical Technology, Vol-1 and Vol – II, S. Chand Publishers , 2005.
3. Kulshreshtha D.C, Basic Electrical Engineering, TMH India, 2009

Reference Books:

1. Kothari D.P. and NagrathI.J.,Theory And Problems Of Basic Electrical Engineering, Prentice Hall India , Third Edition , 2010
2. Mittle and Mittal, Basic Electrical Engineering, TMH, 2005

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Use of measuring instruments and safety precautions in electrical laboratory
2. To verify Kirchoff's voltage law (KVL) and Kirchoff's current law (KCL) in DC circuits (resistive circuit).
3. To verify superposition theorem
4. To determine resonant frequency of series and parallel RLC circuit
5. To measure single phase power by voltmeter and ammeter methods
6. To measure three phase power by two wattmeter method
7. To perform open circuit and short circuit tests on single phase transformer
8. To determine torque speed characteristics of DC shunt motor
9. To find torque slip characteristics of induction motor
10. Study of speed control of DC motor by field current and armature control
11. Study of reversal of direction of rotation of three phase induction motor

Year and Semester: First Year, First Semester.
Course Title: Mechanics and Graphics (BEL 101)

Course Code:	BEL 101	**Course Title:**	Mechanics and Graphics			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Basic Science			

Course Outcomes:

1. To understand and implement Orthographic projection in working objects and develop understanding of theory of projection, improve visualization skills and draw professional engineering projections of engineering objects.
2. To draw and interpret, render 3D isometric and 2D objects and develop professional skills in CAD Software(s).
3. To apply equilibrium equations for mechanics of rigid bodies including friction.
4. To conceptualize the concept of stress and strain. Design of Truss and Beam.
5. To implement algorithms of computer graphics for scan conversion, geometric transformations, clipping methods.

Course Contents:

Module I:
Concept of scales, Representative factor. Engineering curves like cycloid, conic sections. Orthographic projection- Principal planes. Projection of points. Application of Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations and traces. Projection of planes inclined to both the principal planes. Projection of right regular solids inclined to both the planes. Development of surfaces. Conversion of isometric view to orthographic views. Isometric Projection, isometric axes, isometric planes. Isometric views. Conversion of orthographic views to isometric views.

Module II:
Introduction to CAD, applications, Softwares, AUTOCAD, modelling and editing commands. Concept of Layers, annotation. Problems in 2D and 3D. Rendering in AUTOCAD. Concept of Block. Layout building. Solid editing and isometric modelling. Application oriented exercises.

Module III:
Principles of Vector representation of force system, Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force – a couple Wrench , Free Body Diagram, Reactions at supports, Equilibrium of Planar and Spatial force system, friction-sliding, rolling ,wedge. Equilibrium of rigid bodies. 3 force body, 2 force body.

Module IV:
Internal forces in member (TRUSS- Design): Determination of variation of Axial force (Axial Force Diagram). Beam free body diagram and design based on Shear force, Bending moment and twisting moment. Concept of stress and strain: Normal and shear stress and strain, State of stress at a point, Stress strain curve, Hook‟s law, Modulus of elasticity, Poisson's ratio, Modulus of rigidity, Bulk modulus, Transformation of stress. 2D stress system, volumetric stress & strain. Concept of Principal planes and strains.

Module V:
Introduction to Computer Graphics, Input/output devices. Components of graphics system. Memory buffer. Scan conversion of line using DDA, Bresenhams & midpoint line algorithms. Circle generation algorithms—id-point, Bresenhams. Ellipse generation. 2D & 3D Transformation, like translation, scaling, rotation, shear, reflection. Window viewport transformation. Clipping algorithms-Cohen Sutherlan & Mid-point algorithm. Viewing, filling- flood fill algorithm.

Text Books:

1. A. Pytel and F. L. Singer, Strength of Materials, 4th ed., Harper & Row Publishers, 1987.
2. N. D. Bhatt, V. M. Panchal, and P. R. Ingle, Engineering Drawing, 51st ed., Charotar Publishing House, 2012.
3. N. Krishnamurthy, Introduction to Computer Graphics, illustrated ed., McGraw-Hill, 2002.

Reference Books:

1. R. C. Hibbeler, Engineering Mechanics: Statics & Dynamics, 13th ed., Pearson, 2013.
2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers: Statics and Dynamics, Tata McGraw-Hill.
3. I. H. Shames, Engineering Mechanics: Statics and Dynamics, Pearson Education.
4. J. L. Meriam and L. G. Kraige, Engineering Mechanics, John Wiley & Sons.
5. S. Timoshenko, Strength of Materials, Part 1, CBS Publishers and Distributors.
6. E. P. Popov, Mechanics of Deformable Bodies, Prentice-Hall.
7. F. P. Beer and E. R. Johnston, Mechanics of Materials, McGraw-Hill.
8. D. Jolhe, Engineering Drawing with an Introduction to AutoCAD, 1st ed., Tata McGraw-Hill.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Verification of equilibrium equation for coplanar forces.
2. Verification of Lami‟s theorem.
3. Verification of Law of polygon of forces.
4. Determination of coefficient of friction.
5. Analysis of truss (Analytical / Graphical method).

6. Deflection of beam
7. Jib crane apparatus.
8. Support reactions of beams.
9. Development of solids
10. AUTOCAD 2D, 3D Modeling, editing, rendering etc
11. AUTOCAD IN Electronics engineering
12. Principle of Impulse and momentum
13. Principle of work and Energy
14. Orthographic views/Projection
15. Isometric Projection
16. GNU Octave/Matlab programing in Mechanics
17. C programing for scan converting LINe, Circle etc.
18. C programing for 2D/3D transformation.
19. C programing for clipping & flood fill, scan fill algorithm.

Year and Semester: First Year, First Semester.
Course Title: Computer programming (CSL 101)

Course Code:	CSL 101	**Course Title:**	Computer Programming			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Prerequisite (if Any)	Nil	**Type of Course**	Computer Science and Engineering			

Course Outcomes:

1. Appreciation and practice of structured programming
2. Ability to formulate the problem, devise an algorithm and transform into code
3. Understanding different programming techniques and make an informed choice amongst them.
4. Understanding different sorting algorithms, their advantages and disadvantages,
5. Appreciation of the concept of dynamic memory allocation and its utilization, dynamic data structures and implementation, Abstract Data Type and implementations.

Course Contents:

Module I:
Introduction: Flow charts, data types and storage classes, scope of variables, arithmetic operators, assignment, conditional, arithmetic expressions, enumerated data types, decision making, branching, looping, Switch concept, function and parameter passing, recursive functions, macros.

Module II:
Basic programming algorithms: Programs to illustrate basic language constructs in C like - Factorial, Sine/cosine and other mathematical series, Fibonacci series, calculating square-root of a number, calculating GCD of 2 integers (Euclid's method and otherwise), Calculating LCM of 2 integers and similar such programs.

Module III:
Arrays and applications: Introduction to one dimensional and 2-D array with examples. Representing a polynomial using 1-D array and polynomial operations, Use of 2-D array to represent a matrix and matrix operations. Character arrays (strings): String related functions (strlen, strcpy, strcat, strcmp, atoi, itoa, reverse, strstretc) and their function definitions. Searching and Sorting methods: Selection sort, Bubble sort, Insertion sort, Linear and binary search, partitioning an array, merging of 2 sorted arrays. Introduction to "Divide and Conquer" via Mergesort and Quicksort.

Module IV:
Structures and Unions: Basic concept, array of structures and its applications.

Module V:
Pointers: Introduction (declaration and initialization), pointers and arrays, concept of dynamic memory allocation, use of pointers to represent variable-sized 1-D and 2-D arrays, pointers to structures.
File Management in C: Open, close, read and write operations, Sequential and text files.

Text Books:

1. B. W. Kernighan and D. M. Ritchie, The C Programming Language, PHI, 2nd ed.
2. E. Balagurusamy, Programming in ANSI C, Tata McGraw-Hill.

Reference Books:

1. S. A. Kakde and A. A. Deshpande, C and Data Structure, Charles River Media.
2. R. G. Dromey, How to Solve it by Computer, PHI.
3. Y. Kanetkar, Let Us C.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. C program to check the number is even or odd
2. C program to check whether input alphabets is a vowel or not
3. C program to find HCF and LCM
4. C program to perform decimal to binary conversion
5. C program to perform matrix addition and multiplication
6. Implementation of Binary search, Quick Sort, Merge Sort
7. Implementation of linked lists, insertion, deletion, finding an element.
8. Implementation of Sparse matrices, ADT and its Operation.
9. Implementation of Queue and its operations.
10. Implementation of Stacks and its operation.
11. Implementation of Priority Queues and its operations.

Year and Semester: First Year, First Semester.
Course Title: Electronic Devices and Circuits (ECL 101)

Course Code:	ECL 101	**Course Title:**	Electronic Devices and Circuits			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To apply concepts of basic electronic devices into electronic circuits and can analyze various parameters
2. To Relate and apply fundamentals of semiconductor devices, such as diode, BJT, DIAC, LED, UJT, MOSFET in to various practical applications.
3. Design small and large signal amplifier circuits for various practical applications
4. Design various power devices including applications of these devices in to power amplifications
5. Design and analyze basic electronic circuits.

Course Contents:

Module I:
P &N Type Semiconductors, Diodes and Power Supplies, Theory of P-N Junction Diode, Junction Capacitance, Halfwave & Fullwave, Rectifiers, Filters, Ripple-Factor, Characteristics & Applications of Following Diodes, Zener as Regulators, Schottky, Photodiode, LED, LCD, Varactor Diode &Tunnel Diode.

Module II:
Junction Transistors Theory of Operation, Static Characteristics , Break Down Voltages, Current Voltage Power Limitations, Biasing of BJT Different Biasing Arrangements, Stability Factor, Thermal Runaway, Power Transistors.

Module III:
Small Signal Analysis & High Frequency Analysis of BJT CE, CB, CC Amplifiers and Comparison High Frequency Analysis Calculation of Frequency Response, Gain Bandwidth Product.

Module IV:
Power Amplifiers Classification A, B, AB, C Classes, Efficiency, Push Pull Configuration, Complimentary Symmetry, Second Harmonic & Cross Over Distortion.

Module V:
Positive and Negative Feedback Amplifiers Classification, Practical Circuits, Applications, Advantages. Oscillators Stability, Barkhausen Criteria, RC, LC & Crystal Oscillators
Field Effect Transistor & MOSFET, Principle of Operation & Characteristics.

Text Book:

1. J. Millman, and C. C. Halkias, Integrated Electronics, 2nd ed., McGraw Hill, 2011.
2. R. L. Boylestad, and L. Nashelsky, Electronic Devices and Circuit theory, 10th ed., Pearson, 2011.

Reference Books:

1. D. A. Bell, Electronic Devices and Circuits, 2nd ed., Reston Publishing, 1980.
2. T. L. Floyd, Electronic Devices, 10th ed., Pearson, 2008.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Study of Cathode Ray Oscilloscope and Function wave generator.
2. To obtain the Volt-Ampere Characteristics and finding breakdown voltage of PN junction diode.
3. To obtain Volt-Ampere Characteristics and regulator characteristics of Zener Diode.
4. Study of Volt-Ampere Characteristics of Light Emitting Diode.
5. Study of Half-Wave rectifier with and without filter.
6. Study of Full-Wave rectifier with and without filter.
7. Study the characteristics of bipolar Junction Transistor (BJT).
8. Study the bipolar Junction Transistor (BJT) Biasing and Bias Stability.
9. To obtain the Frequency response of CE amplifier.
10. Study of Static Characteristics of MOSFET.
11. To design a RC Phase Shift Oscillator.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	0	0	0	2	0	0	2
CO2	3	3	2	2	3	0	0	0	2	1	0	2
CO3	3	3	3	3	3	0	0	0	2	2	1	2
CO4	3	3	3	3	2	0	0	0	2	2	1	2
CO5	3	3	3	3	3	0	0	0	2	2	1	2

Year and Semester: First Year, First Semester.
Course Title: Communication Skills (HUL 101)

Course Code:	HUL 101	**Course Title:**	Communication Skills			
Category:	Core	**Credit Assigned**	L	T	P	C
			2	0	2	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Humanities			

Rationale

The Bachelor's degree holder in Computer Science Engineering or Electronics Communication and Engineering has to work in the industry. To get the expertise and know the technology in his respective field, it is necessary to know effective communication, team building, leadership quality, good interpersonal skills, and the recent trend in Engineering and Technology.

Course Outcomes:

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

1. Utilize functional English grammar for accurate and enhanced language skills.
2. Construct and use effective interpersonal and workplace communication
3. Acquire better reading comprehension, pronunciation and reading skills
4. Introspect and illustrate the personality traits and soft skills
5. Develop the skills for better pre and post placement communication through effective presentations, personal interviews and group discussions

Course Contents:

Module I:
Communication: Definition of Communication, Process of Communication, Stages of Communication, Content of the message, Types of communication, Transmission, Medium/Modes of Communication, Verbal and Non-verbal Communication (Kinesics, Proxemics, Chronemics, Haptics, Paralinguistic Feature), Levels of Communication, Flow of Communication, Communication Networks, Grapevine, Barriers to Communication, Choice of Medium.

Module II:
Listening Skills: Art of Listening, Listening vs Hearing, (Poor Listening vs Effective Listening), Advantages of Good Listening, Barriers to Effective Listening, Techniques of Effective Listening
Reading Skills: Reading Comprehensions, Process of Reading, Techniques of Reading, Techniques for Good Comprehension, Reading Skills(Skimming, Scanning, Intensive Reading, SQ3R), Orientation in Literary and Scholarly Article.

Module III:
Speaking Skills: Types of Speech, Public Speaking, Components of Effective speech, Stage Presence & Personality Development, Clarity and Fluency, Body Language, , Barriers to Effective Speaking
Presentation Skills: Characteristics of a Successful Presentation, Power Point Presentation, Using Audio Visual Aids.

Module IV:
Group Discussion: Do's and Don'ts of GD, Essential Skills for GD, Evaluation Pattern
Personal Interview: Objectives of Interview, Types of Interview, Job Interviews, Employer's Expectations, Do's & Don'ts of Social Media Profile, Success Factors, Failure Factors.

Module V:
Grammar: Transformation of Sentences, Punctuation, Spellings and Mechanics of Writing.

Text Books:

1. Orient Longman, A Textbook of English for Engineers and Technologists
2. M. Ashraf Rizvi, Effective Technical Communication. Tata Mc Grwa-Hill Publishing Company Limited, 2009.

Reference Books:

1. Quirk R. and Greenbaum S., A University Grammar of English.
2. Krishnaswamy N., English Grammar (Longman Publication) (Macmillan India Ltd)
3. Sanjay Kumar and Pushp Lata. Communication Skills. Oxford Publication
4. Meenakshi Raman and Sangita Sharma. Technical Communication. Second Edition. Oxford Publication,2011.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Presenting a Book Chapter using PowerPoint slides
2. Speaking Skills
3. Presentation Skills
4. Group Discussion
5. Personal Interview/ SWOT Analysis
6. Comprehending a Technical Report/News Paper Article.

Year and Semester: First Year, Second Semester.
Course Title: Health, Sports and Safety (SAP 101)

Course Code:	SAP 101	**Course Title:**	Health, Sports & Safety			
Category:	Core	**Credit Assigned**	L	T	P	C
			0	0	2	0
Pre-Requisite (if Any)	Nil	**Type of Course**	Audit			

Course Outcomes:

1. To provide physical fitness and good health.
2. Create awareness among the students about their health status by conducting various tests and measurements and suggest them suitable remedial physical fitness program so that they can improve physical health status.
3. Improve physiological health status.
4. To improve productivity, foster social harmony, inculcate sense of discipline and dedication in general life.
5. Develop the spirit of teamwork, through various sports activities.

Course Contents:

Module I:
Development of components of fitness through conditioning exercises:
Strength: (Strength Endurance, Maximum Strength, explosive strength), Endurance: (aerobic endurance, anaerobic endurance, speed endurance and strength endurance), Speed, Co-coordinative ability, Flexibility

Module II:
Physical Efficiency Test Level 1 (Testing and Evaluation of Physical Fitness):
Cooper Test 12 minute run or walk test, Sit and reach test, 100 meter run, one minute sit up test, Push up/Bent knee push up test,

Module III:
Teaching and development of sports skills: Cognitive, Perceptual, Motor, Perceptual motor.

Module IV:
First Aid training
Intramural phase 1: Identification of sports talent through exposing students to inter-section tournament. Football, Volleyball, throw ball, table tennis & Chess.

Module V:
Yoga, Meditation and Personal Safety.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1) Physical Efficiency Test(Testing and Evaluation of Physical Fitness):1500 meter run, shuttle run, standing broad jump, one minute sit up test, flexibility test
Testing and assessment of selected Physiological parameters through Sports Medicine Research Lab: Total body fat analysis, Harvard step test, BMI, WHR, Back strength, Leg strength, grip strength, resting pulse rate, and resting respiratory rate.
Intramural phase 2: Badminton, Basketball, Cricket, Kho-Kho, etc.
Yoga and Meditation.

2)Personal Safety Skill Demonstration

Year and Semester: First Year, Second Semester.
Course Title: Matrices, Transform Techniques and Differential Equations (MAL 104)

Course Code:	MAL 104	**Course Title:**	Matrices, Transform Techniques and Differential Equations			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	1	0	4
Pre-Requisite (if Any)	MAL 101	**Type of Course**	Basic Science			

Course Outcomes:

1. To make students understand the basic importance of multi variable calculus (Differential calculus)
2. To make students understand the basic importance of multi variable calculus (Integral calculus).
3. Vector calculus and partial differential equations in engineering.
4. Understand PDE and method of solutions
5. Apply PDE to engineering problems

Course Contents:

Module I:
Calculus of Functions 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, Taylor's formula, maxima and minima, Lagrange's method of undetermined multipliers.

Module II:
Multiple Integrals: Double and triple integrals, change of order of integration, change of variables, application to area, volumes, Mass, Centre of gravity.

Module III:
Vector Calculus: Scalar and vector fields, gradient of scalar point function, directional derivatives, divergence and curl of vector point function, solenoidal and irrotational motion. Vector integration: line, surface and volume integrals, Green's theorem, Stoke's theorem and Gauss divergence theorem (without proof).

Module IV:
Partial Differential Equations: Solution of first order partial differential equations, Lagrange`s equation, four standard forms of PDE, solution of first order non-linear PDE using Charpit's method,

Module V:
Solution of linear equations with constant coefficients, classification of second order PDE, solution of one dimensional wave, heat and diffusion equations, Laplace equation in 2 and 3 dimensions; Methods of solutions (variable separable method, integral transform method).

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics. Hoboken, NJ: John Wiley & Sons.
2. N. Piskunov, Differential and Integral Calculus, Vols. 1 & 2. Moscow: Mir Publishers.
3. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry. Reading, MA: Addison Wesley Longman.

Reference Books:

1. M. D. Greenberg, Advanced Engineering Mathematics. Pearson Education Pvt. Ltd.
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics. New Delhi, India: Narosa Publishers.

Year and Semester: First Year, Second Semester
Course Title: Applied Sciences (ASL 101)

<table>
<tr><td>Course Code:</td><td>ASL 101</td><td>Course Title:</td><td colspan="4">Applied Sciences</td></tr>
<tr><td rowspan="2">Category:</td><td rowspan="2">Core</td><td rowspan="2">Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-Requisite (if Any)</td><td>Nil</td><td>Type of Course</td><td colspan="4">Basic Sciences and Engineering</td></tr>
</table>

Course Outcomes:

1. To gain the knowledge and understanding of the fundamentals of Quantum Mechanics
2. To explain the Electronic conduction and mechanical properties of Metals/Materials
3. To explain the structure and properties of Modern Engineering Materials.
4. To develop basis of Nanoscience and Nanotechnology
5. To know current trends and advances in Nanoelectromechanical systems (NEMS) and Microelectromechanical systems (MEMS)

Course Contents:

Module I:
Quantum Mechanics: Introduction of Quantum Mechanics, Failure of classical mechanics, Black Body radiation, Photoelectric effect, and Compton effect, Dual nature of matter, de-Broglie Hypothesis, phase velocity and group velocity, their relations, wave function & its physical significance, probability density, Schrodinger's wave equation, eigen values & eigen functions, applications.

Module II:
Electronic and mechanical properties of Metals/Materials: Drude-Lorentz Theory, Drift velocity, relaxation time, mean collision time, mean free path, Electrical conductivity, Quantum free electron theory, density of energy states, Fermi energy, thermionic emission.

Module III:
Modern Engineering Materials: Crystal structure, Structure of materials, Metallic glasses, Liquid Crystals, Shape memory alloy and Biomaterials, Properties of materials, Transforming materials, Structure and transformation of materials, Composite materials and smart materials, Engineering applications of materials.

Module IV:
Current trends in Engineering. Applications: Nanoscience and technology, nanoscale systems and nanotechnology, nano and micromechanical systems (NEMS and MEMS).

Module V:
Quantum information & quantum computing, evolution of quantum theory, quantum computer.

Text Books:

1. D. Halliday, R. Resnick, and J. Walker, Fundamentals of Physics, 6th ed., John Wiley & Sons, 2005.
2. B. G. Streetman, Solid State Electronic Devices, 2nd ed., Prentice Hall India, 1986.
3. M. N. Avadhanulu and P. G. Kshirsagar, A Textbook of Engineering Physics, 7th ed., 2004.
4. A. J. Dekker, Electrical Engineering Materials, Prentice Hall India, 1992.
5. K. Krane, Modern Physics, 2nd ed., John Wiley Eastern, 1998.
6. S. O. Pillai, Solid State Physics, 3rd ed., New Age International Publishers, 1999.
7. R. Rathi, Nanotechnology: Technology Revolution of 21st Century, S. Chand & Company Pvt. Ltd., New Delhi.

Reference Books:

1. J. A. Pelesko and D. H. Bernstein, Modeling MEMS and NEMS, CRC Press, 2002.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Planck's constant by Photocell
2. Study of Photocell
3. Study of Hall Effect
4. Semiconductor Energy band gap measurement using Four-probe method
5. Newton's Ring Experiment
6. Spectrometer Setup
7. Introductory Nano Kit
8. Study of electrical characteristics of a Solar cell
9. Study of curie temperature of Dielectric material
10. Write essay on Application of Nanoscience and Nanotechnology.

Year and Semester: First Year, Second Semester
Course Title: Digital Electronics (ECL 102)

Course Code:	ECL 102	**Course Title:**	Digital Electronics			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Representing numbers using various number system and operations.
2. Formulate and design combinational logic using logic gates
3. Improving a digital circuit using optimization techniques.
4. Examine and construct digital sequential circuits.
5. Design a cost effective digital system.

Course Contents:

Module I:
Number systems: Representations, signed, 1's complement, 2's complement, saturation and overflow in fixed point arithmetic.

Module II:
Boolean algebra: Axioms and theorems, DeMorgan's law, universal gate, duality, expression manipulation using axioms and theorems.

Module III:
Introduction to logic families: DTL, RTL, I 2 L, TTL, ECL, CMOS; Parameters of logic families. Introduction to different types of memories: Programmable Logic Devices and FPGAs.

Module IV:
Combinational logic: Introduction to switching algebra, canonical forms, two-level simplification, boolean cube, logic minimization using K-map method, QuineMcCluskey tabular method, minimization for product-of-sum form, minimization for sum-of-product form, multiplexers, demultiplexers, decoders, encoders, hazard free synthesis, Arithmetic circuits, adders, half adder, full adder, BCD adder, ripple carry adder, carry-lookahead adder, combinational multiplier.

Module V:
Sequential logic: Simple circuits with feedback, basic latches, clocks, R-S latch, master-slave latch, J-K flip flop, T flip-flop, D flip-flop, storage registers, shift register, ripple counter, synchronous counters, Finite State Machine (Moore/Mealy Machines), FSM with single/multiple inputs and single/multiple outputs etc.

Text Books:

1. M. M. Mano, Digital Design, 3rd ed., Prentice Hall, 2002.
2. T. L. Floyd, Digital Fundamentals, 10th ed., Prentice Hall, 2009.

Reference Books:

1. J. F. Wakerly, Digital Design: Principles and Practices, 4th ed., Prentice Hall, 2006.
2. S. Brown and Z. Vranesic, Fundamentals of Digital Logic with Verilog Design, 2nd ed., McGraw-Hill, 2007.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Study of basic components and ICs used in digital electronics lab.
2. Implementation of basic logic gates using switches, p-n junction diodes and bipolar junction transistor.
3. Study of universal gates and implementation of Boolean functions using NAND and NOR gates.
4. Implementation of 1-bit Full Adder/Subtractor using logic gates.
5. Implementation of 2-bit binary ripple adder using logic gates.
6. Implementation of 3X2 bit binary multiplier using logic gates.
7. Design and implementation of code converters.
8. Realization of Adder and Subtractor circuits using Multiplexer.
9. Study of sequential circuits and implementation of Flip-Flops.
10. Design and implementation of asynchronous decade counter.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	0	0	0	0	1	0	2
CO2	3	3	2	2	3	0	0	0	0	0	0	2
CO3	3	2	3	2	3	0	0	1	0	0	1	2
CO4	3	3	2	3	3	0	0	0	0	1	0	2
CO5	3	3	2	2	3	0	0	0	0	0	0	2

Year and Semester: First Year, Second Semester
Course Title: Data Structures (CSL 102)

Course Code:	CSL 102	**Course Title:**	Data Structures			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	CSL 101 (Computer Programming)	**Type of Course**	Computer Science and engineering			

Course Outcomes:

1. Appreciation and practice of structured programming
2. Ability to formulate the problem, devise an algorithm and transform into code
3. Understanding different programing techniques and make an informed choice amongst them
4. Understanding different sorting algorithms, their advantages and disadvantages,
5. Appreciation of concept of dynamic memory allocation and its utilization, dynamic data structures and implementation. Understanding of concept of Abstract Data Type and implementations.

Course Contents:

Module I:
Types and operations, Iterative constructs and loop invariants, Quantifiers and loops, Structured programming and modular design, Illustrative examples, Scope rules, parameter passing mechanisms, recursion, program stack and function invocations including recursion, Overview of arrays and array based algorithms - searching and sorting, Mergesort, Quicksort, Binary search, Introduction to Program complexity (Big Oh notation), Sparse matrices.

Module II:
Structures (Records) and array of structures (records). Database implementation using array of records. Dynamic memory allocation and deallocation. Dynamically allocated single and multi-dimensional arrays. Concept of an Abstract Data Type (ADT), Lists as dynamic structures, operations on lists, implementation of linked list using arrays and its operations. Introduction to linked list implementation using self-referential-structures/pointers.

Module III:
Stack, Queues and its operations. Implementation of stacks and queues using both array-based and pointer-based structures. Uses of stacks in simulating recursive procedures/functions. Applications of stacks and queues. Lists - Singly-linked lists, doubly linked lists and circular linked lists. List traversal, insertion, deletion at different positions in the linked lists, concatenation, list-reversal etc. Mergesort for linked lists.

Module IV:
Applications of lists in polynomial representation, multi-precision arithmetic, hash-tables etc. Multi linked structures and an example application like sparse matrices. Implementation of priority queues.

Module V:
Trees, binary trees, binary trees- basic algorithms and various traversals. Binary Search Trees (BSTs) and insertion, deletion in BSTs. Height-balanced (AVL) trees, insertion/deletion and rotations. Heaps and heapsort. Splay trees. Multi-way trees and external sorting - B-trees, Red-black trees. Introduction to B+ trees. Tries. Applications of the above mentioned trees. Generalization of trees to graphs – their representation & traversals. Dijkstra‟s shortest path algorithm, topological sort, all-pairs shortest paths, minimum spanning trees. Huffman coding. Introduction to network flow problem. Introduction to Skip lists, data structures for disjoint set representation.

Text Books:

1. Robert Kruse, G. L. Tondo, and B. Leung, Data Structures and Program Design in C, PHI-EEE.
2. E. Horowitz, S. Sahni, and S. Anderson-Freed, Fundamentals of Data Structures in C, University Press.

Reference Books:

1. A. Aho, J. Hopcroft, and J. Ullman, Data Structures and Algorithms, Addison-Wesley, 1983.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Implementation of Binary search, Quick Sort, Merge Sort
2. Implementation of linked lists, insertion, deletion, finding an element.
3. Implementation of Sparse matrices, ADT and its Operation.
4. Implementation of Queue and its operations.
5. Implementation of Stacks and its operation.
6. Implementation of Priority Queues and its operations

Year and Semester: First Year, Second Semester
Course Title: Environmental Studies (HUL 102)

Course Code:	HUL 102	**Course Title:**	Environmental Studies			
Category:	Core	**Credit Assigned**	L	T	P	C
			2	0	0	2
Pre-Requisite (if Any)	Nil	**Type of Course**	Basic Science			

Course Outcomes:

1. Introduce to various natural resources, their importance and status.
2. Introduce to the concepts of ecosystem, their structure and functions.
3. Introduce to the concept of biodiversity conservation.
4. Introduce to possible causes of various forms of environmental pollution and their consequences, methods of prevention.
5. Introduce to various social and climatic changes due to pollution.

Course Contents:

Module I:
Natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

Module II:
Ecosystem: Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Ecological succession, Food chain, food webs and pyramids.
Biodiversity and its conservation: Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation.

Module III:
Environmental pollution: Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes.

Module IV:
Social issues and environment: Sustainable development, Water conservation, Rain water harvesting, Watershed management, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accident, Holocaust, Environmental rules and regulations.

Module V:
Human population and environment: Population growth, Environment and human health, Human rights, Value education, Role of information technology in environment and human health.

Text Books:

1. Rajgopalan R., Environmental Studies.

Reference Books:

1. Benny Joseph, Environmental Studies, McGraw Hill.
2. ErachBarucha Environmental Studies University press (UGC)

Year and Semester: First Year, Second Semester
Course Title: Application Programming (CSL 103)

Course Code:	CSL 103	**Course Title:**	Application Programming			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	CSL 101 (Computer Programming)	**Type of Course**	Computer Science and engineering			

Course Outcomes:

1. Aware about different tools for Web Programming.
2. Background of working on web.
3. Construct efficient web pages with CSS and Javascript.
4. Demonstrate competency in the use of common HTML code.
5. Able to design efficient client as well as server side scripts.

Course Contents:

Module I:
Internet fundamentals, LAN, WAN, Introduction to common Internet terms, www. Basics of networking, DNS, URL, firewall, proxy, Web protocols – http and https.

Module II:
Designing web pages: HTML, forms, DHTML, XML, CSS. Extensible Hypertext Mark up Language (XHTML): XHTML syntax, headings, linking, images, special characters and horizontal rules, lists, tables, forms, internal linking, meta elements.

Module III:
Introduction to Web Server – Setting up and configuration of Apache Tomcat server, Accessing pages from another machine.

Module IV:
Server Side Programming: Introduction to web programming with PHP. Client side programming with Javascript

Module V:
Introduction to Python - Statements and Control Flow, Expressions, Methods, Typing, Libraries and Developmental Environment, Web Programming using Python.

Text Books:

1. H. M. Deitel and P. J. Deitel, Internet & World Wide Web – How to Program, Prentice-Hall.
2. D. Goodman and M. Morrison, JavaScript Bible, Wiley India.
3. M. Lutz, Learning Python, 4th ed., O'Reilly Media.

Reference Books:

1. S. Garfinkle and G. Spafford, Web Security, Privacy and Commerce, O'Reilly, 2002.
2. L. Atkinson, Core PHP Programming, Prentice Hall.
3. N. P. Gopalan and Akilandeswari, Web Technology, Prentice-Hall.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Creating an HTML Web page, forms.
2. Creating Home Page using HTML
3. Creating XHTML and CSS and understanding its use in creating Web pages.
4. Setting up and configuration of Apache Tomcat server.
5. Understanding modification of Web.XML
6. Creating Websites using PHP.
7. Understanding Javascript
8. Creating a Web page with back end in PHP and front end in Javascript and hosting it on Apache Tomcat Server.
9. Writing and understanding program in Python.
10. Use Python Libraries like Maths statistics to create programs for Scientific Computations.

Second Year

Year and Semester: Second Year, Third Semester
Course Title: Numerical Methods and Probability Theory (MAL 201)

<table>
<tr><td>Course Code:</td><td>MAL 201</td><td>Course Title:</td><td colspan="4">Numerical Methods & Probability Theory</td></tr>
<tr><td rowspan="2">Category:</td><td rowspan="2">Core</td><td rowspan="2">Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-Requisite (if Any)</td><td>Nil</td><td>Type of Course</td><td colspan="4">Basic Science</td></tr>
</table>

Course Outcomes:

1. To understand common numerical methods and how they are used to obtain approximate solutions of mathematical problems.
2. To analyze and evaluate the error and accuracy of common numerical methods.
3. To apply numerical methods to obtain approximate solutions to mathematical problems.
4. To understand concepts of probability, conditional probability and independence, random variables and probability distributions.
5. Application of random processes, autocorrelation and cross-correlation in the field of electronics and communication engineering.

Course Contents:

Module I:
Numerical Analysis: Solutions of algebraic and transcendental equations by Iteration method, method of false position, Newton-Raphson method and their convergence. Solutions of system of linear equations by Gauss elimination method,

Module II:
Gauss Seidal method, LU decomposition method. Newton-Raphson method for system of nonlinear equations. Eigen values and eigen vectors: Power and Jacobi methods. Numerical solution of ordinary differential equations: Taylor's series method, Euler's modified method, Runge-Kutta method, Adam's Bashforth and Adam's Moulton, Milne's predictor corrector method. Boundary value problems: Shooting method, finite difference methods.

Module III:
Probability theory: Random variables, discrete and continuous random variable, probability density function; probability distribution function for discrete and continuous random variable joint distributions. Definition of mathematical expectation, functions of random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis.

Module IV:
Binomial, Geometric distribution, Poisson distribution, Relation between Binomial and Poisson's distribution, Normal distribution, Relation between Binomial and Normal distribution.

Module V:
Random processes, continuous and discrete, determinism, stationarity, ergodicity etc. correlation functions, autocorrelation and cross-correlation, properties and applications of correlation functions.

Text Book:

1. Jain, Iyengar, and Jain, Numerical Methods for Engineers and Scientists, Wiley Eastern.

Reference Book:

1. Rohatgi, V. K., and Ehsanes Sateh, A. K. M., An Introduction to Probability and Statistics, John Wiley & Sons.
2. Cante, S. D., and de Boor, C., Elementary Numerical Analysis: An Algorithmic Approach, McGraw-Hill.
3. Gerald, C. F., and Wheatley, P. O., Applied Numerical Analysis, Addison-Wesley.
4. Spiegel, M. R., Theory and Problems of Probability and Statistics, McGraw-Hill Book Company, 1980.

Year and Semester: Second Year, Third Semester
Course Title: Signals and Systems (ECL 201)

Course Code:	ECL 201	**Course Title:**	Signals and Systems			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Perform various operations on different types of continuous and discrete time signals and systems.
2. Describe an LTI system by impulse/frequency response
3. Apply suitable continuous / discrete transforms to examine signals and systems.
4. Inspect and analyse signals and systems using frequency domain transformation tools.
5. Synthesize systems for various applications in Communications, Control, and Signal Processing

Course Contents:

Module I:
Introduction to Signals and Systems: The unit impulse and unit step functions, Continuous-time signals, Transformations of the independent variables, Exponential and Sinusoidal signals, Continuous-time systems and basic system properties.

Module II:
Linear Time-invariant Systems: Continuous-time Linear Time-invariant (LTI) system, Discrete-time LTI system, Properties of LTI systems, System representation through linear constant coefficient differential equations.

Module III:
Fourier Series Representation of Continuous-time and Discrete-time Signals: Fourier series representation, Convergence of the Fourier series, Properties of Fourier series, Fourier series and LTI systems, Filtering, Examples of filters.

Module IV:
The Continuous-time and Discrete-time Fourier Transforms: Representation of aperiodic signals, The Fourier transform for periodic signals, Properties of the Fourier transform, Convolution and multiplication properties and their effect in the frequency domain, magnitude and phase response.

Module V:
The Laplace Transform**:** The Laplace transform for continuous-time signals and systems, the notion of Eigen value and Eigen functions of LTI systems, Region of convergence, System functions, Poles and zeros of system functions and signals, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform, The unilateral Laplace transform, Applications of signals and systems theory.

Text Book:

1. A.V. Oppenheim, A. S. Willsky, and S. H. Nawab, Signals and Systems, 2nd ed., Prentice Hall, 2003.
2. J.G. Proakis and D. G. Manolakis, Digital Signal Processing. Principles, Algorithms, and Applications, 4th ed., Pearson International, 2014.

Reference Books:

1. S. Haykin and B. V. Veen, Signals and Systems, 2nd ed., Wiley, 2007.
2. B.P. Lathi, Principles of Linear Systems and Signals, 2nd ed., Oxford University Press, 2009.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Record, reading, hearing and plot your voice using matlab commands.
2. Displaying basic test signals u[n], δ[n], ce^{an}
3. Signal operations on audio signal (Shifting and scaling for both independent and dependent axis)
4. Verifying the range of discrete frequency [-0.5,0.5].
5. Convolution of 2 signals without using inbuilt function. Test the audio signal by convolving it with impulse response of various places (bathroom, forest, etc.)
6. Representation of complex exponential as a 3D mesh plot and observing real and imaginary projections.
7. Verify complex exponentials as Eigen functions
8. Plotting Fourier Series Coefficient For Continuous And Discrete-time Signals
9. Demonstrating Gibbs Phenomenon For Continuous Time Signals
10. To implement DTFT
11. To visualize moire pattern (aliasing) due to downsampling.
12. Visualization of S-place
13. Simple filter operations on images

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	3	0	0	0	0	0	0	0
CO2	3	3	0	0	1	0	0	0	0	1	0	1
CO3	3	3	3	2	3	0	0	0	0	2	0	1
CO4	3	3	3	3	3	0	0	0	0	2	0	1
CO5	3	3	0	0	0	1	0	0	1	1	0	1

Year and Semester: Second Year, Third Semester
Course Title: Microprocessor and Interfacing (ECL 202)

<table>
<tr><td>Course Code:</td><td>ECL 202</td><td>Course Title:</td><td colspan="4">Microprocessors & Interfacing</td></tr>
<tr><td rowspan="2">Category:</td><td rowspan="2">Core</td><td rowspan="2">Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-Requisite (if Any)</td><td>Nil</td><td>Type of Course</td><td colspan="4">Electronics and Communication Engineering</td></tr>
</table>

Course Outcomes:

1. Illustrate the internal registers and memory organization of microprocessor.
2. Develop assembly language programs for microprocessor based systems.
3. Demonstrate the ability to select suitable peripherals as per the system requirement.
4. Interface external peripheral devices to microprocessor.
5. Design a system using microprocessor and peripheral devices.

Course Contents:

Module I:
Basics of Microprocessor 8085 & 8086: Architecture, bus structure, timing diagrams, T-states, machine cycle, instruction cycle.

Module II:
Instruction set: Stacks and subroutines, related instructions, interrupts and associated instructions, expanding interrupts.

Module III:
Memory Interfacing: Memory Interfacing, I/O mapped and memory mapped modes, interfacing of input and output devices, multiplexed and matrix interfacing.

Module IV:
Study and Interfacing of (at least two of the following) peripherals with 8085: Peripherals: 8255, 8254, 8251, 8259, 8257/37 and 8279.

Module V:
Overview of design process using modern processors: Desktop & Mobile processors (at least one): Architecture, Programming model, I/O interfacing.
Microprocessor versus Microcontroller. Microcontroller architecture, interrupts, stack, on-chip timers and serial communication. Embedded C programming of microcontroller.

Text Book:

1. R. S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 5th ed., Penram International Publishing, 2002.
2. M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2nd ed., Pearson Education, 2006.

Reference Book:

1. J. Uffenbeck, Microprocessors and Microcontrollers, Prentice Hall of India, 2002.
2. A. K. Ray and K. M. Bhurchandi, Advanced Microprocessors and Peripherals, 3rd ed., McGraw Hill Education India, 2012.

List of Experiments:

Sr. No.	Theme	Pool of Experiments
1-2	Introduction	· Introduction to Microprocessors · Introduction to M85-04 Microprocessor Trainer kit
3-5	Basic Arithmetic	· Addition & subtraction of two 8 bit numbers · Addition & subtraction of two 16 bit numbers · Multiplication & division of two 8 bit numbers
6-10	Arithmetic	· Square of a number · Factorial of a number · Prime number identification · 2x2 matrix multiplication · Parity calculation
11-13	Series generation	· Arithmetic Progression · Geometric Progression · Fibonacci series
14-18	Array operations	· Sum of all elements of an array · Largest & smallest number of an array · Bubble sort · Insertion sort · Selection sort
19-24	Interfacing	· LEDs · 7-Seg Display · ADC / DAC · Stepper motor / DC motor · LCD display · Matrix keypad

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	0	0	0	0	1	0	2
CO2	3	3	2	2	3	0	0	0	0	0	0	2
CO3	3	2	3	2	3	0	0	1	0	0	1	2
CO4	3	3	2	3	3	0	0	0	0	1	0	2
CO5	3	3	2	2	3	0	0	0	0	0	0	2

Year and Semester: Second Year, Third Semester
Course Title: Analog ICs (ECL 203)

Course Code:	ECL 203	**Course Title:**	Analog ICs			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	ECL201	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Through the course, students are able to understand the basics of analog IC design.
2. To understand the Frequency response, stability and noise issues in amplifiers.
3. To understand the implementation of linear and non-linear analog block implementation and their testing.
4. Demonstrate the use of analog circuit analysis to analyze the operation and behavior of various modern analog integrated circuits.
5. Analyze active filters and oscillators and a comprehensive understanding of key integrated circuits used in various electronic systems and applications.

Course Contents:

Module I:
Differential amplifier configurations, DC & AC analysis, constant current bias, current mirror, cascaded differential amplifier stages, level translator.

Module II:
OPAMP: Basics, inverting, non-inverting, differential amplifier configurations, negative feedback, voltage gain, input & output impedance, Bandwidth. Input offset voltage, input bias and offset current, Thermal drift, CMRR, PSRR, Frequency response.

Module III:
Linear applications, DC, ac amplifiers, summing differential amplifier, instrumentation amplifier, V to I and I to V converters, Integrator, Differentiator.

Module IV:
Nonlinear applications, Comparators, Schmitt Trigger, Clipping and Clamping circuits, Absolute value circuits, Peak detectors, Sample and hold circuits, Log and antilog amplifiers.

Module V:
First / Second order low/ high/ bandpass, band reject active filters, All pass filter, phase shift oscillator, Wein bridge oscillator, Square wave and triangular waveform generators. Study of ICs LM-741, LM-555, LM-566, LM-565, LM-339, LM-723.

Text Book:

1. R. A. Gaikwad, Operational Amplifiers and Linear Integrated Circuits, 4th ed., Pearson Education, 2015.
2. B. Razavi, Design of Analog CMOS Integrated Circuits, 2nd ed., McGraw-Hill Education, 2017.

Reference Book:

1. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 2nd ed., McGraw-Hill, 1998.
2. J. M. Fiore, Op Amps and Linear Integrated Circuits: Concepts and Applications, 1st ed., Cengage Learning, 2010.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Introduction to Operational Amplifier (op-amp) and measure various op amp parameters.
2. To design an Inverting Amplifier for the given specifications using Op-Amp IC 741
3. To design a Non-Inverting Amplifier for the given specifications using Op-Amp IC 741.
4. To design an Integrator circuit for the given specifications using Op-Amp IC 741.
5. To design and setup a zero crossing detector circuit with OP AMP 741C and plot the waveforms.
6. To design and setup a summing amplifier circuit with OP-AMP 741C for a gain of 2 and verify the output.
7. To construct and study the behavior of logarithmic and antilogarithmic amplifier.
8. To design and setup a Schmitt trigger, plot the input output waveforms and measure VUT and VLT.
9. To design and obtain the frequency response of second order Low Pass Filter (LPF).
10. To design and setup symmetrical and asymmetrical astable multivibrators using op-amp 741, plot the waveforms and measure the frequency of oscillation.
11. To design and setup a monostable multivibrator using Op-amp 741 and (i) Plot the waveforms (ii) Measure the time delay.
12. To Design and setup a RC phase shift oscillator using Op-Amp 741 and (i) Plot the output waveform (ii) Measure the frequency of oscillation.
13. To Design and setup a square wave and triangular wave generators using Op-Amp 741 and plot the output waveforms.
14. To design and setup symmetrical and asymmetrical astable multivibrators using IC 555 and (i) Plot the output waveform (ii) Measure the frequency of oscillation.
15. Simulations of linear and non-linear applications of op-amp on ORCAD simulator.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	0	0	0	0	1	0	2
CO2	3	3	2	2	3	0	0	0	0	0	0	2
CO3	3	2	3	2	3	0	0	0	0	0	1	2
CO4	3	3	2	3	3	0	0	0	0	1	0	2
CO5	3	3	2	2	3	0	0	0	0	0	0	2

Year and Semester: Second Year, Third Semester
Course Title: Network Theory (ECL 204)

<table>
<tr><td>Course Code:</td><td>ECL 204</td><td>Course Title:</td><td colspan="4">Network Theory</td></tr>
<tr><td rowspan="2">Category:</td><td rowspan="2">Core</td><td rowspan="2">Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-Requisite (if Any)</td><td>Nil</td><td>Type of Course</td><td colspan="4">Electronics and Communication Engineering</td></tr>
<tr><td colspan="7">Course Outcomes:

1. Demonstrate the ability to analyze electrical networks.
2. Develop driving point functions and transfer functions for two-port networks.
3. Examine the steady-state and transient response of electrical networks
4. Understand behavior of electrical networks as filters.
5. Identify the stability of electrical networks.</td></tr>
<tr><td colspan="7">Course Contents:

Module I:
Node and Mesh Analysis: Node and mesh equation, matrix approach of complicated network containing voltage and current sources, and reactances, source transformation and duality.

Module II:
Network theorem: Superposition, reciprocity, Thevenin's, Norton’s, Maximum power Transfer, compensation and Tellegen's theorem as applied to AC. circuits.

Module III:
First order circuits: RC, RL, and RLC networks with and without initial conditions, with Laplace transforms evaluation of initial conditions.

Module IV:
AC Power Analysis: Instantaneous and average power, RMS value, apparent power and power factor
Two port network and interconnections; Z, Y, G, H, ABCD and A’B’C’D’. Driving points and transfer functions.

Module V:
Behavior of series and parallel resonant circuits,
Introduction to band pass, low pass, high pass and band reject filters, transient behavior and concept of complex frequency. Poles and zeros of immittance function, their properties, sinusoidal response from pole-zero integral solutions.</td></tr>
<tr><td colspan="7">Text Book:
1. Van Valkenburg, Network Analysis, 3rd ed., Prentice Hall of India, 2015.
2. Hay William, Kemmerly J. E., S. Durbin, and S.M. Durbin, Engineering Circuit Analysis, 8th eds., Tata McGraw-Hill, 2015.</td></tr>
</table>

Reference Book:

1. A. Sudhakar and S. P. Shyammohan, Circuits and Network, Tata McGraw-Hill, 1994.
2. C. Alexander and M. Sadiku, Fundamentals of Electric Circuits, TMH, 2008.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

Sr. No.	Theme	Pool of Experiments
1	Introduction	· Introduction to Network Simulators (Pspice)
2-3	Analysis Methods	· To analyze the network using mesh analysis. · To analyze the network using nodal analysis.
4-8	Network Theorems	· To verify Superposition theorem. · To verify Thevenin's theorem. · To verify Maximum power Transfer. · To verify Norton's theorem. · To verify Tellegen's theorem.
9-11	First order Networks	· To verify and study behavior of RC networks. · To verify and study behavior of RL networks. · To verify and study behavior of RLC networks .
12-13	Resonant frequencies	· To find the resonant condition and resonant frequency for Series RLC networks. · To find the resonant condition and resonant frequency for parallel RLC networks.
14-15	Two port Networks	· To derive driving point for a given two-port network. · To derive transfer functions for a given two-port network.
16-18	frequency response of filters	· To determine the frequency response of Low Pass Filter. · To determine the frequency response of High Pass Filter. · To determine the frequency response of Band Pass filter.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	1	0	0	0	1	0	0	2
CO2	3	3	2	2	1	0	0	0	1	0	0	2
CO3	3	3	2	3	1	0	0	0	1	0	0	2
CO4	3	2	2	2	1	0	0	0	1	0	0	2
CO5	3	3	2	2	1	0	0	0	1	0	0	2

Year and Semester: Second Year, Third Semester
Course Title: IT Workshop - I (CSP 201)

Course Code:	CSP 201	**Course Title:**	IT Workshop - I			
Category:	Departmental Core (DC)	**Credit Assigned**	L	T	P	C
			0	0	4	2
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Effectively use the Unix programming environment - shell, file system, scripts, filters, program development tools.
2. Automate tasks and write simple programs using scripting languages, such as Awk.
3. Develop good programming style, organization, interface, and documentation habits.
4. Use of effective procedures and tools for building, debugging, testing, tuning, and
5. maintaining programs.
   Use of tools and write programs to assist in developing programs.

Course Contents:

Module I:
Introduction to different tools for identification and possibility of errors in C program – gdb, concepts of "core dump", backtracing using "bt", using "info" to dump all registers, creating watch-list / watch variables. DDD (Data Display Debugger) – introduction and usage, debugging with ddd (step, step into, step over). Using DevCpp and/or VisualStudio b. Setting compiler options and linker options. Unix tools - Awk, sed, Emacs. Make files and automated builds.

Module II:
Text editors. Users, files, permissions, and processes on Linux. Introduction to shell: Set and Unset a variable, Displaying – using echo, Using Expr & Test, Getting input – using read, Header files of shell script – using Shabang, Sample Shell script program. Assigning a command to a variable,Storing output to a variable, Assigning global value – using Export. Command Line Arguments, Conditional & Looping Statement, Functions.

Module III:
Advanced Commands: SED, Replacing values in a file, STTY, TOP, Sending an email – using MAIL, HERE. Scheduler: Scheduling a job – using 'Crontab', 'at' and 'nohup. ShellProgramming: Essential systems administration with shell scripting and elementary Python, Version control. Advanced Shell Scripting: Monitoring a file, Handling Shell Script Interrupts, Extracting data from HTML/XML file, Trapping Signals Database Connectivity, Connecting MYSQL to Shell, Running SQL queries from Shell Script.

Module IV:
Bash and Bash Scripting: Common shell programs, Advantages of BASH, Executing commands, Building blocks, developing good scripting, variables, conditionals, loops, finding logged in users. Writing and Debugging Scripts.

Module V:
Bash Environment: Shell Initialization files, Quoting characters, Shell expansion, Aliases and More options in Bash. Regular Expressions: Meta characters, Extended regular expressions Using GREP, Pattern matching. Python Integration, Testing and Debugging with Software Development Practice.

Text Books:

1. C. Negus, Linux Bible, Wiley.
2. S. Parker, Shell Scripting: Expert Recipes for Linux, Bash & More, Wrox.
3. R. Petersen, Linux: The Complete Reference, TMH.
4. R. Collins, Shell Programming and Bash Scripting: Ultimate Beginners Guide Book, CreateSpace.

Year and Semester: Second Year, Fourth Semester
Course Title: Digital Signal Processing (ECL 205)

<table>
<tr><td>Course Code:</td><td>ECL 205</td><td>Course Title:</td><td colspan="4">Digital Signal Processing</td></tr>
<tr><td rowspan="2">Category:</td><td rowspan="2">Core</td><td rowspan="2">Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-Requisite (if Any)</td><td>Nil</td><td>Type of Course</td><td colspan="4">Electronics and Communication Engineering</td></tr>
<tr><td colspan="7">Course Outcomes:

1. Relate the time and frequency domain effects of sampling
2. Examine the effects of poles and zeros on frequency response.
3. Design and realize appropriate causal, linear-phase digital FIR filters based of frequency-domain specifications
4. Design and realize appropriate digital IIR filters through classical approach of analog filter design
5. Compute DFT using DIT and DIF techniques for filtering</td></tr>
<tr><td colspan="7">Course Contents:

Module I:
DSP Preliminaries: Recapitulation of Sampling, DT signals, sampling theorem in time domain, sampling of analog signals, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, representation of signals as vectors, concept of Basis function and orthogonality. Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing.

Module II:
Discrete Fourier Transform DTFT, Definition, Frequency domain sampling , DFT, Properties of DFT, circular convolution, linear convolution, Computation of linear convolution using circular convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Linear filtering using overlap add and overlap save method, Introduction to Discrete Cosine Transform.

Module III:
Z transform Need for transform, relation between Laplace transform and Z transform, between Fourier transform and Z transform, Properties of ROC and properties of Z transform, Relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Inverse Z transform, Power series method, partial fraction expansion method, Solution of difference equations.

Module IV:
IIR Filter Design Concept of analog filter design (required for digital filter design), Design of IIR filters from analog filters, IIR filter design by approximation of derivatives, , IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Characteristics of Butterworth filters, Chebyshev filters and elliptic filters, Butterworth filter</td></tr>
</table>

design, IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design.
FIR Filter Design Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. FIR filters realization using direct form, cascade form and lattice form, Finite word length effect in FIR filter design.

Module V:
Multirate DSP and Introduction to DSP Processor Concept of Multirate DSP, Sampling rate conversion by a non-integer factor, Design of two stage sampling rate converter, General Architecture of DSP, Introduction to Code composer studio. Application of DSP to Voice Processing, Music processing, Image processing and Radar processing.

Text Book:

1. J.G. Proakis and D. G. Manolakis, Digital Signal Processing. Principles, Algorithms, and Applications, 4th ed., Pearson International, 2014.

Reference Book:

1. S.K. Mitra, Digital Signal Processing A Computer -Based Approach, Tata McGraw-Hill, Edition, New Delhi, 2001.
2. A.V. Oppenheim, and R.W. Schafer, Discrete Time Signal Processing, 3rd ed., PHI Ltd, 2014.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Visualization of z-plane
2. Pole-zero plot using zplane()
3. Magnitude and phase of a system.
4. Effect of distance of poles from the unit circle on the magnitude and phase.
5. Visualization of z-plane for the comb filter.
6. Maximum and minimum phase systems.
7. Discrete fourier transform and inverse discrete fourier transform.
8. Verify properties of dft.
9. Take coefficients from the user and plot max and
10. Circular convolution, linear convolution from circular convolution.
11. Denoising of sound using simple filters.
12. Decimation-in-time dft. And decimation-in-frequency dft.
13. Construction of fir filters using windowing technique
14. Warping effect in blt
15. Design of butterworth iir lp, hp, bp, bs filters
16. Frequency domain analysis of multirate building blocks
17. Implementation of linear and circular convolution on dsp kit
18. Generation of sine waves using tms320c6748 dsp kit
19. Fir and iir filtering on dsp kit.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	0	0	0	0	1	0	0	0
CO2	3	3	0	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	2	0	1
CO4	3	3	3	3	3	0	0	0	1	2	0	1
CO5	3	3	0	3	3	1	1	0	1	1	0	1

Year and Semester: Second Year, Fourth Semester
Course Title: Analog Communication (ECL 206)

Course Code:	ECL 206	**Course Title:**	Analog Communication			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Understand signal multiplexing, modulation and demodulation; bandwidth requirements for analog communication systems.
2. Analyze analog communications in time domain and frequency domain.
3. Understand issues related to transmission of signals through communication channels
4. The students will be able to evaluate the performance of analogue communications in the presence of noise
5. Develop critical thinking skills by analyzing communication systems through associated laboratory activities.

Course Contents:

Module I:
Review of Signal Analysis using Fourier series representation of periodic signals, Fourier transform, Properties of Fourier transform, Convolution, Analysis of Linear time invariant systems. Transmission of signals through systems: Criteria for distortion less transmission, ideal filters, distortions in practical systems, power and energy of signals.

Module II :
Amplitude modulation: Need of modulation, AM DSB-SC, SSB-SC and vestigial side band modulation and demodulation, AM transmitter (broadcast and low power), FDM, and Noise in AM systems.

Module III:
Angle modulation: FM and PM, reactance FET modulator Armstrong method, Foster-Seely discriminator, PLL detector, Stereophonic FM, Spectrum of FM, Narrow band and wide band FM, FM transmitter (broadcast and low power).

Module IV:
Noise in FM systems. Radio receivers: TRF and super- heterodyne receiver, AGC, FM receiver, sensitivity, selectivity, image frequency rejection measurements, communication receiver and its special features. Transceivers for wireless mobile communication devices.

Module V:
Analog pulse modulation: Sampling theorem, PAM, PWM, PPM, generation & Detection of these pulse modulated signals, TDM. Noise in communication systems.

Text Books:

1. Haykin, Simon, and M. Moher. Introduction to Analog and Digital Communications. 2nd eds., Wiley India Pvt. Ltd., 2014.
2. Lathi, B. P., and Zhi Ding. Modern analog and digital communication systems. Oxford University Press, 4th Edition,2017.

Reference Book:

1. Kennedy George, Davis B. & Prasanna S.R.M., Electronic Communication Systems. 6th Edition., McGraw Hill Education, 2018.
2. Frenzel. Communication Electronics Principles and Applications. 3rd Edition., TMH, 2008.
3. Robert J. Schoenbeck. Electronic Communication Modulation and Transmission. Second Edition., PHI, 2009.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To Perform Amplitude Modulation And Demodulation
2. To Perform DSB-SC AM Transmitter And Receiver
3. To Perform FM Transmitter And Receiver
4. To Perform Analog Sampling And Reconstruction
5. To Perform PAM Modulation/Demodulation
6. To Perform PWM Modulation/Demodulation
7. To Perform PPM Modulation/Demodulation.
8. Write a programme to add white gaussian noise in a given signal and analyze the effect.
9. Write a programme to perform SSB-SC modulation and demodulation using and draw the spectrum.
10. Design a circuit for Companding and analyze the result.
11. To Perform Frequency Division Multiplexing/ Demultiplexing.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	0	0	0	0	1	0	2
CO2	3	3	2	2	2	0	0	0	0	1	0	2
CO3	3	3	2	2	2	1	0	0	0	1	0	2
CO4	3	3	2	3	2	0	0	0	0	1	0	3
CO5	2	3	3	3	3	0	0	1	1	2	1	3

Year and Semester: Second Year, Fourth Semester
Course Title: Control Systems (ECL 207)

Course Code:	ECL 207	**Course Title:**	Control Systems			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Students will learn the modelling of linear dynamic systems via differential equations and transfer functions utilizing state-space and input- output representations.
2. They can analysis of control systems in the time and frequency domains and using transfer function and state-space methods.
   Through the successful completion of the course, the student will be able to:
3. Learn various systems exhibiting control mechanisms and understand their operation,
4. Represent Mathematical model of Feedback Control Systems.
5. Evaluate the concept and significance of a Control System model and its applicability.

Course Contents:

Module I:
Introduction to need for automation and automatic control. Use of Feedback, Broad spectrum of system application. Mathematical modelling, Diff. Equations, transfer functions, block diagram, signal flow graphs, Application to elementary system simplifications, Effect of feedback on parameter variation, disturbance signal, servomechanisms and regulators. Control system components, Electrical, Electromechanical, hydraulic, pneumatic and other components. Their functional analysis and input output representation.

Module II:
Time response of systems, First order and second order system, standard inputs concept of gain and time constants. Steady state error, type of control system, approximate methods for higher order system.

Module III:
Root location and its effect on time response, Elementary idea of Root Locus, effect of adding pole and zero in proximity of imaginary axis. Stability control systems, conditions of stability, characteristic equation, Routh Hurwitz criterion, special cases for determining relative stability. Frequency response method of analyzing linear system.

Module IV:
Nyquist and Bode plots stability and accuracy analysis from frequency responses, open loop and close loop frequency response. Nyquist criterion, Effect of variation of gain and addition of pole and zero on response plot, stability margins in frequency response.

Module V:
State variable method of analysis, characteristic of system state, choice of state representation in vector matrix, different standard form, relation between transfer function and state variable.

Text Books:

1. I. J. Nagrath and M. Gopal, Control System Analysis, 6th eds., New Age Internationl (P) Limited Publishers, 2018.
2. J.J. D'Azzo and C.H. Houpis, Linear Control System Analysis and Design: Conventional and Modern, 2nd eds., McGraw-Hill, 1995.

Reference Books:

1. B. C. Kuo, Automatic Control Systems, Prentice Hall, 1991.
2. N. S. Nise, Control System Engineering, John Wiley & Sons, 2000.
3. M. Gopal, Control Systems: Principles and Design, 4th Ed.,Tata McGraw-Hill, 2012.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	1	0	0	0	0	0	0	2
CO2	3	3	2	2	1	0	0	0	0	0	0	2
CO3	2	2	2	1	1	0	0	0	0	0	0	2
CO4	3	3	2	2	1	0	0	0	0	0	0	2
CO5	2	2	2	2	0	0	0	0	0	0	0	2

Year and Semester: Second Year, Fourth Semester
Course Title: Electromagnetics (ECL 208)

Course Code:	ECL 208	**Course Title:**	Electromagnetics			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply vector calculus for static electric and magnetic fields in different coordinate systems.
2. Calculate electric and magnetic field due to various charge and current distributions.
3. Solve boundary value problems for electromagnetic fields.
4. Analyze electromagnetic wave propagation in different mediums.
5. Examine the power associated with an EM wave.

Course Contents:

Module I:
Vector calculus**:** Cartesian, Cylindrical and spherical co-ordinate systems, differential lengths, surfaces and volumes.

Module II:
Electrostatics: Coulomb's law, Electric field, intensity, electric flux density, Gauss's law and applications, divergence and divergence theorem, potential difference and potential gradient, Electric dipole and dipole moment, Energy in electric field.

Module III:
Magnetostatics: Biot Savart's law, Ampere's circuital law and application, Curl and Stroke's theorems, Magnetic flux density and magnetic flux, scalar and vector magnetic potentials,

Module IV:
Maxwell Equations and Uniform Plane Wave Maxwell's equations and time varying fields, Faraday's law, displacement current, Maxwell's Equations in point & integral form, Retarded potentials. Uniform Plane waves: Maxwell's equation in phasor form, wave equation in general medium and perfect dielectric mediums, Solution of wave equations, intrinsic impedance, velocity and wavelength, conductors and dielectrics, depth of penetration, Poynting's vector theorem.

Module V: Wave Propagation In Dispersive media Electromagnetic Waves: Reflection of Electromagnetic waves: Normal incidence, standing waves, laws of reflection, reflection of obliquely incident waves, Brewster's angle.

Text Books:

1. W. H. Hayt, and J. A. Buck, Engineering Electromagnetics, 8th Ed., Tata McGraw-Hill, 2012.
2. 2. E. C. Jordon, and K. G. Balmain, Electromagnetic Fields and Radiating Systems, 2nd Ed., PHI, 1968.

Reference Books:

1. M. N. O. Sadiku, Elements of Electromagnetics, 7th ed., Oxford University Press, 2018.
2. G. Raju, Antennas and Wave Propagation, Pearson Education India, 2006.
3. J. D. Kraus, Antennas for All Applications, McGraw-Hill, 2004.
4. R. Shevgaonkar, Electromagnetic Waves, McGraw-Hill Education, 2017.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	0	0	0	0	0	0	0	0
CO2	3	3	1	1	0	0	0	0	0	0	0	0
CO3	3	3	3	2	0	1	0	0	1	1	0	2
CO4	3	2	3	3	1	2	1	1	1	2	0	2
CO5	3	2	2	3	1	3	2	2	1	2	0	2

Year and Semester: Second Year, Fourth Semester
Course Title: Computer Architecture and Organisation (ECL 209)

Course Code:	ECL 209	**Course Title:**	Computer Architecture and Organisation			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Understanding computer's work and basic principles.
2. Analyze computer performance.
3. Design ALU and Control Unit of a computer.
4. Perform interfacing of memory with the processor.
5. Examine the issues affecting modern processors (caches, pipelines etc.).

Course Contents:

Module I:
Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Ques, Subroutines.

Module II:
Processor organization, Information representation, number formats. multiplication & division ALU design, Floating Point arithmetic, IEEE 754 floating point formats.

Module III:
Control Design, Instruction sequencing, Interpretation, Hard-wired control - Design methods, and CPU control unit.

Module IV:
Microprogrammed Control - Basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit.

Module V:
Memory organization, device characteristics, RAM, ROM, Memory management, Concept of Cache & associative memories, Virtual memory, System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces. Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network

Text Books:

1. M. M. Mano, Computer System Architecture, 3rd ed., Pearson, 1993.
2. V. C. Hamacher, Z. G. Vranesic, and S. G. Zaky, Computer Organization, 5th ed., McGraw-Hill Education, 2011.

Reference Books:

1. A. S. Tanenbaum, Structured Computer Organization, 1st ed., Prentice-Hall, 1976.
2. Y. Chu, Computer Organization and Microprogramming, 5th ed., Prentice-Hall India Learning Pvt. Ltd., 2006.
3. C. W. Gear, Computer Organization and Programming, 3rd ed., McGraw-Hill, 1980.
4. J. P. Hayes, Computer Architecture and Organization, 2nd ed., McGraw-Hill, 1988.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	0	0	0	0	0	0	0	0	2
CO2	3	3	1	0	0	0	0	0	0	0	0	2
CO3	3	3	3	2	0	0	0	0	0	0	3	2
CO4	3	3	3	2	3	0	0	0	2	2	2	2
CO5	3	3	3	3	3	1	0	0	3	2	2	2

Year and Semester: Second Year, Fourth Semester.
Course Title: IT Workshop – II (CSP 202)

Course Code:	CSP 202	**Course Title:**	IT Workshop - II			
Category:	Departmental Core (DC)	**Credit Assigned**	L	T	P	C
			0	0	4	2
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Understand programming paradigm for JAVA language.
2. Understand the installation of JDK with web server and databases connectivity along with its configuration.
3. Understand commands for JAVA bases tasks inkling exception handling. The students should get understanding of the advanced features for database connectivity.
4. Get to know the necessary tools for JAVA administration and learn about special features offered by JAVA as J2EE.
5. Learn to use to software and debug them.
6. Build a mini project using the overall concepts learned.

Course Contents:

Module I:
The Java Environment: Java Source File Structure, Compilation, Executions. Lexical Tokens, Identifiers, Keywords, Literals, Comments, Primitive Datatypes, Operators Assignments. Object Oriented Programming Class. Fundamentals including Object & Object reference, Object Life time & Garbage Collection, Creating and Operating Objects, Constructor & initialization code block, Access Control, Modifiers, methods Nested, Abstract Class & Interfaces Defining Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, Finalize () Method, Use of "this" reference, Use of Modifiers with Classes & Methods.

Module II:
Package Organizing Classes and Interfaces, CLASSPATH Setting for Packages, Making JAR Files for Library Packages, Import and Static Import Naming Convention. Exception Handling: The Idea behind Exception, Exceptions & Errors, Types of Exception, Control Flow In Exceptions, JVM reaction to Exceptions, Use of try, catch, finally, throw, throws in Exception Handling, Checked and Un-Checked Exceptions.

Module III:
Advance Java Technologies - Servlets: Overview and Architecture, Setting Up the Apache Tomcat Server, Handling HTTP get Requests, Deploying a web Application, Multitier Applications, Using JDBC from a Servlet, Java Server Pages (JSP): Overview, First JSP Example, Implicit Objects, Scripting, Standard Actions, Directives, Multimedia: Applets and Application: Loading, Displaying and Scaling Images, Animating a Series of Images, Loading and playing Audio clips.

Module IV:
Concept of Threading, Needs of Multi-Threaded Programming, Thread Priorities, Synchronizing Threads, Inter Communication of Threads, Critical Factor in Thread and

DeadLock. Event Handling, Two Event Handling Mechanisms, The Delegation Event Model, Events, Event Sources, Event Listeners, Event Classes, The MouseEvent Class. Database Programming using JDBC Introduction to JDBC, JDBC Drivers & Architecture, CURD operation Using JDBC, Connecting to non conventional Databases.

Module V:
Python for data Science: Python data types, Python Lists, Conditional Statements, Functions, packages, Numpy, matplotlip, control flow and pandas

Text Books:

1. P. Naughton and H. Schildt, The Complete Reference Java 2, Tata McGraw-Hill.
2. H. M. Deitel and P. J. Deitel, Java: How to Program, Pearson Education, Asia.
3. C. S. Horstmann and G. Cornell, Core Java 2, Vol. I & II, Sun Microsystems.
4. I. Horton, Beginning Java 2, JDK 5 Edition, Wiley India.
5. R. Russell, Java Programming for the Absolute Beginners, PHI Learning.
6. M. Lutz, Learning Python, 5th ed., O'Reilly Media, 2013, ISBN: 978-1-4493-5573-9.
7. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, 2012.

Third Year

Year and Semester: Third Year, Fifth Semester
Course Title: Hardware Description Languages (ECL 303)

Course Code:	ECL 303	**Course Title:**	Hardware Description Languages			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

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

1. Model digital systems using Verilog HDL constructs.
2. Implement combinational and sequential circuits through gate-level, dataflow, and behavioral modeling techniques, while analyzing synthesis outcomes.
3. Design and optimize Finite State Machines (FSMs) using behavioral Verilog, incorporating proper state encoding and timing constraints.
4. Develop efficient RTL designs leveraging SystemVerilog enhancements.
5. Create comprehensive testbenches and implement verification protocols to validate digital system functionality.

Course Contents:

Module I: Introduction to HDL and Basic Concepts
Overview of Digital Design, VLSI design flow, Evolution of CAD, emergence of HDLs, HDL-based design flow, Why Verilog HDL? Trends in HDLs, Basic Concepts, Lexical conventions, data types, value set, Modules and Ports, Module definition, port declaration, Hierarchical Modeling Concepts, Top-down and bottom-up design methodology, Introduction to synthesis (synthesizable vs. non-synthesizable code), Simulation tools overview, Testbench structure.

Module II: Modeling Techniques in Verilog
Differences between modules and module instances, design block, stimulus block, Gate-Level Modeling, Verilog primitives, delay modeling, Dataflow Modeling, continuous assignments, operators, Behavioral Modeling, always/initial blocks, Blocking vs. non-blocking assignments, Combinational logic design, Sequential logic (latches, flip-flops), Timing controls, Switch-Level Modeling.

Module III: Advanced HDL Constructs and Behavioral Modeling
Conditional statements (if-else, case), loops (for, while), Tasks and Functions (differences, usage), Finite State Machines (Moore vs. Mealy, state encoding), FSM design examples, Timing constraints (setup/hold basics), Synthesis issues in behavioral code, Sequential vs. parallel blocks (fork-join), Parameterized modules, Introduction to FPGA, FPGA design consideration.

Module IV: SystemVerilog
Introduction to SystemVerilog, Data Types (logic, bit, enum, typedef), Arrays (static, dynamic, associative, queues), Structures, and unions, Interfaces, modular design, reducing port clutter, Packages and namespaces.

Module V: Advanced SystemVerilog Features
OOP basics, Static methods/properties, Inheritance and polymorphism, Shallow vs. deep copy, Parameterized classes, SystemVerilog Assertions (SVA): immediate (assert), concurrent (assert property), SVA sequences and properties (handshake protocols), Functional coverage basics.

Text Books:

1. S. Palnitkar, Verilog HDL: A Guide to Digital Design & Synthesis, 2nd ed., Pearson, 2003.
2. M. M. Mano and M. D. Ciletti, Digital Design, 5th ed., Pearson, 2013.

Reference Books:

1. P. P. Chu, FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version, 1st ed., Wiley-Interscience.
2. T. L. Floyd, Digital Fundamentals, 10th ed., Prentice Hall, 2009.
3. S. Sutherland, S. Davidmann, P. Flake, and P. Moorby, SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling, 2nd ed., Springer.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any):

1. Introduction to Simulation, Synthesis, and Interfacing by Xilinx ISE Design Suite
2. Write Verilog Code for (Dataflow & Behavioral Modeling) to Realize Basic Gates
3. Realize and Implement Half Adder, Half Subtractor, Full Adder & Full Subtractor Using All Three Styles of Modeling
4. Write Verilog Code for 4:1 Multiplexer Using Basic Logic Gates & Implement the Same on FPGA
5. Design the 4-bit Gray to Binary Code Converter and Binary to Gray Code Converter & Implement the Same on FPGA
6. Write Verilog Code for 7 Segment Display
7. Write Verilog Code for ALU (Arithmetic Logic Unit)
8. Design of MO-10 Counter Using Verilog & Implement it on FPGA
9. Write Verilog Code for 4:1 Multiplexer Using Structural Modeling & Implement the Same on FPGA
10. Write Verilog Code for an ALU with Testbench and Synthesis
11. Introduction to SystemVerilog Assertions (SVA): Write Basic Assertions for Simple Circuits
12. Write Verilog Code with Assertions for Half Adder and Full Adder
13. Design and Implement a Simple Flip-Flop with SVA for Edge Detection
14. Design and Verify a Simple FSM (Finite State Machine) with Assertions

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	3	0	0	1	1	1	0	2
CO2	3	3	3	2	3	0	0	1	1	1	0	2
CO3	3	3	3	2	3	0	0	1	1	1	0	2
CO4	3	2	3	2	3	0	0	1	1	1	0	2
CO5	3	3	3	3	3	0	0	1	1	2	0	2

Year and Semester: Third Year, Fifth Semester
Course Title: Waveguides and Antennas (ECL 307)

Course Code:	ECL 307	**Course Title:**	Waveguides and Antennas			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Examine the guided wave propagation.
2. Analyze and design transmission line based systems and components.
3. Illustrate the radiation theory, antenna theory and terminology.
4. Investigate the proficiency of antenna array analysis and design.
5. Design various types of antennas and related technologies for different applications.

Course Contents:

Module I:
Revision of Maxwell's equations for time varying fields and physical significance of Curl, Divergence and Gradient. Waves between parallel planes, TE, TM,& TEM and their characteristics. Attenuation in a parallel plane guides wave impedances.

Module II:
TE, TM waves and impossibility of TEM mode in Rectangular waveguide. Different characteristics like group velocity, phase velocity, guide wavelength and wave impedances.

Module III:
Transmission line equations and their solutions. Transmission line parameters, Characteristic impedances, Propagation constant, Attenuation constant, Phase constant, Waveform distortion, Distortion less transmission lines, Loading of transmission lines, Reflection coefficient and VSWR. Equivalent circuits of transmission lines, Transmission lines at radio frequency. Open circuited and Short circuited lines, Smith Chart, Stub matching. Scalar and vector potentials related potentials, field due to a current element, power radiated and radiation resistance for field due to a dipole, power radiated and radiated resistance. Reciprocity theorem applied to antennas.

Module IV:
Antenna terminology: Gain, Aperture, Radiation intensity, Directivity, Directive gain, Beam width, Radiation patterns, FBR, Antenna bandwidth etc. Concept of antenna arrays, Two element arrays and their directional characteristics, Linear array analysis, Broadside and end fire arrays, Principles of pattern multiplication & their application. Polynomial representation, Binomial arrays, Design of broadcast array for a specific pattern, Chebyshev array synthesis. Analysis of power patterns of various antennas like Parabolic reflectors, Lens antenna, folded dipole, Turnstile antenna, Yagi antenna, Log-periodic antenna, Horn antenna & feeding, Traveling wave antenna, Printed antennas, Case grain antenna, Patch & Micro strip antennas, Superconducting antenna, Rhombic, Helical, Open ended waveguide radiator, Small design problems & applications. Signal processing antennas or smart antenna, DOA, Principle beam

formation & Digital beam formatting, Switched beam systems, Adaptive antennas, introduction to concepts of various signal processing algorithms, Principle of special filtering, Antenna diversity, TRB, SRB and Nulling of interference.

Module V:
Introduction to antenna measurement methods: measurement of Gain, Radiation pattern, Time domain gating, Antenna noise temperature & G/T, Impedance & Bandwidth. Introduction to measurement of cellular radio handset antenna.

Text Books:

1. K. D. Prasad, Antenna and Wave Propagation, 3rd ed. (reprint), Satya Prakashan, 2003.
2. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd ed., Pearson, 2015.

Reference Books:

1. G. S. N. Raju, Antennas and Wave Propagation, 1st ed., Pearson Education India, 2009.
2. G. S. N. Raju, Antennas and Wave Propagation, Pearson, 1st ed., Pearson Education India, 2004.
3. J. D. Kraus, Antennas for All Applications, 3rd ed., McGraw-Hill, 2017.
4. M. N. O. Sadiku, Elements of Electromagnetics, 7th ed., Oxford University Press, 2018.
5. R. K. Shevgaonkar, Electromagnetic Waves, 1st ed., McGraw-Hill Education (India), 2005.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	2	2	1	1	1	1	1	1	2
CO2	3	3	2	1	1	1	1	1	1	1	1	2
CO3	3	3	3	3	3	1	1	0	1	1	1	2
CO4	3	2	3	3	2	1	1	0	1	1	1	2
CO5	3	3	2	2	3	1	1	1	1	1	1	2

Year and Semester: Third Year, Fifth Semester
Course Title: Embedded Systems (ECL 308)

Course Code:	ECL 308	**Course Title:**	Embedded Systems			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply development flow for designing an embedded system.
2. Demonstrate the ability to select and program suitable microcontroller for embedded system.
3. Identify suitable peripheral devices as per requirement of embedded system.
4. Rectify faults and revamp embedded system's design as per the requirement.
5. Manage resources for different tasks in embedded system.

Course Contents:

Module I:
Embedded Systems: Introduction, Overview and Characteristics. Concept of Real time Systems, Challenges in Embedded System Design.

Module II:
Design Process: Requirements, Specifications, Architecture Design, Designing of Components, System Integration.

Module III:
Embedded System Architecture: (a). Instruction Set Architecture: CISC and RISC instruction set architecture Design Process (b). Basic Embedded Processor/Microcontroller Architecture: CISC Examples, RISC Example, DSP Processors, Harvard Architecture (PIC).

Module IV:
Interfacing: (a). Memory Interfacing (b).I/O Device Interfacing: Interfacing Protocols, I/O Devices

Module V:
OS for Embedded Systems: Basic Features, Kernel Features, Processes and Threads, Context Switching, Scheduling, Inter-process Communication, Real-time Memory Management, I/O and Example Real-time OS
Design Examples: (any two) Washing Machine, Air Conditioner, PID system for boiler etc.

Text Books:

1. K. J. Ayala, The 8051 Microcontroller: Architecture, Programming, and Applications, 2nd ed., Delmar Cengage Learning, 1996.

2. Mazidi M.A., Mazidi J.G., & McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2nd ed., Pearson Education India, 2005.

Reference Books:

1. J. W. Valvano, Embedded Microcomputer Systems: Real-Time Interfacing, 3rd ed., Cengage Learning, 2012.
2. J. Ganssle, The Art of Designing Embedded Systems, 2nd ed., Newnes, 2008.
3. D. E. Simon, An Embedded Software Primer, 1st ed., Addison-Wesley Professional, 1999.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

Sr. No.	Theme	Experiments
1.	Design Process	Understand the design process and estimate system's requirement, Specifications, Architectural Design, and Components for System Integration.
2.	Interfacing	Interfacing of peripheral devices like; Led, 7-segment,
3.	Interfacing	Design a digital watch and interface a LCD Display,
4.	Interfacing	Stepper and servo motors with the microcontroller.
5.	Timers	Design timers and simulate different timing operations and waveforms of different duty cycles.
6.	Interfacing	Understand Serial communication interfacing of devices with microcontroller.
7.	Interrupts	Understand interrupts and use those to control devices using microcontroller.

8.	OS for Embedded Systems	Study effect of context switching and scheduling on performance of embedded system.
9.	Design Examples	Develop a system to control temperature inside the boiler as per the setting provided.
10.	Design Examples	Develop an embedded system for the Washing Machine.
11.	Design Examples	Develop an embedded system for an Air Conditioner.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	1	0	0	0	0	0	0	2
CO2	3	3	2	1	1	0	0	0	0	0	2	2
CO3	3	3	3	3	1	1	0	0	1	1	2	2
CO4	3	3	3	3	2	1	0	0	2	2	2	2
CO5	3	3	3	3	1	1	0	0	2	2	3	2

Year and Semester: Third Year, Fifth Semester
Course Title: Digital Communication (ECL 320)

Course Code:	ECL 320	**Course Title:**	Digital Communication			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	ECL201	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. The students will have the deep knowledge of components of the digital communication system.
2. The students will be able to critically think and solve problems related to digital transmission and reception in baseband format.
3. Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
4. Describe and analyze the digital communication system with spread spectrum modulation and its applications in wireless communication.
5. Develop critical thinking skills by analyzing communication systems through associated laboratory activities.

Course Contents:

Module I:
Introduction to digital communication. Comparison of analog and digital communication. Advantages and disadvantages of digital communication. Source Coding of Analog Sources: PCM,Delta modulation, Adaptive DM, DPCM, ADPCM.

Module II:
Basic digital modulations schemes: Amplitude shift keying (ASK), frequency shift keying (FSK), Phase shift keying (PSK) and Quadrature Phase shift keying (QPSK) and QAM Methods. Constellation diagram and its practical applications; M-ary signalling and bandwidth efficiency; coherent demodulation and detection; probability of error.

Module III:
Baseband transmission: Line coding fundamentals, transmission formats spectral requirements. Media used for digital communication; storage and transmission, guided and unguided. Types of noise and other impairments. Inter-symbol interference, Nyquist's results for ISI, Eye pattern and adaptive equalization. Overview of geometric representation of signals, Gram-Schmidt Orthogonalization procedure.

Module IV:
Source coding of digital sources: Information, entropy, Shannon's source coding theorem, Huffman algorithm, prefix codes. Generalized digital communication system, geometric interpretation of signals, performance of matched filter receiver and correlator receive in the presence of white noise. Threshold setting and error probability.

Module V:
Spread spectrum methods: Properties of PN sequences, DSSS system, slow and fast FHSS. Block diagrams and performance analysis, carrier and symbol synchronization. Error control coding: Shannon's channel capacity theorem, significance of the theorem. Linear block codes generation and decoding, Hamming distance considerations, Cyclic codes and their applications, Convolutional codes and Viterbi decoding algorithm. Introduction to modern digital wireless communication technology CDMA, OFDM, MIMO.

Text Books:

1. Haykin, Simon, and M. Moher. Introduction to Analog and Digital Communications. 2nd eds., Wiley India Pvt. Ltd., 2014.
2. B. P. Lathi and Z. Ding, Modern Analog and Digital Communication Systems, 4th Ed., Oxford University Press, 2017.

Reference Books:

1. S. Haykin, Digital Communications, Wiley, 1988.
2. S. Haykin, Communication Systems, 4th ed., Wiley, 2006.
3. J. G. Proakis, Digital Communication, 5th ed., Tata McGraw-Hill, 2014.
4. A. B. Carlson and P. B. Crilly, Communication Systems, 5th ed., McGraw-Hill, 2010.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Signal sampling and reconstruction techniques
2. Study of TDM-Pulse Code Modulation and Demodulation.
3. Perform the Delta modulation and demodulation.
4. Perform the Adaptive Delta Modulation and Demodulation.
5. Study of Delta Sigma Modulation and Demodulation.
6. Study of ASK.
7. Study of FSK.
8. Perform PSK.
9. Study of QPSK Signaling method.
10. Study of Quadrature Amplitude Multiplexing.
11. Working of Error Check Code.
12. Eye diagram Observation**.**

CO PO Mapping												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	0	0	0	0	1	0	2
CO2	3	3	3	2	2	0	0	0	0	1	0	2
CO3	3	3	2	2	2	0	0	0	0	1	0	2
CO4	3	2	3	2	3	1	0	0	0	1	1	3
CO5	2	3	3	3	3	0	0	1	1	2	1	3

Year and Semester: Third Year, Sixth Semester
Course Title: Wireless Communication (ECL 311)

Course Code:	ECL 311	**Course Title:**	Wireless Communication			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Analog and Digital Communication	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To accustom the student's deep knowledge in modern digital communication systems at the theoretical & practical level
2. To understand modern digital wireless communication systems including the cellular concept, mobile radio environment, signals generation, modulation & processing.
3. To accustom the students with the most advanced standards, the future of digital wireless communication systems & networks.
4. To understand modern digital wireless communication systems including the cellular concept, mobile radio environment, signals generation, modulation & processing.
5. Students should be able to work in the communication industry & in mobile communication networks.

Course Contents:

Module I:
Wireless Communications and Diversity: Wireless Channel Modeling, Path loss, Shadowing, Fast Fading, Rayleigh/Ricean Fading Channels BER Performance; Diversity in Wireless Systems: Antenna Diversity (MRC), BER Performance with diversity, Types of Diversity.

Module II:
Wireless Channel Modeling: WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading; Radio propagation and cellular engineering concepts; frequency reuse, frequency management and channel assignment, handoff and handoff strategies, trunking theory, coverage and capacity improvements, medium access techniques, FDMA, TDMA, CDMA, SDMA.

Module III:
CDMA: Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization

Module IV:
OFDM : Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues-PAPR, Frequency Offset

Module V:
MIMO: Introduction to MIMO, MIMO Channel Capacity, SVD and Eigen modes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MIMO Beam forming–MRT, MIMO- OFDM.

Text Books:

1. Theodore Rappaport. Wireless Communication: Principles and Practices. Pearson Education 2nd Ed., 2010.
2. Kamilo Feher. Wireless Digital Communication. PHI, 2009.

Reference Books:

1. John Proakis. Digital communication. Tata- McGraw-Hill, 3rd Ed., 1995.
2. Simon Haykin. Digital communication. Wiley, 2006.
3. Simon Haykin. Communication systems. Wiley, 4th Ed., 2006.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To write a MATLAB code for plotting the Probability Density Function for a Gaussian Random Variable.
2. Write a MATLAB program to plot the Probability Density Function of a Rayleigh distributed random variables.
3. Write a MATLAB program to plot the CDF of a Rayleigh distributed random variable.
4. Write a MATLAB program to plot the bit error rate (BER) for a wired BPSK modulated transmitter.
5. Write a MATLAB program to plot the avergae bit error rate of a wireless BPSK modulated transmitter.
6. Write a MATLAB program for generating a PN sequence. Verify the balance property as well as the autocorrelation property for the generated PN sequence.
7. Write a MATLAB code to generate the Walsh code and check the orthogonality of the codes.
8. To write a MATLAB code to generate Gold Code and evaluate the autocorrelation property for the same.
9. Write a Report on Challenges for Practical Implementation of MIMO Systems
10. Mini project on wireless communication .

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	3	0	0	0	0	1	0	3
CO2	3	3	3	2	3	1	0	0	0	1	0	2
CO3	3	2	3	2	3	1	0	0	0	1	1	3
CO4	3	3	3	2	3	1	0	0	0	2	1	3
CO5	2	2	3	2	3	1	0	1	1	2	2	3

Year and Semester: Third Year, Sixth Semester
Course Title: CMOS Design (ECL 312)

Course Code:	ECL 312	**Course Title:**	CMOS Design			
Category:	Core	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply the fundamental principles of VLSI (Very Large Scale Integrated) circuit design and layout.
2. Examine CMOS design fabrication technologies.
3. Analyse the basic building blocks of large scale CMOS digital integrated circuits along with timing analysis and noise margin constraints.
4. Design of Analog CMOS circuits.
5. Investigate the designs of various memories and its performances.

Course Contents:

Module I:
MOS Transistor Theory: MOS Structure and its operation, I-V Characteristics, Threshold Voltage Equation, Body Effect, Second Order Effects, Scaling Theory and Limitations of Scaling, Short- Channel Effects, MOS Device Models, Small Signal operation and Equivalent Circuit of MOS Transistor, MOS Capacitors, MOS switch, Noise in MOS transistors, Latch up.

Module II:
CMOS Design Introduction: Flow of circuit design, Fabrication Process Flow: Basic Steps, Layout Design Rules.

Module III:
CMOS Digital Circuits: Inverters, Static logic gates, Transmission gates and Flip-Flops, Dynamic logic Gate, Noise margin computation, digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; Propagation delay estimation; timing parameter and timing issues (clock skew and jitter) and clock distribution techniques.

Module IV:
Memory Circuits: 6T SRAM, 4T, 3T, 2T, 1T DRAM.

Module V:
CMOS Analog Circuits: MOS Analog models, Current Sources and sinks, References, amplifiers, Differential Amplifiers, Operational Amplifiers, Phase lock loop (PLL)

Text Books:

1. B. Razavi, Design of Analog CMOS Integrated Circuits, 2nd Ed., McGraw-Hill Education, 2017.
2. R. J. Baker, H. W. Li, and D. E. Boyce, CMOS Circuit Design, Layout, and Simulation, 2nd Ed., Wiley-IEEE Press, 2004

Reference Books:

1. B. Razavi, Fundamentals of Microelectronics, 2nd Ed., Wiley, 2014.
2. E. Sicard, Basics of CMOS Cell Design, McGraw-Hill, 2005.
3. J. P. Uyemura, Circuit Design for CMOS VLSI, Springer, 2001.
4. S.-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 3rd Ed., McGraw-Hill, 2002.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Analysis of RC and RLC circuits using Netlist.
2. V-I characteristics of PMOS, NMOS and CMOS Inverter.
3. Implementation of various functions using CMOS Technology
   (i) 3 input Nand Gate
   (ii) 3 input NOR Gate
   (iii) Y = (ABC + D)'
   (iv) Y = ((AB+C)D)'
   (v) Y = (AB + C(D+E))'
4. Implementation of various functions using Pass Transistor Logic
   (i) Y = ABC + D
   (ii) Y = AB+C)D
   (iii) Y = (AB + C(D+E)
5. Layout Designing of PMOS, NMOS and CMOS Inverter
6. Layout Designing of following function
   (i) Y = ((A+D+E)(B+C))'
   (ii) Y = (ABC + D + E)'
7. Design a CMOS Full adder.
8. Design a 6T SRAM cell.
9. Layout Design of Multiplexer.
10. Layout Design of Clock network for minimum skew.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	3	1	3	0	0	0	1	1	1	2
CO2	3	3	2	2	2	1	2	1	1	1	1	2
CO3	3	3	3	3	2	0	0	1	1	1	1	2
CO4	3	2	3	3	3	0	0	0	1	1	1	2
CO5	3	3	2	2	2	0	1	0	1	1	1	2

B.Tech ECE
Elective Courses
Syllabus
IIIT Nagpur
(2023 Batch Onwards)

List of Theory only Elective Courses (3 credits) Offered by ECE

Course Code	Course Name	L	T	P	Credits
ECL420	Advanced Wireless Networks	3	0	0	3
ECL413	Radio Frequency Circuit Design	3	0	0	3
ECL430	Biomedical Engineering	3	0	0	3
ECL313	Electronic System Design	3	0	0	3
ECL433	Satellite Communication	3	0	0	3
ECL434	Radar Engineering	3	0	0	3
ECL436	Optical Communication	3	0	0	3
ECL 340	IC Fabrication	3	0	0	3
BEL 402	Neuro Fuzzy Techniques	3	0	0	3
ASL 301	Electronic Engineering Materials	3	0	0	3
CSL 446	Neural Network and Deep Learning	3	0	0	3
CSL 210	Data Structures with Applications	3	0	0	3
ECL 443	Electromagnetic Interference-Electromagnetic Compatibility	3	0	0	3
ECL 457	Process Instrumentation	3	0	0	3
ECL 309	Electronic Instrumentation	3	0	0	3
ECL 341	Sensors and Antennas for Biomedical Applications	3	0	0	3
ECL 460	Microsystems and MEMS	3	0	0	3
ECL 461	Microwave Devices	3	0	0	3

List of Theory+Lab Type Elective Courses (4 credits) Offered by ECE

Course Code	Course Name	L	T	P	Credits
ECL415	Digital Image Processing	3	0	2	4
ECL421	Pattern Recognition	3	0	2	4
ECL416	Image and Video Communication	3	0	2	4
ECL411	Advanced Digital Signal Processing & Wavelets	3	0	2	4
ECL414	Adaptive Signal Processing	3	0	2	4
ECL439	Coding Techniques	3	0	2	4
ECL432	Wireless Sensor Network	3	0	2	4
ECL459	Biomedical Signal Processing	3	0	2	4
ECL314	Devices and Modelling	3	0	2	4
ECL410	Computer Communication Network	3	0	2	4
ECL437	Statistical Signal Analysis	3	0	2	4
ECL 441	Computer Vision	3	0	2	4
BEL 403	Robotics	3	0	2	4
CSL 421	Artificial Intelligence	3	0	2	4
CSL 422	Machine Learning	3	0	2	4
CSL 202	Introduction to Object Oriented Programming	3	0	2	4
ECL453	Estimation Theory of Signals and Systems	3	0	2	4
ECL 454	Deep Learning for Computer Vision	3	0	2	4
BEL 401	Finite Element Methods	3	0	2	4
ECL 455	Multi-rate and Filterbanks	3	0	2	4
ECL 458	Real Time Operating Systems	3	0	2	4
ECL 462	Fundamentals of Machine Learning	3	0	2	4

Course Title: Advanced Wireless Networks

Course Code:	ECL 420	**Course Title:**	Advanced Wireless Networks			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)		**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To understand various channel model
2. To understand the principles and algorithms for processing both deterministic and random signals.
3. To understand the capacity of vector channel
4. To understand Capacity of MIMO systems
5. Describe the layering architecture of computer networks.

Course Contents:

Module I:
Wireless channel models and latest multiple access technologies, Introduction to various channel models (namely frequency flat, frequency selective, Rayleigh and Ricean fading models). Introduction to CDMA and OFDM.

Module II:
Capacity of scalar wireless channels: Introduction to the notion of channel capacity, Capacity of time invariant channels. Capacity of time varying (or fading) channels.

Module III:
Capacity of vector (MISO, SIMO, MIMO) channels and spatial multiplexing, Capacity of MISO and SIMO channels for both time varying and time invariant cases.

Module IV:
Capacity of MIMO systems. V-BLAST and D-BLAST, STBC and STTC.
Multiuser detection (MUD): Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD

Module V:
Introduction, Network Layer services: Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classful Addressing, Classless Addressing, DHCP, Network Address Resolution, Forwarding of IP Packets: Based on destination Address and Label. L1, L2. Network Layer Protocols: Internet Protocol (IP): Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams, ICMPv4: Messages, Debugging Tools, Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP.

Text Books:

1. D. Tse and P. Viswanath, Fundamentals of Wireless Communication. Cambridge, U.K.: Cambridge Univ. Press, 2005.

2. Forouzan, Data Communications and Networking, 5th Edition, McGraw Hill, 2016 ISBN: 1-25-906475-3

Reference Books:

1. A. Goldsmith, Wireless Communications. Cambridge, U.K.: Cambridge Univ. Press, 2005.
2. W. Tomasi, Introduction to Data Communication and Networking, Pearson Education, 2007, ISBN:0130138282
3. J. G. Proakis, Digital Communications, 5th ed. New York, NY, USA: McGraw-Hill, 2007.
4. A. J. Paulraj, R. Nabar, and D. Gore, Introduction to Space-Time Wireless Communications. Cambridge, U.K.: Cambridge Univ. Press, 2003

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	0	1	2	2	1	0	0	1
CO2	3	3	2	1	2	2	2	1	2	0	0	0
CO3	3	2	2	2	1	2	2	2	1	1	1	1
CO4	3	2	2	1	1	2	2	2	2	0	0	0
CO5	3	2	2	2	2	1	2	2	1	1	1	1

Course Title: Radio Frequency Circuit Design

Course Code:	ECL 413	**Course Title:**	Radio Frequency Circuit Design			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Describe the components of RF circuits.
2. Analyze the various diodes and their performances.
3. Describe the design of RF amplifiers.
4. Analyze the RF power amplifier.
5. Describe the components used in analog communication circuits

Course Contents:

Module I:
Characteristics of passive components for RF circuits. Passive RLC networks. Transmission lines. Two-port network modeling. S-parameter model. The Smith Chart and its applications.

Module II:
Active devices for RF circuits: SiGe MOSFET, GaAspHEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance.

Module III:
RF Amplifier design: single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, band-pass and band-reject filters. Bandwidth estimation methods. Voltage references and biasing.

Module IV:
Low Noise Amplifier design: noise types and their characterization, LNA topologies, power match vs. noise match. Linearity and large-signal performance. RF Power amplifiers: General properties. Class A, AB and C PAs. Class D, E and F amplifiers. Modulation of power amplifiers.

Module V:
Analog communication circuits: Mixers, phase-locked loops, oscillators and synthesizers. Design and performance characterization. Trans-receiver design.

Text Book:

1. B. Razavi, Design of Analog CMOS Integrated Circuits (1 ed.), McGraw-Hill, Inc., New York, NY, USA, 2001.

Reference Book:

1. T. H. Lee, The Design of CMOS Radio-Frequency Integrated Circuits, 2nd ed. Cambridge, U.K.: Cambridge Univ. Press, 2004.

2. B. Leung, VLSI for Wireless Communication. Upper Saddle River, NJ, USA: Pearson Education, 2002.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	0	0	0	1	0	0	1
CO2	3	3	2	1	3	0	0	0	2	1	0	1
CO3	3	2	2	2	2	0	0	0	1	0	0	1
CO4	3	3	3	2	3	0	0	0	2	1	0	1
CO5	3	2	2	1	2	0	0	0	1	0	0	1

Course Title: Biomedical Engineering

Course Code:	ECL 430	**Course Title:**	Biomedical Engineering			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Digital Electronics, Signal and Systems	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Describe and characterize the sources of biomedical signals and needs of using biomedical instruments & their limitations.
2. Understand & describe pc based medical instrumentation & regulation of medical devices.
3. Describe and characterize medical instruments as per their specifications, static & dynamic characteristics and understand data acquisition system.
4. Understand, describe, characterize, and design various medical recording systems & their components.
5. Understand and describe patient monitoring systems and their necessity in healthcare system.

Course Contents:

Module I:

Human body physiology and subsystems: Sources of Biomedical Signals, Basic medical system, Performance requirements of medical Instrumentation system, Microprocessors in medical instruments, General constraints in design of medical system, Regulation of Medical devices.

Module II:

Measurement system parameters: Specifications of medical instruments, Static & Dynamic characteristics, Classification of errors, Statistical analysis, Reliability, Accuracy, Fidelity, Speed of response, Linearization of technique, Data Acquisition System.

Module III:

Bioelectric signals: Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Instrumentation amplifiers

Module IV:

Biomedical recording systems: Basic Recording systems, Measurement of electrical and non-electrical quantity in human body, General consideration for signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrocardiograph, Vector cardiograph, Phonocardiograph, Electroencephalograph, Electromyography, Other biomedical recorders.

Module V:

Patient Monitoring Systems and recent advancements: System concepts, Cardiac monitor, selection of system parameters, Bedside monitors, Central monitors, Heart rate meter, Pulse rate meter, Holter monitor and Cardiac stress test, Cardiac cauterization instrumentation, Aspects related to the designing of various biomedical devices, Patient isolation and accident prevention, Latest trends in Biomedical Instrumentation

Text Book:

1. R. S. Khandpur, Handbook of Bio-Medical Instrumentation, 2nd ed. New Delhi, India: TataMcGraw-Hill,2003.

2. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, Biomedical Instrumentation and Measurement, 2nd ed. New Delhi, India: Prentice-Hall of India, 2003.

Reference Books:

1. J. Webster, Bioinstrumentation. Hoboken, NJ, USA: Wiley & Sons, 2003.

2. J. D. Bronzino, The Biomedical Engineering Handbook, 2nd ed. Boca Raton, FL, USA: CRC Press, 2000.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	1	2	1	1	1	1	1	1
CO2	3	2	2	2	2	1	0	1	1	1	1	1
CO3	3	3	2	2	1	1	0	0	1	1	1	1
CO4	3	3	2	3	2	1	1	1	1	1	1	2
CO5	3	2	3	3	2	2	1	1	1	1	1	1

Course Title: Electronic System Design

Course Code:	ECL 313	**Course Title:**	Electronic System Design			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Understand the basic principles and operations of devices such as Bipolar Junction Transistors, Operational Amplifiers, Filters, Data converters (D/A, A/D), Timer and Power Supply Systems.
2. Design and analyze digital systems.
3. Understand the coupling mechanisms that occur in a cable during signal transmission, grounding principles, and shielding methods.
4. Implement balancing and filtering techniques in electronic systems for optimized power line quality and apply ESD protection measures effectively to enhance system reliability.
5. Analyze the influence of packaging on electronic system performance and design factors affecting packaging.

Course Contents:

Module I:

Passive components: Understanding and interpreting data sheets and specifications of various passive and active components, non-ideal behavior of passive components.

Op amps: DC performance of op amps: Bias, offset and drift. AC Performance of operational amplifiers: band width, slew rate and noise. Properties of a high quality instrumentation amplifier. Design issues affecting dc accuracy & error budget analysis in instrumentation amplifier applications. Isolation amplifier basics. Active filers: design of low pass, high pass and band pass filters. ADCs and DACs: Characteristics, interfacing to microcontrollers. Selecting an ADC. Power supplies: Characteristics, design of full wave bridge regulated power supply. Circuit layout and grounding in mixed signal system.

Module II:

Understanding and interpreting data sheets & specifications of various CMOS & BiCMOS family Logic devices. Electrical behavior (steady state & dynamic) of CMOS & BiCMOS family logic devices. Benefits and issues on migration of 5-volt and 3.3 volt logic to lower voltage supplies. CMOS/TTL Interfacing Basic design considerations for live insertion. JTAG/IEEE 1149.1 design considerations. Design for testability, Estimating digital system reliability. Digital circuit layout and grounding. PCB design guidelines for reduced EMI.

Module III:

Cabling of Electronic Systems: Capacitive coupling, effect of shield on capacitive coupling, inductive coupling, effect of shield on inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, coaxial cable versus shielded twisted pair, ribbon cables. Grounding of Electronic Systems: Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground

layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies.

Module IV:
Balancing & Filtering in Electronic Systems: Balancing, power line filtering, power supply decoupling, decoupling filters, high frequency filtering, and System bandwidth.
Protection Against Electrostatic Discharges (ESD): Static generation, human body model, static discharge, ESD protection in equipment design, software and ESD protection, ESD versus EMC.

Module V:
Packaging & Enclosures of Electronic System: Effect of environmental factors on electronic system (environmental specifications), nature of environment and safety measures. Packaging's influence and its factors. Cooling in/of Electronic System: Heat transfer, approach to thermal management, mechanisms for cooling, operating range, basic thermal calculations, cooling choices, heat sink selection

Text Books:

1. K. R. Fowler, Electronic Instrument Design, 1st ed. New York, NY, USA: Oxford Univ. Press,1996.

2. H. W. Ott, Noise Reduction Techniques in Electronic Systems, 2nd ed. New York, NY, USA: John Wiley & Sons, 1988.

Reference Book:

1. W. Bosshart, Printed Circuit Boards: Design and Technology, 1st ed. New Delhi, India: Tata McGraw-Hill, 1983.

2. J. F. Wakerly, Digital Design: Principles and Practices, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall International, 2000.

3. M. T. Thompson, Intuitive Analog Circuit Design. Oxford, U.K.: Elsevier, 2006.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	1	0	0	0	0	0	1
CO2	3	3	3	2	3	0	0	0	1	2	1	2
CO3	3	2	2	0	2	2	1	1	0	0	0	1
CO4	3	2	2	1	3	2	1	2	0	2	1	2
CO5	3	2	2	1	1	1	1	1	1	1	1	2

Course Title: Satellite Communication

Course Code:	ECL 433	**Course Title:**	Satellite Communication			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Describe the motion dynamics of satellites.
2. Discuss the subsystems of the satellite.
3. Examine the uplink and downlink communication design.
4. Analyzing the different modulation techniques for satellite communications.
5. Describe the Earth station system.

Course Contents:

Module I:
Orbital Mechanics:
Orbital aspects of satellite communication, Orbit mechanisms, Kepler's laws of planetary motions, Equation of orbit, Locating satellite in orbit, Orbital elements, Orbital area coverage, Look angles, Slant range.

Module II:
Satellite subsystems:
Attitude and orbit control system, Telemetry tracking and command system (TTC), Transponders, Power subsystems, Communications subsystems, Antennas.

Module III:
Link Design:
Satellite link design, System noise temperature, G/T ratio, Down link design, Uplink design, Link for specified (C/N) base-band noise signal.

Module IV:
Modulation Techniques in satellite communications:
Digital Satellite Links, Frequencies and channel allocations, Modulation techniques, QPSK, QAM, BER analysis, medium access methods for satellite communication.

Module V:
Earth Station Systems:
Earth station technology, Earth station design for low system noise temperature, Equipment for earth stations, VSAT systems: Overview of VSAT systems, Access control protocols, multiple access selection, modulation, coding and interference issues

Text Books:

1. T. Pratt, C. Bostian, and J. Allnutt, Satellite Communications, 2nd Ed., John Wiley & Sons, 2003.

2. W. L. Pritchard, H. G. Suyderhoud, and R. A. Nelson, Satellite Communication Systems Engineering, 4th Ed., Pearson Education, 2008.

Reference Books:

1. W. Tomasi, Advanced Electronic Communications Systems, 6th ed., Prentice Hall of India Pvt. Ltd., 2015.
2. F. R. Dungan, Electronic Communication Systems, 3rd ed., International Thomson Publishing Company, 1987.
3. D. Roddy, Satellite Communications, 4th Ed., McGraw-Hill, 2003.
4. K. Miya, Satellite Communication Technology, 2nd Ed., 1985.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	0	0	0	0	0	0	0	2
CO2	3	3	1	1	0	0	0	0	0	0	0	2
CO3	3	3	3	3	2	2	2	0	2	2	2	3
CO4	3	3	3	3	2	2	0	0	0	0	0	3
CO5	3	3	1	1	0	2	0	0	0	0	0	3

Course Title: RADAR Engineering

Course Code:	ECL 434	**Course Title:**	RADAR Engineering			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To learn Radar Fundamentals like Radar Equations, Operating frequencies and applications.
2. To understand the basic concepts of different types of Radars for surveillance and tracking.
3. To know the various types of tracking techniques involved.
4. To understand Radar Receivers and its related applications.
5. To know about MTI filters, displays and antennas.

Course Contents:

Module I:

Basics of RADAR: Introduction, Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation, Related Problems. Radar range equation: SNR, Envelope Detector-False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Related Problems.

Module II:

CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW Radar, Related Problems. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar.

Module III:

MTI and Pulse Doppler Radar: Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar. Tracking Radar: Tracking with Radar, Sequential Lobing, Conical Scan, Monopulse Tracking Radar – Amplitude Comparison Monopulse (one- and two- coordinates), Angular Accuracy, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.

Module IV:

Detection of Radar Signals in Noise: Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross-correlation Receiver, Efficiency of Non-matched Filters, Matched Filter with Non-white Noise.

Module V:
Radar Receivers: Noise Figure and Noise Temperature, Displays – types, Introduction to Phased Array Antennas –Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Applications, Advantages and Limitations.

Text Books:

1. M. I. Skolnik, Introduction to Radar Systems, 3rd Ed., McGraw-Hill, 2001.

Reference Books:

1. B. Edde, Radar Principles, Technology, Applications, Pearson Education, 2004.
2. P. Z. Peebles Jr., Radar Principles, New York: Wiley, 1998.
3. M. A. Richards, J. A. Scheer, and W. A. Holm, Principles of Modern Radar: Basic Principles, Chennai: Yesdee Publishing, 2013.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	2	2	0	0	0	0	0	0	0
CO2	3	3	2	2	0	0	0	0	0	0	0	0
CO3	3	3	3	2	0	1	0	0	1	1	0	2
CO4	3	3	2	2	1	1	1	1	1	1	0	1
CO5	3	2	3	3	2	2	1	1	1	1	1	1

Course Title: Optical Communication

Course Code:	ECL 436	**Course Title:**	Optical Communication			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Enables students to develop a full understanding of the components and the design and operation of optical fiber communication systems
2. To understand the principles of wavelength division multiplexed (WDM) systems, RF photonic systems and passive optical networks (PONs).
3. To understand the characteristics and limitations of system components like laser diodes, external modulators, optical fiber, and optical amplifiers.
4. Students will be able to analyze the performance of both analog and digital optical fiber systems
5. Students will be able to calculate the system bandwidth, noise, probability of error and maximum usable bit rate of a digital fibre system.

Course Contents:

Module I:
Optical Fibre: Basic concepts of optical communication. The nature of light. Light as an Electromagnetic Wave, Polarization, Interference. Transmitting light on a Fibre Refractive index, Fibre refractive index profiles,

Module II:
Light Propagation : Modes of propagation Light Propagation in Multimode Fibre, Snell's Law Critical Angle, and Numerical aperture.

Module III:
Optical Sources: Light Emitting Diodes (LEDS), The Semiconductor Junction Diode, Construction and Operation of LED's , Heterojunctions (Practical LED's) , Characteristics of LED'S, Lasers, Principle of the LASER, Semiconductor Laser Diodes

Module IV:
Optical Detectors: Photoconductors, Photodiodes, P-N Diodes, P-I-N Diodes, Schottky-Barrier Photodiodes, Avalanche Photodiodes (APDS), Hetero-interface photodetectors, Traveling wave photodetectors , Phototransistors

Module V:
Optical Communication Systems: Point-to-point Transmission Systems, Modulation techniques, On-off key, Multi state coding, Forward Error correction, Receiving the signal, Timing recovery, Bandwidth Occupancy.

Text Books:

1. J. M. Senior, Optical Fiber Communications: Principles and Practice, 3rd Ed. Harlow, U.K.: Pearson Education, 2009.

Reference Books:

1. D. C. Agrawal, Fiber-Optic Communication Systems, 3rd Ed. New York, NY, USA: Wiley, 2002.
2. G. Keiser, Optical Fiber Communications, 4th Ed. New York, NY, USA: McGraw-Hill, 2010

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	0	1	0	0	0	1	0	1
CO2	3	2	2	0	1	2	0	0	0	0	0	1
CO3	3	2	2	1	1	1	0	0	0	0	0	1
CO4	3	3	0	2	2	0	0	0	0	0	0	1
CO5	3	3	0	3	3	0	0	0	1	0	0	1

Course Title: IC Fabrication

Course Code:	ECL 340	**Course Title:**	IC Fabrication			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	CMOS Design	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To enable the students to understand how a silicon wafer is turned into an operating chip by learning the fundamentals of IC design.
2. To develop the basis of IC fabrication by learning the initial processing of wafer by crystal growth and epitaxy.
3. To analyse the series of processes that establishes the shapes, dimensions and placement of required physical components of IC on the wafer surface layer, understands different types of lithography. The principles and practice of the oxidation, doping techniques, diffusion and ion implantation.
4. Carry out the process integration needed to produce NMOS and CMOS transistors.
5. Design of Integrated Circuit by understanding the IC packaging.

Course Contents:

Module I:
Introduction to IC Technology: Historical Perspective, IC classifications, IC design flow, Crystal Growth and Wafer preparation: Material Properties, Wafer terminology, Different crystalline orientations, CZ method, Crystal Defects.

Module II:
Introduction to processing steps: Epitaxy, Clean room and safety requirements, oxidation, diffusion and ion implantation.

Module III:
Deposition and growth, etching and cleaning, photolithography, metallization, Next generation technologies.

Module IV:
Process integration: Basic NMOS and CMOS fabrication sequence.

Module V:
Packaging: Die separation, package type, attachment methods.

Text Books:

1. S. K. Ghandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, 2nd Ed., John Wiley & Sons, 1994.
2. S. M. Sze, VLSI Technology, 2nd Ed., McGraw-Hill, 1998.

Reference Books:

1. J. Y. Chen, CMOS Devices and Technology for VLSI, 1st Ed., Prentice Hall, 1990.
2. P. Van Zant, Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th Ed., McGraw-Hill, 2013.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	0	0	0	0	1	0	2
CO2	3	2	2	1	2	0	0	0	0	0	0	2
CO3	3	3	2	1	3	0	0	0	1	1	1	2
CO4	3	3	3	1	3	0	0	0	1	1	1	2
CO5	3	2	2	1	2	0	1	1	0	1	0	2

Course Title: Neuro Fuzzy Techniques

Course Code:	BEL 402	**Course Title:**	Neuro Fuzzy Techniques			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. This course intends to give students the fundamentals of image and video processing and communications.
2. Students would learn various standard image and video codecs
3. Students would have learn the architectures of the state-of-the-art image and video codecs
4. Students would have learn the Fuzzy Set and Fuzzy Logic Controller.
5. Students would have learn the Fuzzy Neurons

Course Contents:

Module I:
Neural Networks: History, overview of biological neuro-system, mathematical models of neurons, ANN architecture

Module II:
Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, Learning Tasks

Module III:
ANN training Algorithms-Single layer perceptron, multi-layer perceptron, Self-organizing Map, Applications of Artificial Neural Networks.

Module IV:
Introduction to fuzzy set, Operations on fuzzy sets, Fuzzy relation, Fuzzy implication, approximate reasoning, Fuzzy rule-based systems, Fuzzy reasoning schemes, Fuzzy logic controller.

Module V:
Implementing fuzzy IF-THEN rules by trainable neural nets. Fuzzy neurons, Hybrid neural networks, Neuro-fuzzy classifiers.

Text Books:

1. T. J. Ross, Fuzzy Logic with Engineering Applications, 2nd ed. New York, NY, USA: McGraw-Hill, 2004.

2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd ed. Upper Saddle River, NJ, USA: Prentice-Hall, 1999.

Reference Books:

1. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence. Upper Saddle River, NJ, USA: Prentice-Hall, 1997.

2. R. A. Aliev and R. R. Aliev, Soft Computing and Its Applications. Singapore: World Scientific, 2001.

3. K. Mehrotra, C. K. Mohan, and S. Ranka, Elements of Artificial Neural Networks. Cambridge, MA, USA: MIT Press, 1997.

4. B. Kosko, Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence. Englewood Cliffs, NJ, USA: Prentice-Hall, 1992.

Course Title: Electronic Engineering Materials

Course Code:	ASL 301	**Course Title:**	Electronic Engineering Materials			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Departmental elective offered for ECE			

Course Outcomes:

1. To recall the concept of various properties of the material and their applications in designing electronic devices and components.
2. To analyse behaviour of dielectric and magnetic materials under various conditions.
3. To analyse behaviour of Conductive and superconducting materials under various conditions.
4. To identify the appropriate engineering materials considering its electrical, magnetic, other relevant properties, cost and safety factors for specific engineering applications
5. To learn to think and work like professional scientists and engineers.

Course Contents:

Module I:
Dielectric Materials:
Dielectric properties of insulators in static fields, Polarization, Dielectric constant, Dielectric behavior of materials, Ferroelectric, Piezoelectric and Pyroelectric materials, Dielectric properties of insulators in alternating fields, Complex dielectric constant, Dipolar relaxation, Dielectric loss, Loss tangent, Dielectric break down, different types of capacitor and dielectric materials applications.

Module II:
Magnetic Materials:
Magnetic materials classification, Soft and Hard magnetic materials, Ferrites, Magnetic cores of transformers, Relays, memory elements, Magnetic resistors and Magnetic tapes

Module III:
Multiferroic Materials:
Introduction, Type of Multiferroic and few examples

Module IV:
Conductive Materials:
Conductivity of pure metals and alloys, Temperature coefficient of resistivity, High conductivity materials, Fixed and variable resistors, Resistors used in electronic circuits.

Module V: Superconducting Materials:
Superconductivity, Type-I and Type-II superconductors, High temperature superconductivity, Applications of superconductivity.

Text Books:

1. A. J. Dekker, Electrical Engineering Materials. New Delhi, India: Prentice-Hall of India, 1992.

2. S. P. Seth, A Course in Electrical Engineering Materials, 3rd ed. New Delhi, India: Dhanpat Rai Publications, 2003.
3. S. O. Kasap, Principles of Electronic Materials and Devices, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2002.

Reference Books:

1. M. A. Joshi, Electronic Components and Materials. New Delhi, India: SPD Publications, 2006.
2. S. O. Pillai, Solid State Physics, 5th ed. New Delhi, India: New Age International Publishers, 1999.

Course Title: Neural Network and Deep Learning

Course Code:	CSL 446	**Course Title:**	Neural Network and Deep Learning			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Ability to understand the fundamental concepts of neural networks and underlying error convergence algorithms such as backpropagation and gradient descent.
2. Ability to gain an insight into deep neural networks and incorporation of the above stated algorithms in deep neural networks.
3. Acquire the depth knowledge of various deep models, architectural aspects, and comparative analysis along with accuracy/performance measures.
4. Ability to implement, analyse, and optimise deep models for the computer vision, natural language processing, and wind estimation.
5. Ability to extend the acquired deep learning knowledge in the direction of research for deep learning/ machine learning/ data sciences.

Course Contents:

Module I:
Neural network working, Backpropagation and Gradient Descent algorithms. Introduction to deep neural network. Role of vectorization in various operations in deep learning. Comparisons of shallow and deeper networks.

Module II:
Hyperparameter and its tuning in converging deep networks. Gradient descent optimization algorithms and its importance such as Adam's algorithm and RMSProp. Introduction and importance of domain knowledge in deep learning.

Module III:
Convolutional neural networks, its architecture, deep CNN, parameter sharing, and applications. Recurrent neural networks and its architectural variants such as LSTM, GRU. Architectural aspects and applications. Hybridization of deep models.

Module IV:
Applications of deep learning models to computer vision, natural language processing, and wind estimation. Research direction in deep learning. Introduction to autoencoder and Reinforcement learning.

Text Books:

1. I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. Cambridge, MA, USA: MIT Press, 2016.
2. J. Patterson and A. Gibson, Deep Learning: A Practitioner's Approach, 1st ed. Beijing, China: O'Reilly Media, 2017.

3. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd ed. Upper Saddle River, NJ, USA: Prentice-Hall, 1999.

Reference Books:

1. K. Mehrotra, C. K. Mohan, and S. Ranka, Elements of Artificial Neural Networks. Cambridge, MA, USA: MIT Press, 1997.

Course Title: Data Structure with Applications

Course Code:	CSL 210	**Course Title:**	Data Structure with Applications			
Category:	Elective	**Credit Assigned**	L	T	P	C
			2	0	2	3
Pre-Requisite (if Any)	Data structures	**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Appreciation of advance data structures, advantages and disadvantages.
2. Ability to identify problem requirements, constraints to be satisfied and ability to select the best possible data structures to satisfy the constraints.
3. Evaluate advanced data structures and algorithms with an emphasis on persistence.
4. Analyze data structure impact on designing algorithms and program performance.
5. Ability to communicate about program/algorithm/data-structure efficiency (time and space) and recognize a better solution.

Course Contents:

Module I:
Applications of lists in polynomial representation, multi-precision arithmetic, Hash tables, Radix Sort etc. Multi linked structures and an example application like sparse matrices. Implementation of priority queues.

Module II:
Overview of Binary Search Tree (BST), Height-balanced (AVL) trees, insertion/deletion and rotations. Heaps and heapsort. Multi-way trees and external sorting - B-trees – insertion and deletion, Introduction to B+ trees with insertion and deletion algorithms. Red-black trees, Splay trees.

Module III:
Tries, Multi-way tries, Suffix trees, Segment trees. Applications of the above mentioned trees. Introduction to Skip lists, Data structures for disjoint set representation

Module IV:
Overview and definition of Graph as data structure, Traversals (BFT, DFT, Topological Sort), Data structures for Dijkstra's Shortest Path Algorithm, All-pairs shortest paths, Minimum spanning trees – Algorithms (Kruskal, Prim) and data structures. Huffman coding. Introduction to network flow problem.

Text Books:

1. C. L. Liu, Elements of Discrete Mathematics, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2000.

2. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science. New York, NY, USA: McGraw-Hill, 1997.

Reference Books:

1. K. H. Rosen, Discrete Mathematics and Its Applications, 7th ed. New York, NY, USA: McGraw-Hill, 2012.

2. S. Lipschutz and M. Lipson, Schaum's Outline of Discrete Mathematics, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2007.

3. N. Deo, Graph Theory with Applications to Engineering and Computer Science. New Delhi, India: Prentice-Hall of India, 1989.

Course Title: Electromagnetic Interference-Electromagnetic Compatibility

Course Code:	ECL 443	**Course Title:**	Electromagnetic Interference-Electromagnetic Compatibility			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Examine the concepts of Real-world EMC design.
2. Justify the basic electromagnetic compatibility problems.
3. Prioritize Interconnection Techniques along with Cable routing & connection.
4. Plan high speed Printed Circuit board with minimum interference.
5. Design electronic systems that function without errors or problems related to Electromagnetic compatibility.

Course Contents:

Module I:

Aspects of EMC with examples, Common EMC units, EMC requirements for electronic systems. Radiated emissions, Conducted emissions, ESD.

Module II:

Application of EMC design, Wires, PCB lands, Component leads, resistors, capacitors, inductors, and ferrites. Electromechanical devices, Digital circuit devices. Mechanical switches (as suppression).

Module III:

Simple emission models for wires and PCB lands, Cross talk and reflection issues in digital circuits. Lice impedance stabilization network (LISN), Power supply filters. Power supplies including SMPS.

Module IV:

Three conductor lines and crosstalk, Shielded wires, twisted wires, Multiconductor lines and effects of incident fields, Shielding, Origin effects, prevention of ESD event, its hardware and immunity.

Module V:

System design for EMC, Grounding, System configuration, PCB design for signal integrity, EMI standards and regulations.

Text Books:

1. C. R. Paul, Introduction to Electromagnetic Compatibility, 2nd Ed. Hoboken, NJ, USA: Wiley-Interscience, 2006.

2. D. A. Weston, Electromagnetic Compatibility: Methods, Analysis, Circuits, and Measurement, 3rd Ed. Boca Raton, FL, USA: CRC Press, 2001.

Reference Books:

1. R. Schmitt, Electromagnetics Explained: A Handbook for Wireless/RF, EMC, and High-Speed Electronics. Boston, MA, USA: Elsevier/Newnes, 2002.

2. V. P. Kodali, Engineering Electromagnetic Compatibility, 2nd Ed. New York, NY, USA: IEEE Press, 2001.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	1	1	3	2	1	1	0	0	2
CO2	3	3	1	2	1	3	2	1	1	0	0	2
CO3	3	3	3	2	1	1	2	1	1	0	0	1
CO4	3	3	3	2	1	1	2	1	1	2	0	1
CO5	3	3	3	1	2	1	2	1	2	2	1	2

Course Title: Process Instrumentation

Course Code:	ECL 457	**Course Title:**	Process Instrumentation			
Category:	Departmental Elective (DE)	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Analyze the process control system and evaluation.
2. Applications of electronic and pneumatic controller in control systems.
3. Illustrate PID controller for improving the transient response.
4. To discuss final control elements
5. Compare and analysis of conventional and smart tuning techniques.

Course Contents:

Module 1:

Introduction to process control Control system Evaluation. ON-OFF control, Time proportional control, proportional control, Integral control, Derivative control. Typical Time-Domain Analysis of Feedback Control Systems - Typical reference test signals and their significance, transient behaviour of closed loop systems under feedback control.

Module II:
Pneumatic controller: P, PD, PI, PID controllers. Hydraulic controller: P, PI, PD, PID controller, Electronic controller. Complex control schemes: ratio control systems, split range controls, cascade controls, feed forward control.

Module III:
Proportional plus derivative and rate feedback control actions for improving the transient response. Steady state behaviour of closed loop feedback control systems. Types of open loop transfer functions. Steady state errors. Proportional plus integral control action for the improvement of steady state errors.

Module IV:
Final control elements: Mechanical, Electrical, Fluid valves: control valve principles, valve-sport and plug and characteristics, control valve types, Valve sizing and selection. Type of actuators: Pneumatic actuators, Hydraulic actuators.

Module V:
Tuning of controllers: Ziegler-Nicolas methods and other classical methods. Optimization techniques for tuning parameters, GA, PSO, etc.

Text Books:

1. D. P. Eckman, Automatic Process Control. New Delhi, India: Wiley India Pvt. Ltd., 2003.
2. D. Patranabis, Principles of Process Control, 2nd Ed. New Delhi, India: Tata McGraw-Hill, 1999.

Reference Books:

1. S. K. Singh, Industrial Instrumentation, 2nd Ed. New Delhi, India: Tata McGraw-Hill, 2003.
2. G. K. Mitra and S. K. Gupta, Programmable Logic Controller and Industrial Automation. New Delhi, India: Jaico Publishing House, 2008.
3. C. D. Johnson, Process Control Instrumentation Technology, 8th Ed. Upper Saddle River, NJ, USA: Prentice Hall PTR, 2006.
4. D. R. Coughanowr and S. E. LeBlanc, Process Systems Analysis and Control, 3rd Ed. New York, NY, USA: McGraw-Hill Education, 2017.

	Program Outcomes											
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**P011**	**PO12**
CO1	3	2	2	1	1	0	0	0	0	0	0	1
CO2	3	2	2	2	2	0	0	0	0	0	0	1
CO3	3	3	3	2	2	1	1	0	3	0	0	1
CO4	3	2	2	2	2	1	1	0	3	0	0	1
CO5	2	3	3	2	3	2	2	0	3	0	0	1

Course Title: Electronic Instrumentation

Course Code:	ECL 309	**Course Title:**	Electronic Instrumentation			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Examine the working principle of basic electronic instruments.
2. Measure various electrical quantities with desired accuracy, precision and resolution.
3. Mathematically model and analyse an electronic instrument.
4. Design an instrument as per the requirements of measurand.
5. Demonstrate ability to select suitable instruments for measurement of physical quantity.

Course Contents:

Module I:

Accuracy and precision, Significant figures, Types of errors, statistical, Probability of errors, Limiting errors.

Functional elements of an instrument, Active and Passive transducers, Analog and Digital mode of operation, Null deflection methods, Input and output configuration of measuring instrument and instrument system.

Module II:

Electromechanical Indicating Instruments: PMMC galvanometer, DC ammeters, DC voltmeter, series & shunt type ohmmeters, multi-meter, electrodynamometer for power measurement, power factor meter, instrumentation transformer.

Bridge Measurements: Wheat stone bridge: Basic operation, measurement errors, Thevenin's equivalent circuit, Guarded Wheat-stone bridge, Kelvin bridge: Effects of connecting leads, Kelvin double Bridge. AC Bridges and their application: Condition and application of the balance equation. Maxwell's bridge, Hay Bridge, Schering Bridge, Wein Bridge unbalanced condition.

Electronic Instruments: Amplified DC meter, AC voltmeter, electronic multimeter, digital voltmeter, Q meter.

Module III:

Transducers as input elements to instrumentation system. Basic methods of force measurement, torque measurement, pressure and sound measurement. Temperature measurement: Standards and calibration, thermal expansion methods, thermocouples, resistance thermometers junction semiconductors sensors, digital thermometers. Strain Measurement: Bonded and un-bonded electrical strain gauges, gauge factor, temperature compensation methods. Biomedical sensors used for measurement of biological, chemical and physical process of human body.

Module IV:

Oscilloscope: Introduction, Oscilloscope block Diagram, Cathode Ray tube (CRT), CRT circuits, Deflection systems, Delay line. Multiple trace, Simple frequency counters. Strip XY recorder, CRO. LED display, LCD display, DSO. Signal conditioning Techniques used in

various transducers, Gain clipping, filtering, amplification, data logger. IEEE 488 Bus: Principles of operation, protocols.

Module V:

PLC & SCADA: Introduction to PLC, relay logic, ladder diagram and programming, Introduction to SCADA.

Text Books:

1. W. D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, 5th Ed. New Delhi, India: Prentice-Hall of India, 2002.
2. E. O. Doebelin, Measurement Systems: Application and Design, 5th Ed. New York, NY, USA: McGraw-Hill, 2003.

Reference Books:

1. K. Sawhney, Electronic Instrumentation, Petil ed. New Delhi, India: Kogalsusha Terman, 1998.
2. H. S. Kalsi, Electronic Instrumentation, 3rd Ed. New Delhi, India: Tata McGraw-Hill, 2010.
3. J. Oliver, Electronic Measurement and Instrumentation. New Delhi, India: Tata McGraw-Hill, 2005.
4. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation, 19th Ed. New Delhi, India: Dhanpat Rai & Sons, 2011.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	2	1	1	0	0	2	1	0	2
CO2	3	2	2	2	2	1	1	0	2	1	1	2
CO3	3	3	3	2	3	1	2	0	2	2	1	2
CO4	3	3	3	3	3	2	2	1	3	2	2	2
CO5	3	3	3	3	3	2	1	0	2	2	2	2

Course Title: Sensors and Antennas for Biomedical Applications

Course Code:	ECL 341	**Course Title:**	Sensors and Antennas for Biomedical Applications			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if Any)	Electromagnetics	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Understand the basic working principles of various sensors and antennas for biomedical applications.
2. Identify and analyze various sensor structures and sensing principles.
3. Understand, analyze and infer how wearable and implantable antennas can be used for health care applications.
4. Understand the importance of telemetry link and safety regulations involved in biomedical applications
5. Analyze wireless power transfer between wearable/implantable medical devices with external units.

Course Contents:

Module I:

BASICS OF SENSORS AND ANTENNAS: Sensors and Their Classification, Characteristics of measurement system and units, Special Requirements for Biomedical Applications, Static and dynamic Characteristics Antenna basics and performance parameters, Patch and slot antenna, Linear and circular polarized patch antenna, Wideband Antenna, Fractal antenna

Module II:

APPLICATION OF SENSORS IN BIOMEDICINE: Basic Sensor structures, Sensing effects, Thermoresistive Effects, Thermoelectric Effect, Piezoelectric Effect, Pyroelectric Effect, Mechanical Sensors in Biomedicine, Sensors in Ultrasound Imaging, Magnetic Field Sensors, Inkjet-Printed Smart Skins Sensors for Wearable Applications

Module III:

WEARABLE AND IMPLANTABLE ANTENNA: Introduction to wearable and Implantable antenna and its application, Challenges towards the design of wearable antenna: antenna size, impedance matching, antenna gain, Specific Absorption Rate (SAR), etc., wideband wearable antenna for 5G, Phantom Models: skin, muscle, fat, Impact of body tissues over the antenna performances, impact of antenna orientation inside the human body, Link budget calculation.

Module IV:

ANTENNA FOR BIOMEDICAL TELEMETRY: Design consideration of biomedical telemetry devices, Sensing principle and technologies, Power issue, Biosensor communication

technologies, Propagation and communication issue for telemetry, Safety and security in biomedical telemetry, Various health regulatory bodies and standards.

Module V:

WIRELESS POWER TRANSFER TO THE IMPLANTABLE DEVICE: Wireless charging of the battery for the implantable devices, Various power transfer mechanism in Near and Far field. Various approaches to improve power transfer efficiencies in implantable environment.

Text Books:

1. T. Togawa et. al., Biomedical Sensors and Instruments, CRC Press, 2011
2. C. A. Balanis, Antenna Theory: Analysis and Design, 4th Ed., Wiley, 2016.

Reference Books:

1. A. W. Rudge, The handbook of Antenna Design, IEE Electromagnetic Wave Series, 1982
2. G. Harsanyi, Sensors in Biomedical Applications: Fundamentals, Technology and Applications, CRC Press, 2000.
3. K. S. Nikita, Handbook of Biomedical Telemetry, 1st Ed., John Wiley & Sons, 2014.
4. T. Sun et.al., Wireless Power Transfer for Medical Microsystems, Springer, 2013.
5. A. Sabban, Wearable system and antenna technologies for 5G, IOT and medical systems, CRC Press, 2020.

Additional Resources:

1. https://www.digimat.in/nptel/courses/video/108101092/L01.html
2. https://nptel.ac.in/courses/117/105/117105139/

Program Outcomes												
CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
CO1	3	3	2	2		1	2	2	1			1
CO2	3	3	2	1	2	2	2	1				
CO3	3	2	1	2	1	2	2	2	1	1	1	1
CO4	3	3	1	1		2	2	2	2			
CO5	3	2	2	2	2	1	2	2	1	1	1	1

Course Title: Microsystems and MEMS

Course Code:	ECL 460	**Course Title:**	Microsystems and MEMS			
Category	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if-any)	Analog circuits or CMOS design or IC Fabrication	Type of Course	Electronics and Communication Engineering			

Course Outcomes:

1. Understand and apply concepts of microfabrication and micromachining.
2. Understand working of micro-sensors and their fabrication.
3. Understand working of micro-actuators and their fabrication.
4. Understand different surface micromachining techniques.
5. Study and understand modern MEMS areas.

Course Contents:

Module I:

Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA)

Module II:

Physical Micro-sensors: Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples for: Thermal, Electrical, Mechanical, Chemical and Biosensors.

Module III:

Micro-actuators: Electromagnetic and Thermal micro-actuation, Mechanical design of micro-actuators, Micro-actuator examples, micro-valves, micro-pumps, micro-motor and micro-actuator based systems, Ink-Jet printer heads, Micro-mirror TV Projector.

Module IV:

Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micro-machined Systems : Success Stories, Micro-motors, Gear trains, Mechanisms

Module V:

Application Areas: All-mechanical miniature devices, 3-D electromagnetic actuators and sensors, RF/Electronics devices, Optical/Photonic devices, Medical devices e.g. DNA-chip, micro-arrays. MEMS for RF Applications: Need for RF MEMS components in communications, space and defense applications.

Textbooks:

1. S. A. Campbell, The Science and Engineering of Microelectronic Fabrication, 2nd Ed. New York, NY, USA: Oxford Univ. Press, 2001.
2. G. K. Ananthasuresh, K. J. Vinoy, S. Gopala Krishnan, K. N. Bhat, and V. K. Aatre, Micro and Smart Systems, 1st Ed. New Delhi, India: Wiley-India, 2010.

Reference Books:

1. S. M. Sze, Modern Semiconductor Device Physics. New Delhi, India: Wiley Eastern, 1998

2. J. W. Gardner, V. K. Varadan, and O. O. Awadelkarim, Microsensors, MEMS, and Smart Devices, 1st Ed. Hoboken, NJ, USA: Wiley, 2001.
3. S. M. Sze, VLSI Technology, 2nd Ed. New York, NY, USA: McGraw-Hill, 1988.

Program Outcomes												
CO\ PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	2	2	3	2	3	1	3	3	1	2
CO2	3	2	1	2	1	1	2	1	2	1	2	1
CO3	3	2	1	2	1	1	2	1	2	1	2	1
CO4	3	1	1	2	2	0	0	1	2	1	1	2
CO5	2	2	1	1	1	2	1	1	1	2	2	1

Course Title: Microwave Devices

Course Code:	ECL 461	**Course Title:**	Microwave Devices			
Category	Elective	**Credit Assigned**	L	T	P	C
			3	0	0	3
Pre-Requisite (if-any)		Type of Course	Electronics and Communication Engineering			

Course Outcomes:

1. Describe the use of Microwave frequency and components.
2. Describe the use and advantages of compound semiconductor-based devices.
3. Describe the limitation of conventional vacuum devices.
4. Analyze the linear Microwave devices.
5. Analyze the cross-field Microwave devices

Course Contents:

Module I:
Introduction to Microwave frequencies, Scattering parameters, E-plane Tee, H-plane Tee, Magic Tee, two-hole directional coupler, isolator, and circulator.

Module II:
Transferred electron devices: Gunn-effect diodes, Gunn effect. Ridley-Watkins-Hilsum Theory; differential negative resistance al Two valley model theory. LSA diode, InP diode. Modes of operation.

Module III:
Read diode; Physical description, Avalanche multiplication, and output power. IMPATT diode; Physical structure, negative resistance, output power and efficiency. TRAPPAT diode; principal of operation, output power and efficiency. BARITT diode; physical description, output power and efficiency, and PIN diode.

Module IV:
Microwave O-Type Tubes: Limitations of conventional active devices at microwave frequency, Reentrant Cavities, operating principal of Two cavities Klystron, Velocity modulation, output power and efficiency. Reflex klystron; operating principal, current modulation, and output power, Travelling wave tube: operating principle, slow-wave structure, amplification process.

Module V:
Microwave M-Type Tubes: Introduction, operating principal of Magnetrons. Linear and cylindrical magnetrons. Forward-wave cross-field amplifier; operating principal, Backward-wave cross-field amplifier; operating principal. Backwards-wave cross-field oscillator; operating principal.

Textbooks:

1. S.Y. Liao, Microwave Devices and Circuits, 3rd Ed., Prentice-Hall, 1990.
2. A. Das and S. K. Das, Microwave Engineering, 4th Ed., McGraw-Hill Education India, 2020.

Reference Books:

1. D. M. Pozar, Microwave Engineering, 3rd ed. New Delhi, India: John Wiley India Pvt. Ltd., 2008.
2. S. Das, Microwave Engineering, 2nd ed. New Delhi, India: Oxford Higher Education, 2015.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	2	2	1	1	1	1	1	1	2
CO2	3	3	2	1	1	1	1	1	1	1	1	2
CO3	3	3	3	3	1	1	1	0	1	1	1	2
CO4	3	2	3	3	2	1	1	0	1	1	1	2
CO5	3	3	2	2	3	1	1	1	1	1	1	2

Course Title: Digital Image Processing

Course Code:	ECL 415	**Course Title:**	Digital Image Processing			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Review the fundamental concepts of a digital image processing system
2. Analyze images in the spatial and frequency domain using various transforms.
3. Evaluate the techniques for image enhancement and image restoration.
4. Able to apply various image compression and Segmentation used in digital image processing
5. Implement selected algorithms in real time applications.

Course Contents:

Module I:
Elements of visual perception, Digital Image fundamentals, Basic image processing steps,

Module II:
Image Transforms, Image enhancement in spatial and frequency domain, linear gray level transformations, Histogram equalization and specification, smoothing & sharpening spatial filters. Image degradation models, image restoration, inverse filtering, Wiener filtering.

Module III:
Image reconstructions from projections, radon transform, projection theorem of computerized tomography.

Module IV:
Morphological image processing, dilation, erosion, Basic morphological algorithms, thinning algorithms. Edge detection, Edge linking & Boundary Detection, watershed segmentation algorithm,

Module V:
Introduction to object recognition, color image processing, RGB and HSI color models, Gray level to color transformation.

Text Books:

1. R.C. Gonzalez, and R.E. Woods, Digital Image Processing, 2nd Ed., Pearson Education, 2002.
2. A. K. Jain, Fundamentals of Digital Image Processing, 1st Ed., Prentice-Hall Inc., 1989.

Reference Books:

1. W.K. Pratt, Digital Image Processing, 3rd Ed., JOHN WILEY & SONS, INC., 2001.

2. NPTEL course by Prof. P. K. Biswas, IIT Kharapur,

   https://nptel.ac.in/courses/117105135

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Simulation and Display of an Image, Negative of an Image(Binary & Gray Scale)
2. Implementation of Relationships between Pixels
3. Implementation of Transformations of an Image
4. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization
5. Display of bit planes of an Image
6. Display of FFT(1-D & 2-D) of an image
7. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image
8. Implementation of Image Smoothening Filters(Mean and Median filtering of an Image)
9. Implementation of image sharpening filters and Edge Detection using Gradient Filters
10. Image Compression by DCT,DPCM, HUFFMAN coding
11. Implementation of image restoring techniques
12. Implementation of Image Intensity slicing technique for image enhancement
13. Canny edge detection Algorithm

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	1	1	1	2	0	1	2
CO2	3	3	3	2	3	1	1	1	2	1	2	2
CO3	3	2	3	3	3	0	1	0	1	2	1	2
CO4	3	3	2	3	2	0	1	0	2	2	1	2
CO5	3	2	3	2	3	1	0	1	2	2	1	3

Course Title: Pattern Recognition

Course Code:	ECL 421	**Course Title:**	Pattern Recognition			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply basic concepts in pattern recognition
2. Gain knowledge about state-of-the-art algorithms used in pattern recognition research,
3. Analyze pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
4. Apply pattern recognition techniques in practical problems.
5. To solve engineering value problem using ANN.

Course Contents:

Module I:
Basics of Probability, Random Processes and Linear Algebra (recap): Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.

Module II:
Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors. Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.

Module III:
Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering -Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation.

Module IV:
Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbour method. Dimensionality reduction: Principal component analysis - its relationship to eigen analysis. Fisher discriminant analysis - Generalized eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning method. Non negative matrix factorization - a dictionary learning method. Linear discriminant functions: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.

Module V:
Artificial neural networks: Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural

networks. Non-metric methods for pattern classification: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).

Text Books:

1. R.O. Duda, P.E. Hart, and D.G. Stork, Pattern Classification, 2nd Ed., JOHN WlLEY & SONS, INC., 2001.

Reference Books:

1. T.M. Mitchell, Machine learning, McGraw-Hill, New York, 1997.
2. S. Theodoridis, and K. Koutroumbas, Pattern recognition, 2nd ed., Academic Press, Elsevier, 2003.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To perform feature representation
2. To perform mean and covariance
3. To perform linear perceptron learning
4. To plot different Random Variables
5. To perform Bayesian Classification
6. To implement MLE: Learning the classifier from data
7. To implement Data Clustering: K-Means, MST-based
8. Parallel and distributed processing - I: Interactive activation and competition models
9. Parallel and distributed processing - II: Constraint satisfaction neural network models
10. To model a Multi-layer feed forward neural networks

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	0	0	1	0	0	0
CO2	3	3	0	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	1	0	1	2	0	1
CO4	3	3	3	3	3	0	0	0	1	2	0	1
CO5	3	3	0	3	3	1	1	0	1	1	0	1

Course Title: Image and Video Communication

Course Code:	ECL 416	**Course Title:**	Image and Video Communication			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. This course intends to give students the fundamentals of image and video processing and communications.
2. Students would learn filtering techniques in spatial and frequency domains.
3. Students would learn various standard image and video codecs
4. Students would have learn the architectures of the state-of-the-art image and video codecs
5. Students will learn to implement selected algorithms in MATLAB or C-language.

Course Contents:

Module I:
Fundamentals of image and video processing, including color image capture and representation; color coordinate conversion; contrast enhancement; spatial domain filtering (linear convolution, median and morphological filtering).

Module II:
Two-dimensional (2D) Fourier transform and frequency domain interpretation of linear convolution; 2D Discrete Fourier Transform (DFT) and DFT domain filtering.

Module III:
Image sampling and resizing; geometric transformation and image registration; video motion characterization and estimation; video stabilization and panoramic view generation

Module IV:
Basic compression techniques (entropy coding, vector quantization, predictive coding, transform coding); JPEG image compression standard; wavelet transform and JPEG2000 standard; video compression using adaptive spatial and temporal prediction;

Module V:
Video coding standards (MPEGx/H26x); Stereo and multi- view image and video processing (depth from disparity, disparity estimation, video synthesis, compression).

Text Books:

1. Y. Wang, J. Ostermann, and Y.Q. Zhang, Video Processing and Communications, (Signal Processing Series) Prentice Hall, 2002.

Reference Books:

1. J. W. Woods, Multidimensional Signal, Image and Video Processing and Coding, 2nd Ed., Academic Press, Elsevier, 2012.

2. R.C. Gonzalez, and R.E. Woods, Digital Image Processing, 2nd Ed., Pearson Education, 2002.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Basic operations on videos
   (a) Extracting frames from videos
   (b) Playing video in reverse
   (c) Applying background subtraction, frame differencing algorithm.
2. To perform interlace scanning, color conversion and chroma subsampling on videos.
3. Conversion of videos into standard formats, deinterlacing, vertical interpolation, temporal interpolation and 3:2 Pull-Down.
4. To perform low-pass and high-pass filtering on images.
5. To transform image into frequency domain and back to time domain.
6. To apply DCT on images and IDCT on transformed images.
7. To perform motion estimation and compensation on integer pixels.
8. To perform sub-pixel motion estimation.
9. To apply DWT on images and IDWT on transformed images.
10. To compress image using Huffman coding technique and compute the compression ratio.
11. To implement JPEG compression technique.
12. To implement Video Codec using block based motion estimation and compensation.

	Program Outcomes											
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	0	1	0	0	1	0	0	0
CO2	3	3	0	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	1	0	1	2	0	1
CO4	3	3	3	3	3	1	1	0	1	2	0	1
CO5	3	3	3	3	3	1	1	0	1	1	0	1

Course Title: Advanced Digital signal processing and Wavelets

Course Code:	ECL 411	**Course Title:**	Advanced Digital signal processing and Wavelets			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Analyze multirate DSP systems.
2. Determine coefficients for perfect reproduction filter banks and wavelets.
3. Choose parameters to take a wavelet transform, and interpret and process the result.
4. Analytical Solution for real time solutions using wavelet techniques.
5. Designing of digital signal processing system for image and video compression

Course Contents:

Module I:
Introduction: Origin of Wavelets Haar Wavelet Dyadic Wavelet Dilates and Translates of Haar Wavelets L2 norm of a function.

Module II:
Equivalence of functions & sequences Angle between Functions & their Decomposition Additional Information on Direct-Sum Introduction to Filter Bank Haar Analysis Filter Bank in Z-domain Haar Synthesis Filter Bank in Z-domain.

Module III:
Moving from Z-domain to frequency domain Frequency Response of Haar Analysis Low pass Filter bank Frequency Response of Haar Analysis High pass Filter bank Ideal Two-band Filter bank Disqualification of Ideal Filter bank Realizable Two-band Filter bank Demonstration: DWT of images.

Module IV:
Relation Fourier transform of Scaling function to filter bank, Fourier transform of scaling function, Construction of Scaling and Wavelet function, Demonstration of scaling and wavelet functions.

Module V:
Applications: Speech, audio, image, and video compression, Signal denoising, Feature extraction, Inverse problems

Text Book:

1. M. Vetterli, and J. Kovacevic, Wavelets and Subband Coding, 2nd Ed., Prentice Hall, , 1995.
2. S. Mallat, A Wavelet Tour of Signal Processing, 2nd Ed., Academic Press, Elsevier, 1999.

Reference Book:

1. J. C. Goswami, and A. K. Chan, Fundamentals of Wavelets: Theory, Algorithms, and Applications, 2nd Ed., John Wiley & Sons, Inc., 2011.

2. B.B. Hubbard, The World according to Wavelets - A Story of a Mathematical Technique in the Making, 2nd Ed., Universities Press (Private) India Limited, 2003.

3. G. Strang, and T. Q. Nguyen, Wavelets and Filter Banks, Wellesley-Cambridge Press, Revised ed., 1997.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Implementation of Haar Wavelet and decomposition of the signal using Haar.
2. Study of Upsampling and Downsampling operations.
3. Design of quadrature mirror filter bank (QMF) Using FIR Filter.
4. Edge detection using Wavelets.
5. Image denoising using Wavelets.
6. Image compression using Wavelets.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	0	0	0	0	1	0	0	0
CO2	3	3	0	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	2	0	1
CO4	3	3	3	3	3	0	0	0	1	2	0	1
CO5	3	3	0	3	3	1	1	0	1	1	0	1

Course Title: Adaptive Signal Processing

Course Code:	ECL 414	**Course Title:**	Adaptive Signal Processing			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To gain the importance of signal processing in non stationary environment through various applications and to understand the basics of adaptive filters as a means for adaptive signal processing.
2. To develop the understanding of mathematical modelling of various adaptive filters.
3. To develop the understanding of various error (cost) functions
4. To develop the understanding of various error minimization schemes.
5. To extend the knowledge gained about adaptive filter theory to some signal processing applications.

Course Contents:

Module I:
Introduction to Adaptive Filters: Adaptive filters, filter structures, cost functions, applications etc.

Module II:
Stationary Processes and Models: Mean Ergodic theorem, correlation matrix and its properties, stochastic models, the eigen analysis.

Module III:
Wiener Filters: Principle of orthogonally, minimum mean-squared error (MMSE), Wiener-Hopf equations, MMSE cost function, linearly constrained minimum variance filter.
Linear Prediction: Forward and backward linear prediction, Levinson algorithm, lattice filters and their properties, joint process estimation.

Module IV:
Stochastic Methods: Steepest-descent algorithm, its stability and transient behavior, Least Mean Square (LMS) algorithm, properties of LMS, Eigen System decomposition. Gradient search technique, Recursive LMS (RLMS) algorithm.
Least Square Methods: Least squares and orthogonally, Recursive least squares (RLS) algorithms, properties of RLS.

Module V:
Mathematical modelling of adaptive filter theory for various practical applications.

Text Book:

1. S. Haykin, Adaptive Filter Theory, 5th Ed., Pearson, 2014.

Reference Book:

1. J.R. Treichler, C. R. Johnson Jr., M.G. Larimore, Theory and Design of Adaptive Filters, 1st Ed., Prentice Hall Inc., 2001.
2. B. Widrow, and S.D. Stearns, Adaptive Signal Processing, Prentice Hall-PTR, 1985.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To perform basic signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation and Frequency analysis in MATLAB
2. To implement FIR and IIR filters in MATLAB
3. Design and demonstration of Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering.
4. Implementation of wiener filter for signal denoising
5. Estimation of MMSE cost function
6. Implementation of gradient search technique
7. Implementation of gradient descent algorithm
8. Implementation of least mean square algorithm
9. Implementation of recursive least mean square algorithm
10. Estimation of system transfer function using adaptive filtering

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	0	0	0	1	0	0	0
CO2	3	3	2	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	0	0	1
CO4	3	3	3	3	3	0	0	0	1	0	0	1
CO5	3	3	3	3	3	1	1	0	1	1	0	1

Course Title: Coding Techniques

Course Code:	ECL 439	**Course Title:**	Coding Techniques			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To understand the mutual information and channel capacity.
2. To Illustrate source coding and channel coding techniques.
3. To Examine the channel performance using information theory.
4. Mathematically formulate the error correction codes.
5. Design a digital communication system using appropriate error correcting codes.

Course Contents:

Module I:
Information Theory and Source Coding 7L Introduction to information theory, Entropy and its properties, Source coding theorem, Huffman coding, Shannon-Fano coding, The Lempel Ziv algorithm, Run Length Encoding, Discrete memory less channel, Mutual information, Examples of Source coding-Audio and Video Compression.
Case Study: Huffmans coding in image compression/Detail overview of JPEG.

Module II:
Information Capacity and Channel Coding 8L Channel capacity, Channel coding theorem, Differential entropy and mutual Information for continuous ensembles, Information Capacity theorem, Linear Block Codes: Syndrome and error detection, Error detection and correction capability, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes, Repetition codes and dual codes, Hamming code, Golay Code, Interleaved code.
Case Study: Shannon's Publications on information theory.

Module III:
Cyclic Codes 8L Galois field, Primitive element & Primitive polynomial, Minimal polynomial and generator polynomial, Description of Cyclic Codes, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Circuit implementation of cyclic code. BCH and RS Codes 7L Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes, Cyclic Hamming code and Golay code, CRC code, FEC and ARQ systems.
Case Study: RS Coding in CD recording. Case Study: CRC used in Ethernet LAN.

Module IV:
Convolutional Codes 7L Introduction of convolution code, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Sequential decoding and Viterbi decoding, Known good convolution code, Introduction to LDPC and Turbo codes.

Module V:

Coding and Modulation 8L Goals of a communication System designer, Error Probability plane, Nyquist minimum bandwidth, Shannon Hartley theorem, Bandwidth efficiency plane, Modulation and coding tradeoffs, Defining, designing and evaluating digital communication system. Trellis Coded Modulation: Concept of TCM and Euclidean distance, Asymptotic coding gain, Mapping by set partitioning, Ungerboeck's TCM design rule.
Case Study : TCM used in MODEMs

Text Books:

1. R. Bose, Information Theory, Coding and Cryptography, 2nd Ed. New Delhi, India: McGraw-Hill, 2008.
2. J. C. Moreira and P. G. Farrell, Essentials of Error-Control Coding. Hoboken, NJ, USA: Wiley, 2006.

Reference Books:

1. B. Sklar, Digital Communications: Fundamentals and Applications, 2nd Ed. Upper Saddle River, NJ, USA: Pearson Education, 2001.
2. S. Haykin, Communication Systems, 4th Ed. Hoboken, NJ, USA: John Wiley & Sons, 2001.
3. S. Lin and D. J. Costello, Error Control Coding: Fundamentals and Applications, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2004.
4. T. K. Moon, Error Correction Coding: Mathematical Methods and Algorithms. Hoboken, NJ, USA: Wiley, 2005.
5. K. Sayood, Introduction to Data Compression, 3rd ed. San Francisco, CA, USA: Morgan Kaufmann, 2006.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To build a Huffman code from a list of probability
2. To design a convolutional encoder and Decoder
3. To implement linear block code
4. To implement encoding and decoding of data using LBC
5. To study Huffmans coding in image compression/Detail overview of JPEG.
6. To build a Huffman code from a list of probability
7. To build a Shannon-Fano coding from a list of probability
8. To study Shannon's Publications on information theory.
9. Case Study: RS Coding in CD recording. Case Study: CRC used in Ethernet LAN.
10. For a given matrix find out Syndrome and error detection, Error detection and correction capability,
11. Case Study : TCM used in MODEMs

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	0	0	0	1	0	0	0	0	0	2
CO2	3	3	2	2	0	0	0	0	0	0	0	1
CO3	3	2	2	2	0	1	0	0	0	1	0	1
CO4	3	2	3	3	2	0	0	0	0	0	0	2
CO5	3	3	3	3	2	0	0	0	0	0	0	2

Course Title: Wireless Sensor Networks

Course Code:	ECL 432	**Course Title:**	Wireless Sensor Networks			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Familirize with the WSN
2. Understanding issues with MAC protocols in WSN
3. Understnanding data transmission protocols associated with WSN
4. Able to apply QoS parameters in WSN for different applications.
5. Capability to design node architecture.

Course Contents:

Module I:
Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile AdhocNETworks (MANETs) and Wireless Sensor Networks,

Module II:
Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks: routing protocols; MAC protocols; Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol.

Module III:
IEEE 802.15.4 standard and ZigBee, Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network;

Module IV:
Real-time traffic support and security protocols. Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, Internet to WSN Communication.

Module V:
Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.

Text Books:

1. W. Dargie and C. Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice. Hoboken, NJ, USA: John Wiley & Sons, 2010.
2. P. Levis and D. Gay, TinyOS Programming. Cambridge, U.K.: Cambridge Univ. Press, 2009.

Reference Books:

1. S. Soloman, Sensors Handbook. New York, NY, USA: McGraw-Hill, 1996.
2. F. Zhao and L. Guibas, Wireless Sensor Networks: An Information Processing Approach. San Francisco, CA, USA: Elsevier/Morgan Kaufmann, 2004.
3. K. Sohraby, D. Minoli, and T. Znati, Wireless Sensor Networks: Technology, Protocols, and Applications. Hoboken, NJ, USA: Wiley-Interscience, 2007.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Create a sample wireless topology using Simulation Tool.
2. Create a mobile Ad-hoc networks using Simulation Tool.
3. Implement an Ad-hoc On-demand Distance Vector protocol using Simulation Tool.
4. Implement a Transmission Control Protocol using Simulation Tool.
5. Implement an User Datagram Protocol using Simulation Tool.
6. Implement a Low Energy Adaptive Hierarchy protocol using Simulation Tool.
7. Implement a Power Efficient Gathering in Sensor Information System using Simulation Tool. Implement a Sensor Protocol for Information via Negotiation (SPIN) using Simulation Tool.
8. Implementation of Single node architecture for sensing, processing and communication.
9. Any one application architecture using WSN.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	0	0	0	1	0	0	1
CO2	3	3	2	1	3	0	0	0	2	1	0	1
CO3	3	2	2	2	2	0	0	0	1	0	0	1
CO4	3	3	3	2	3	0	0	0	2	1	0	1
CO5	3	2	2	1	2	0	0	0	1	0	0	1

Course Title: Biomedical Signal Processing

Course Code:	ECL 459	**Course Title:**	Biomedical Signal Processing			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Prerequisite (if Any)	Signals and Systems	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To understand the principle of different medical imaging modalities.
2. To understand basic operations on deterministic signals.
3. To study algorithms for biomedical image processing.
4. To study random signals from the point of view of statistical and probabilistic properties
5. Computer vision applications related to the biomedical domain.

Course Contents:

Module I:
Biomedical Signals and Images:
ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications. Speech Signals: The source-filter model of speech production, spectrographic analysis of speech. Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders. Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT. MRI: Physics and signal processing for magnetic resonance imaging. Surgical Applications: A survey of surgical applications of medical image processing.

Module II:
Fundamentals of Deterministic Signal:
Data Acquisition: Sampling in time, aliasing, interpolation, and quantization.
Digital Filtering: Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution. DTFT: The discrete-time Fourier transform and its properties. FIR filter design using windows. DFT: The discrete Fourier transform and its properties, the fast Fourier transform (FFT), the overlap-save algorithm, digital filtering of continuous-time signals. Sampling Revisited: Sampling and aliasing in time and frequency, spectral analysis.

Module III:
Basic Image processing
Image processing I: Extension of filtering and Fourier methods to 2-D signals and systems.
Image processing II: Interpolation, noise reduction methods, edge detection, homomorphic filtering.

Module IV:
Probability and Random Signals:
PDFs: Introduction to random variables and probability density functions (PDFs).
Classification: Bayes' rule, detection, statistical classification. Estimating PDFs: Practical techniques for estimating PDFs from real data. Random signals I: Time averages, ensemble averages, autocorrelation functions, cross correlation functions. Random signals II: Random signals and linear systems, power spectra, cross spectra, Wiener filters. Blind source

separation: Use of principal component analysis (PCA) and independent component analysis (ICA) for filtering.

Module V:
Image Segmentation and Registration:
Image Segmentation: statistical classification, morphological operators, connected components. Image Registration I: Rigid and non-rigid transformations, objective functions. Image Registration II: Joint entropy, optimization methods.

Text Books:

1. E.N. Bruce, Biomedical Signal Processing and Signal Modelling, 1st Ed., Wiley Series in Telecommunications and Signal Processing, 2001.

Reference Books:

1. D.C. Reddy, Biomedical Signal Processing: Principles and Techniques, 1st Ed., Mc Graw Hill, 2005.
2. K. Najarian, and R. Splinter, Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To read and plot sequences of ECG and speech signals.
2. To read and show dicom medical images of different modalities.
3. To perform 1-D and 2-D convolutions on a set of signals.
4. To perform discrete Fourier and inverse Fourier transformation on 1-D and 2-D signals.
5. To implement noise reduction and edge detection filtering on images.
6. To perform statistical analysis of data.
7. To implement principal component analysis and Independent component analysis of signals
8. To implement some algorithms for registration of images of different modalities such as CT and MRI.
9. To perform statistical and bayesian classification on a set of biomedical signal data.
10. To plot different objective functions and perform some basic optimization techniques.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	0	0	0	0	0	0	0	0
CO2	3	3	0	3	3	1	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	2	0	1
CO4	3	3	3	3	3	1	0	0	0	2	0	1
CO5	3	3	0	0	3	1	1	0	1	0	0	1

Course Title: Devices and Modelling

Course Code:	ECL 314	**Course Title:**	Devices and Modelling			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

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

1. Explain the fundamental principles of semiconductor materials and carrier transport mechanisms.

2. Analyze junction devices and their characteristics, including breakdown, Schottky barriers, and heterojunctions.

3. Analyze MOSFET operation and apply basic modeling techniques to evaluate device behavior under various conditions.

4. Explore advanced solid-state devices and assess their potential applications in modern electronics.

5. Analyze semiconductor device structures and behavior using modeling tool.

Course Contents:

Module 1:
Crystal structures, atoms and electrons, photoelectric effect, quantum mechanics, Energy bands in solids (Metal, Insulator, Semiconductor), Band slicing, E-K diagram, DOS, Carrier statics, transport of carrier, carrier drift, diffusion, generation and recombination, continuity equation, thermoinic emission, tunneling, ballistic transport.

Module 2:
Equilibrium condition, contact potential, equilibrium fermi level, space charge at junction breakdown, current flow at junction, Reverse bias breakdowns, Zener and avalanche breakdown, Schottky Barrier and ohmic contacts, switching diodes, diode capacitance, Rectifying contacts, Heterojunctions.

Module 3:
MOS Devices: Energy band diagram, equilibrium and under bias, Flat band voltage, potential balance, effect of gate body voltage, Regions: Accumulation , depletion, inversion, Modelling of MOS, effective mobility, Level 1 models, Modelling with different phenomenons: temperature effects, short channel effects, carrier velocity saturation, channel length modulation, DIBL, GIDL, Punch through phenomenon, Junction and oxide capacitances.

Module 4:
Junctionless transistors and FinFETs, Tunnel FETs, HEMTs, and power electronic devices, Optoelectronic devices: Photodetectors and quantum well devices, Introduction to device simulation and TCAD modeling, Future trends in nanoelectronics and semiconductor devices.

Module 5:

Introduction to SPICE Simulation, Analysis of complex electronic circuits, simulation and analysis using SPICE, AC/DC operation, DC sweep transfer function, frequency response, feedback control analysis, transient response, device models, simulation and analysis of electronic circuits and systems

Text Books:

1. S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd Ed. Hoboken, NJ, USA: Wiley-Interscience, 2006.

2. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 7th Ed. Boston, MA, USA: Pearson, 2015.

Reference Books:

1. K. Hess, Advanced Theory of Semiconductor Devices. New York, NY, USA: IEEE Press, 2000.
2. Y. Taur and T. H. Ning, Fundamentals of Modern VLSI Devices, 2nd Ed. Cambridge, U.K.: Cambridge University Press, 2009.

3. Y. Tsividis and C. McAndrew, Operation and Modeling of the MOS Transistor, 3rd Ed. Oxford, U.K.: Oxford University Press, 2011.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Analysis of band Structure of Silicon bulk.
2. Analysis of band Structure of Germanium bulk.
3. Analysis of Density of states of Silicon bulk.
4. Analysis of Density of states of Germanium bulk.
5. Analysis of band Structure and DOS of Compound Semiconductor (Two materials).
6. Analysis of band Structure and DOS of Compound Semiconductor (Three materials)l.
7. Band Structure Plot of Junction Semiconductor (PN).
8. Analysis of spice model of MOSFET.
9. Analysis of spice model of MOSFET.
10. To construct and simulate various semiconductor devices using tools such as PSPICE/multisim.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	0	0	1	1	1	0	2
CO2	3	3	2	2	2	0	0	1	1	1	0	2
CO3	3	3	3	2	3	0	0	1	1	1	0	2
CO4	3	2	3	2	2	0	0	1	1	1	0	2
CO5	3	3	3	3	3	0	0	1	1	1	0	2

Course Title: Computer Communication Network

Course Code:	ECL 410	**Course Title:**	Computer Communication Networks			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. This course provides students with an overview of the concepts and fundamentals of data communication and computer networks.
2. Through the course, students will be able to understand the fundamental concepts of computer networking and familiar with the basic taxonomy and terminology of the computer networking area.
3. The student will understand TCP/IP and ISO OSI network layer.
4. The students will understand LAN, WAN, MAN and VLAN and study various layer functions.
5. The course introduces the student to advanced networking concepts and gains expertise in some specific areas of networking such as the design and maintenance of individual networks.

Course Contents:

Module I:
Networks and services; network topologies; switching methods; network evolution; concept of layered architecture; the OSI model; the TCP/IP model; standardization and standards organizations.Study of telephone network; PCM-TDM based IDN; circuit switching; space and time division switching; signaling methods; store-and-forward switching. ISDN fundamentals; SS#7; Frame relay and ATM networks; SONET and SDH; LANs and MAC protocols.

Module II:
ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture.

Module III:
Network Layer: services offered to the transport layer, internal organization as datagram or virtual circuit subnets; routing algorithms; congestion control; internetworking; Study of IPv4 and IP v6, DNS and Internet routing protocols.

Module IV:
Transport Layer: Design issues; study of TCP; connection setup and removal; flow control; reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc. Network applications: World Wide Web and HTTP; Web servers and browsers, Content Engines; FTP and TFTP; SMTP and MIME; DNS; multimedia networking; streaming stored audio and video; Internet audio and video communications.

Module V:
Network Security: Principles of cryptography; authentication; integrity, key distribution and certification; secure e-mail; Fire-walls Network management: issues in network management; infrastructure for NM, MIB, SNMP, RMON, ASN1

Text Books:

1. A.S.Tanenbaum, Computer networks. Pearson Education India, 4th Ed,. PHI, 2003.
2. A.B. Forouzan, Data communications and networking. Huga Media, 4th Ed., TMH, 2007.

Reference Books:

1. J.F. Kurose, Computer networking: A top-down approach featuring the internet, 3/E. Pearson Education India, 2005.
2. A.M. Gallo, and H.M. William, Computer communications and networking technologies. Brooks/Cole Publishing Co., 2002.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Client server application for chat
2. Connecting the computers in the Local Area Network.
3. To perform initial switch configuration
4. To perform initial router configuration
5. PC to PC file transfer using serial port
6. Implementation of shortest path routing
7. Implementation of Open Shortest Path First Protocol
8. Observing Static and Dynamic Routing
9. Configuring and Troubleshooting a Switched Network
10. Implementation of IP address configuration
11. Exploring Different LAN Switch Options

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	0	1	2	0	0	0	0	1	0	2
CO2	3	2	2	2	2	0	0	0	0	1	0	2
CO3	3	2	3	2	2	1	0	0	0	1	1	2
CO4	3	3	2	3	3	0	0	0	0	1	1	2
CO5	2	3	2	3	3	0	0	0	0	2	1	3

Course Title: Statistical Signal Analysis

Course Code:	ECL 437	**Course Title:**	Statistical Signal Analysis			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To understand the concept of estimation theory.
2. To understand the concept of detection theory.
3. Able to design statistical signal processing systems.
4. To design estimators for various signal processing and communication problems
5. To design a parametric model with optimal model parameters.

Course Contents:

Module I:
Probability Theory: Review of probability, Sample space, Algebra and random variable, Distribution and densities, Characteristics functions and moment generating functions, Transformation (function) of random variables; Conditional expectation.

Module II:
Sequences of random variables: convergence of sequences of random variables, Statistical Independence, Uncorrelation of Random Variables, Joint and Marginal Densities Function of random variables.

Module III:
Stochastic processes: wide sense stationary processes, orthogonal increment processes, Wiener process, Ergodicity, Mean square continuity.

Module IV:
Stochastic Calculus: mean square derivative and mean square integral of stochastic processes.

Module V:
Stochastic systems: response of linear dynamic systems to stochastic inputs correlation function; power spectral density function; introduction to linear least square estimation, Least square and mean square error.

Text Book:

1. A. Papoulis, and S.U. Pillai, Probability Random Variables and Stochastic Processes, 4th ed., Mc Graw Hill, 2002.

Reference Book:

1. A. Larson and B.O. Schubert, Stochastic Processes, Vol. I and II, Holden-Day, 1979.
2. A.L. Gracia, Probability and Random Processes for Electrical Engineer, 3rd Ed. Pearson Education, Inc., 2008.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. To study Basics of Random Signals and Probability Analysis
2. To perform Signal Estimation
3. To perform Scalar Parameter Cramer-Rao Lower Bound
4. To perform Vector Parameter Cramer-Rao Lower Bound
5. To perform Maximum-Likelihood Estimation
6. To perform Bayesian Estimation
7. To design and perform Kalman Filtering
8. Introduction to Signal Detection
9. To detect the Deterministic Signals
10. To detect the Random Signals

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	3	3	0	1	0	1	0	0	1
CO2	3	3	0	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	2	0	1
CO4	3	3	3	3	3	0	0	0	1	2	0	1
CO5	3	3	0	0	3	1	1	0	1	0	0	1

Course Title: Computer Vision

Course Code:	ECL 441	**Course Title:**	Computer Vision			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	NIL	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply development flow for designing a Computer Vision system.
2. Demonstrate the ability to select and perform suitable image and video processing followed by post processing operations as required by Computer Vision system.
3. Identify suitable processing device for CV as per the application.
4. Rectify algorithmic steps to improve accuracy of Computer Vision system.
5. Manage resources for different tasks in Computer Vision system.

Course Contents:

Module I:
Camera Geometry: Introduction, Homogenous Coordinate system, Epipolar Geometry. Camera Calibration: Monocular & Binocular Vision, Camera matrices, Camera calibration

Module II:
Depth information in binocular vision: perception of depth in binocular vision, 3D images usign depth information.

Module III:
Motion Estimation: Motion estimation and compensation. Case Study: Optical flow and applications.

Module IV:
Image Features: Edge, Corners, Blob, Ridge features. Case Study: Histogram of oriented gradients (HoG).

Module V:
Learning in Computer Vision: Introduction to Machine learning, Adaboost learning (Face detection), Deep learning based object detection and recognition.

Text Book:

1. R. Szeliski, Computer Vision: Algorithms and Applications, 2nd Ed., Springer, 2010.

Reference Book:

1. T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning, 2nd Ed., Springer Series in Statistics, 2009.
2. D. Forsyth, and J. Ponce, Computer Vision: A Modern Approach, 2nd Ed., Pearson Education, Inc., 2012.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any) :

1. Introduction to CPU, GPU, Cloud processing in context to Computer Vision.
2. Calibrate a camera and find camera parameters and matrices.
3. Calibrate stereo camera (Binocular vision) and find stereo parameters.
4. Generate 3D point cloud using Binocular Vision i.e using two cameras.
5. Track an object by estimating its motion in video sequence
6. Develop feature extraction algorithm (ex. Histogram of Oriented Gradients)
7. Add feature information along with its motion to track an object in video sequence
8. Develop face detection algorithm (Ref. Viola Jones face detector)
9. Object detection using deep learning algorithms in python framework and libraries
10. Object recognition using deep learning algorithms in python framework and libraries.

Program Outcomes												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO-1	3	2	2	1	1	0	0	0	0	0	1	2
CO-2	3	3	3	1	1	0	0	0	0	0	1	2
CO-3	3	3	3	3	1	0	0	0	1	0	2	2
CO-4	3	3	3	3	2	0	0	1	2	2	3	2
CO-5	3	3	3	3	2	0	0	1	3	3	3	2

Course Title: Robotics

Course Code:	BEL 403	**Course Title:**	Robotics			
Category:	Departmental Elective (DE)	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	NIL	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply knowledge of robotics for understanding, formulating and solving engineering problems.
2. Acquire knowledge and hands-on competence in applying the concepts in the design and development robots
3. Demonstrate creativeness in designing and development of robotics.
4. Identify, analyze and design of robots useful to the society.
5. Work effectively with multidisciplinary robots.

Course Contents:

Module I:
Introduction Fixed & flexible automation, evolution of robots and robotics, laws of robotics, progressive, advancement in robots, manipulator anatomy, arm configuration & work space, human arm characteristics, design and control issues, manipulation and control, actuators, sensors and vision, programming of robots, applications – material handling, processing applications, assembly applications, inspection applications etc, the future prospects, notations.

Module II:
Coordinate Frames, Mapping and Transforms Coordinate frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices. mechanical structure and notations, description of links and joints, kinematic modeling of the manipulator, Denavit – Hartenberg notation, kinematic relationship between adjacent links, manipulator transformation matrix.

Module III:
Kinematic Modeling of Robots Position analysis - direct and inverse kinematic models of robotic manipulators, various examples. velocity analysis – Jacobian matrix, introduction to inverse kinematic model.

Module IV:
Robotic Sensors and Vision Introduction regarding sensing technologies, sensors in robotics, classification, characteristics, internal sensors – position, velocity, acceleration sensors, force sensors, external sensors – proximity, touch and slip sensors. robotic vision, process of imaging, architecture of robotic vision systems, image acquisition, components of vision system, image representation, image
processing.

Module V:
Motion Planning and Control of Robot Manipulators Trajectory planning of robotic manipulator: joint space and Cartesian space techniques. open and close loop control, linear control schemes, examples of control models. Robot applications Industrial applications,

material handling, processing applications, assembly applications, inspection application, principles for robot application and application planning, justification of robots, robot safety, non-industrial applications, robotic application for sustainable development.

Text Books:

1. R. K. Mittal and I. J. Nagrath, Robotics and Control. New Delhi, India: Tata McGraw-Hill, 2003.
2. S. B. Niku, Introduction to Robotics: Analysis, Systems, Applications, 2nd Ed. Upper Saddle River, NJ, USA: Pearson, 2010.

Reference Books:

1. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations. New Delhi, India: Prentice-Hall of India, 2005.
2. R. S. Hartenberg and J. Denavit, Kinematic Synthesis of Linkages. New York, NY, USA: McGraw-Hill, 1964.
3. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, Robotics: Control, Sensing, Vision, and Intelligence. New York, NY, USA: McGraw-Hill, 1987.
4. R. D. Klafter, T. A. Chmielewski, and M. Negin, Robotic Engineering: An Integrated Approach. New Delhi, India: Prentice-Hall of India, 1989.
5. S. K. Saha, Introduction to Robotics. New Delhi, India: McGraw-Hill, 2008.
6. J. J. Craig, Introduction to Robotics: Mechanics and Control, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2005.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Introduction to CPU, GPU, Cloud processing in context to Computer Vision.
2. Calibrate a camera and find camera parameters and matrices.
3. Calibrate stereo camera (Binocular vision) and find stereo parameters.
4. Generate 3D point cloud using Binocular Vision i.e using two cameras.
5. Track an object by estimating its motion in video sequence
6. Develop feature extraction algorithm (ex. Histogram of Oriented Gradients)
7. Add feature information along with its motion to track an object in video sequence
8. Develop face detection algorithm (Ref. Viola Jones face detector)
9. Object detection using deep learning algorithms in python framework and libraries
10. Object recognition using deep learning algorithms in python framework and libraries

Course Title: Artificial Intelligence

Course Code:	CSL 421	**Course Title:**	Artificial Intelligence			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Apply and implement various search techniques to solve real world problems
2. Apply algorithms for designing games and solving constraint satisfaction problem
3. Represent knowledge using formal logic and apply algorithms to deuce conclusion
4. Design and develop practical algorithms for solving planning and uncertainty problems

Course Contents:

1. Introduction: What is AI? , History, Overview, Intelligent Agents, Performance Measure, Rationality, Structure of Agents, Problem-solving agents, Problem Formulation, Uninformed Search Strategies
2. Informed (Heuristic) Search and Exploration, Greedy best first search, A* search, Memory bounded heuristic search, Heuristic functions, inventing admissible heuristic functions, Local Search algorithms, Hill-climbing, Simulated Annealing, Genetic Algorithms, Online search
3. Constraint Satisfaction Problems, Backtracking Search, variable and value ordering, constraint propagation, intelligent backtracking, local search for CSPs, Adversarial Search, Games, The minimax algorithm, Alpha-Beta pruning, Imperfect Real-Time Decisions, Games that include an Element of Chance.
4. Knowledge Based Agents, Logic, Propositional Logic, Inference, Equivalence, Validity and Satisfiability, Resolution, Forward and Backward Chaining, DPLL algorithm, Local search algorithms, First Order Logic, Models for first order logic, Symbols and Interpretations, Terms, Atomic sentences, complex sentences, Quantifiers, Inference in FOL, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution
5. Planning, Language of planning problems, planning with state-space search, forward and backward state-space search, Heuristics for state-space search, partial order planning, planning graphs, planning with propositional logic
6. Uncertainty, Handing uncertain knowledge, rational decisions, basics of probability, axioms of probability, inference using full joint distributions, independence, Baye's Rule and conditional independence, Bayesian networks, Semantics of Bayesian networks, Exact and Approximate inference in Bayesian Networks

Text Books:

1. S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2003.

2. D. W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2004.

Reference Books:

1. E. Rich, K. Knight, and S. B. Nair, Artificial Intelligence, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2009.
2. N. J. Nilsson, Artificial Intelligence: A New Synthesis. San Francisco, CA, USA: Morgan Kaufmann, 1998.
3. W. Ertel, Introduction to Artificial Intelligence, 2nd ed. Cham, Switzerland: Springer, 2017.

Course Title: Machine Learning

Course Code:	CSL 422	**Course Title:**	Machine Learning			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Understand the working of various supervised and unsupervised machine learning models
2. Apply classification and regression models to solve real world problems.
3. Apply unsupervised learning to solve real world problems.
4. Evaluate the performance of various machine learning models.

Course Contents:

Module I:
Introduction to ML, Linear Regression, Logistic Regression, Inductive Classification

Module II:
Decision Trees: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning

Module III:
Artificial Neural Networks: Neurons and biological motivation. Linear threshold units.
Perceptrons: representational limitation and gradient descent training. Multilayer networks and Backpropagation.

Module IV:
SVM, Multiclass & Ordinal Classification, Kernel Methods, Bayesian Learning: Naive Bayes learning algorithm. Parameter smoothing. Bayes nets and Markov nets for representing dependencies. Hidden Markov Model, and Bayesian networks

Module V:
Clustering and unsupervised learning: Clustering. Hierarchical Aglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labelled and unlabelled data.

Module VI:
Evaluating hypothesis: Training and test splits, k-fold cross validation, confusion matrix, Estimating hypothesis accuracy, sample and true error.

Text Books:

1. T. M. Mitchell, Machine Learning. New York, NY, USA: McGraw-Hill, 1997.
2. E. Alpaydin, Introduction to Machine Learning, 3rd ed. New Delhi, India: PHI Learning, 2016.

Reference Books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. C. Bishop. Pattern Recognition and Machine Learning. 2e, 2006.
3. R. O. Duda, P.E. Hart, D. G. Stork. Pattern classification, Wiley, New York, 2001.

Course Title: Introduction to Object Oriented Programming

Course Code:	CSL 202	**Course Title:**	Introduction to Object Oriented Programming			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)		**Type of Course**	Computer Science Engineering			

Course Outcomes:

1. Understand the necessity of encapsulation, data hiding, inheritance, and exception handling.
2. Formulate a software application and propose an object oriented design.
3. Write generic programs using the standard template library.
4. Study and use design tools like UML, design patterns etc.

Course Contents:

Module I:
Object Oriented Programming, Features of object oriented programming languages like data encapsulation, inheritance, polymorphism and late binding.

Module II:
Concept of a class, Access control of members of a class, instantiating a class, static and non-static members, overloading a method.

Module III:
Deriving a class from another class, access control of members under derivation, different ways of class derivation, overriding of a method, run time polymorphism.

Module IV:
Concept of an abstract class. Concept of an interface. Implementation of an interface.

Module V:
Exception and exception handling mechanisms. Study of exception handling mechanisms in object-oriented languages

Module VI:
Introduction to streams, use of stream classes. Serialization and de-serialization of objects.

Module VII:
Templates, Implementation of data structures like linked lists, stacks, queues, trees, graphs, and hash table etc. using object oriented programming languages.

Module VIII:
Introduction to concept of refactoring, modelling techniques like UML, Design patterns.

Text Books:

1. B. Stroustrup, The C++ Programming Language, 4th ed. Boston, MA, USA: Addison-Wesley, 2013.
2. H. Schildt, C++: The Complete Reference, 4th ed. New Delhi, India: McGraw-Hill, 2003.

Reference Books:

1. K. Arnold, J. Gosling, and D. Holmes, The Java Programming Language, 4th ed. Boston, MA, USA: Addison-Wesley, 2005.
2. M. Weisfeld, The Object-Oriented Thought Process, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2013.
3. B. Cox, Object-Oriented Programming: An Evolutionary Approach, 2nd ed. Reading, MA, USA: Addison-Wesley, 1987.

Course Title: Estimation Theory of Signals and Systems

Course Code:	ECL 453	**Course Title:**	Estimation Theory of Signals and Systems			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To understand the concept of random variables and random process .
2. To understand the concept of Estimation and Detection.
3. Implement the system identification using a system model.
4. Design the dynamic system according to the behaviour of input.
5. Implement the estimator using the filter model.

Course Contents:

Module I:
Introduction, Probability Theory, Random Variables, Function of Random Variable Joint Density, Mean and Variance, Random Vectors, Random Processes, Random Processes and Linear Systems.

Module II:
Linear Mean Square Error Estimation, Autocorrelation and Power Spectrum Estimation, z-Transform Revisited, Eigenvectors and Eigenvalues, The Concept of Innovation, Linear Minimum Mean Square Estimation, Least Squares Estimation, Optimal IIR Filters, Introduction to Adaptive Filters.

Module III:
State Estimation, Kalman Filter Model and Derivation, Estimator Properties - Algebraic and Probabilistic, The Time Invariant Kalman Filter, Kalman Filter Coloured Noise, Kalman Filter - Case Study.

Module IV:
Linear Regression Recursive Least Squares, Variants of Least Squares Estimation, Least Squares Estimation, Model Order Selection Residual Tests, Practical Issues in Identification Dynamic.

Module V:
Case Study: Stochastic Processes: Stationarity, Ergodicity, Second-order theory, Estimation Problems in Instrumentation and Control.

Text Books:

1. B. Hajek, Random Process For Engineers, 1st ed., Cambridge University Press, 2015.
2. J.L. Speyer, and W.H Chung, Stochastic Processes, Estimation and Control, SIAM Publications, 2008.

Reference Books:

1. G. Grimmett, and D. Stirzaker, Probability and Random Processes, 3rd Ed., Oxford University Press, 2001.
2. P.R. Kumar, and Pravin Variaya, Stochastic Systems: Estimation, Identification, and Adaptive Control, SIAM Publications, 2016.
3. L. Ljung, System Identification: Theory for the User, 2nd Ed., Prentice Hall Information and System Sciences Series, 1999.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Overview of MATLAB for Signal Processing.
2. Implement MATLAB code to generate random samples from various probability distributions like Gaussian, uniform, exponential, etc. Visualize the probability density functions and cumulative distribution functions.
3. MATLAB scripts to compute the mean, variance, and other statistical properties of random variables. Generate random vectors and calculate joint probabilities.
4. Develop MATLAB functions to estimate autocorrelation and power spectrum of random signals using different methods like the periodogram or Welch's method.
5. Implement MATLAB functions to compute the z-transform of discrete-time signals and use it to analyze the stability and frequency response of linear systems.
6. Code a MATLAB simulation of the Kalman filter for state estimation in linear dynamic systems and analyze the performance of the Kalman filter under different noise conditions.
7. Implement MATLAB code to perform linear regression using recursive least squares (RLS) and compare it with batch least squares estimation.
8. Develop MATLAB scripts to perform model order selection for system identification using criteria like Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC).
9. Create MATLAB code to identify linear models from input-output data using different identification techniques such as ARX (AutoRegressive with exogenous inputs) or ARMAX (AutoRegressive Moving Average with exogenous inputs).
10. Implement MATLAB functions to analyze stochastic processes for stationarity, ergodicity, and compute second-order statistics like autocorrelation and power spectral density.
11. Implement MATLAB programs to address estimation problems in instrumentation and control, such as sensor calibration and state estimation in dynamic systems.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	3	1	0	0	0	0	0	0
CO2	3	3	0	3	3	1	1	0	1	1	0	1
CO3	3	3	3	3	3	1	0	0	1	2	0	1
CO4	3	3	3	0	3	1	1	0	0	2	0	1
CO5	3	0	0	0	3	1	1	0	1	0	0	1

Course Title: Deep Learning for Computer Vision

Course Code:	ECL 454	**Course Title:**	Deep Learning for Computer Vision			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Conceptualize computer vision and deep learning to mimic human visual system.
2. Understand individual components computer vision and deep learning.
3. To estimate the requirements and choose pre-processing and deep neural model for the system.
4. To analyze and troubleshoot the deep learning model for computer vision system
5. To design a complete computer vision systems using deep learning.

Course Contents:

Module I:

Introduction and Overview: Introduction to Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution

Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc.

Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow

Deep Learning Review: Review of Deep Learning, Multi-layer Perceptrons, Backpropagation

Module II:

Convolutional Neural Networks (CNNs): Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets

Visualization and Understanding CNNs: Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM,Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad)

Module III:

CNNs for Recognition, Verification, Detection, Segmentation: *CNNs for Recognition and Verification:*Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss. *CNNs for Detection*: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet. *CNNs for Segmentation*: FCN, SegNet, U-Net, Mask-RCNN.

Module IV:

Recurrent Neural Networks (RNNs): Review of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition

Attention Models: Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks

Module V:

Deep Generative Models: Review of (Popular) Deep Generative Models: GANs, VAEs; Other Generative Models: PixelRNNs, NADE, Normalizing Flows, etc

Variants and Applications of Generative Models in Vision: Applications: Image Editing, Inpainting, Superresolution, 3D Object Generation, Security; Variants: CycleGANs, Progressive GANs, StackGANs, Pix2Pix, etc.

Text Book:

1. R. Szeliski, Computer Vision: Algorithms and Applications, 2nd Ed., Springer, 2010.
2. S.J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

Reference Book:

1. I. Goodfellow, Y. Bengio, and Aaron Courville, Deep Learning, Cambridge: The MIT Press, 2016.
2. M. Nielsen, Neural Networks and Deep Learning, Determination Press, 2016.
3. Y. Bengio, Learning Deep Architectures for AI, Now Publishers Inc., 2009.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Implementation of multilayer perceptron network from scratch along with backpropagation.
2. Implementation of basic convolutional, pooling and batch normalization layer.
3. Data handling in deep learning libraries
4. Implementation of VGG Net and AlexNet networks
5. Implementation of recurrent neural networks
6. Implementation of Unet and its variants for image segmentation
7. Implementation of generative adversarial networks and its variants
8. Implementation of YOLO
9. Implementation of Visual Transformers
10. Integrating deep neural network with conventional modelling for image denoising

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	0	0	3	0	0	0	0	0	0	0
CO2	3	3	0	3	3	0	0	0	1	1	0	1
CO3	3	3	3	3	0	1	0	0	1	2	0	1
CO4	3	3	3	0	3	1	1	0	0	2	0	1
CO5	3	0	0	0	3	1	1	0	1	0	0	1

Course Title: Finite Element Methods

Course Code:	BEL 401	**Course Title:**	Finite Element Methods			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Apply knowledge of finite element method for understanding, formulating and solving engineering problems.
2. Acquire knowledge and hands-on competence in applying the concepts finite element method in the analysis of structural and thermal systems.
3. Demonstrate creativeness in designing new systems components and processes in the field of engineering.
4. Work effectively with engineering and science teams as well as with multidisciplinary problems.
5. Apply FEM to real world problems

Course Contents:

Module I:
Formulation of Finite Element Equation starting from governing differential equation, Domain residual and minimization, Weighted residual method, Weak form of weighted residual method, solution of weak form using trial function, piecewise continuous trial function solution, formulation of one dimensional bar element using weak form of weighted residual element

Module II:
Minimization of potential energy, Rayleigh-Ritz method, finite element form of Rayleigh-Ritz method, formulation of bar element and heat transfer element using Rayleigh-Ritz method

Module III:
One dimensional finite element analysis, generic form of total potential for one dimensional case, determination of shape functions for linear bar finite element and quadratic bar finite element, stiffness matrix, one dimensional problems of structure mechanics and heat conduction

Module IV:
Stiffness matrix formulation for beam and frame element, Determination of shape functions and element matrices, Application problems
Two dimensional finite element analysis, simple three node triangular elements, four node rectangular element, six node triangular element, natural coordinates, coordinate transformation, simple two dimensional problems, Gauss Quadrature Technique

Module V:
Finite element analysis for plane stress and plane strain problem, Strain displacement matrix for 2-D elements, two-dimensional integrals. Application problems, Scalar field problems.

Text Books:

1. P. Seshu, Textbook of Finite Element Analysis. New Delhi, India: Prentice-Hall of India, 2003.
2. D. V. Hutton, Fundamentals of Finite Element Analysis. New Delhi, India: Tata McGraw-Hill, 2004.

Reference Book:

1. C. R. Alavala, Finite Element Method: Basic Concepts and Applications. New Delhi, India: PHI Learning, 2008.
2. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, 4th ed. Singapore: Pearson Education, 2011.
3. R. D. Cook, D. S. Malkus, M. E. Plesha, and R. J. Witt, Concepts and Applications of Finite Element Analysis, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, 2002.
4. G. R. Liu and S. S. Quek, The Finite Element Method: A Practical Course, 2nd ed. New York, NY, USA: McGraw-Hill, 2014.
5. S. S. Rao, The Finite Element Method in Engineering, 5th ed. Burlington, MA, USA: Elsevier, 2011.
6. J. N. Reddy, An Introduction to the Finite Element Method, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2005.
7. O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, 6th ed. Oxford, U.K.: Butterworth-Heinemann, 2005.
8. C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, 2nd ed. New Delhi, India: Tata McGraw-Hill, 1994.
9. K. J. Bathe, Finite Element Procedures. Upper Saddle River, NJ, USA: Prentice-Hall, 1996.
10. D. L. Logan, A First Course in the Finite Element Method, 5th ed. Stamford, CT, USA: Cengage Learning, 2011.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Bar element stress, temperature variation using FEM
2. Plate element application
3. 2D FEM modelling and simulation
4. Vibration using FEM
5. 3D finite elements in engineering application
6. Shell elements
7. ANSYS modelling
8. ANSYS meshing
9. ANSYS simulation
10. ANSYS : various application problems

Course Title: Multi-rate and Filter banks

Course Code:	ECL 455	**Course Title:**	Multi-rate and Filter banks			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	ECL 301 Digital Signal Processing	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. Characterize the practical multi-rate system.
2. Determine the mathematical interpretation for decomposition and realization of digital filters.
3. Examine and identify the building blocks in multi-rate system.
4. Classify the signals which are non-stationary.
5. Design of multi-rate system for compression of signals and images.

Course Contents:

Module I:
Introduction to Multirate DSP, Sampling and Nyquist criterion, Signal Reconstruction, Discrete time processing of continuous time signal, Discrete time processing of continuous time signal.

Module II:
Decimator properties, Properties of Upsampler and Down sampler, Fractional sampling rate change, Multiplexer/ demultiplexer interpretation, Noble identities and polyphase decomposition.

Module III:
Introduction to Multirate Filter Banks, Spectral Analysis of Filter Bank, DFT and High-Resolution Spectral Analysis, Trans-multiplexer and Maximally Decimated Filterbanks.

Module IV:
Study of Two-channel filter bank, Introduction to Quadrature Mirror Filters (QMF) and its design, Applications of Multirate.

Module V:
Multi-rate DSP framework for Multi-carrier Modulation, M-channel multicarrier Transceiver, Orthogonal Frequency Division Multiplexing.

Text Books:

1. A.V. Oppenheim, and R.W. Schafer, Digital-Time Signal Processing, 3rd Ed., Prentice Hall Signal Processing Series, 2010.

Reference Books:

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks, 1st Ed., Prentice Hall Inc., 1993.

2. F.J. Harris, Multirate Signal Processing for Communication Systems, Prentice Hall PTR, 2004.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	0	0	0	1	0	0	0
CO2	3	3	2	3	3	0	1	0	1	1	0	1
CO3	3	3	3	3	3	0	0	0	1	0	0	1
CO4	3	3	3	3	3	0	0	0	1	0	0	1
CO5	3	3	0	3	3	1	1	0	1	1	0	1

Course Title: Real Time Operating Systems

Course Code:	ECL 458	**Course Title:**	Real Time Operating Systems (RTOS)			
Category:	Elective	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Computer Architecture and Organization, Embedded systems	**Type of Course**	Electronics and Communications Engineering			

Course Outcomes:

1. Understanding the features of operating systems.
2. Understanding different scheduling approaches of real time systems.
3. Developing the ability to create the real time systems.
4. Implementation of real time system using ARM processor.
5. Develop embedded multitasking application.

Course Contents:

Module I:

Introduction to Operating Systems: Introduction of operating systems, OS structures, types of operating systems, Memory management systems, I/O systems.

Module II:

Introduction to real time computing: Basic structure of a real time system, Characteristics of real time systems - Hard and Soft real time systems, Design Challenges - Performance metrics - Prediction of Execution Time: Source code analysis, IDE and Programming Languages for Real-Time Systems.

Module III:

Scheduling Mechanisms: Understanding Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms- Fault tolerant scheduling.

Module IV:

Case Study: ARM (Cortex- M) [FreeRTOs]

Module V:

Implementation of real time system using ARM controller or simulator.

Text Book:

1. J. W. S. Liu, Real-Time Systems. New Delhi, India: Pearson Education, 2006.
2. C. M. Krishna and K. G. Shin, Real-Time Systems. New York, NY, USA: McGraw-Hill, 1997.

References Books:

1. A. Silberschatz, P. B. Galvin, and G. Gagne, Operating System Concepts, 7th Ed. Hoboken, NJ, USA: Wiley Higher Education, 2005.
2. R. Mall, Real-Time Systems: Theory and Practice. New Delhi, India: Pearson Education, 2007.

List of Lab Assignments / Experiments OR List of Tools on which the lab assignment should be based (If Any)

1. Create an application that creates two tasks that wait on a timer whilst the main task loops.
2. Write an application that creates a task which is scheduled when a button is pressed, which illustrates the use of an event set between an ISR and a task
3. Write an application that Demonstrates the interruptible ISRs(Requires timer to have higher priority than external interrupt button)
4. Write an application to Test message queues and memory blocks.
5. Write an application to Test byte queues
6. Write an application that creates two tasks of the same priority and sets the time slice period to illustrate time slicing.
7. Sending message to PC through serial port by three different tasks on priority Basis.
8. Porting Linux and developing simple application on Xilinx Zed board
9. Developing image processing application with Linux OS on Xilinx Zynq FPGA
10. Write simple applications using RTX (ARM Keil's real time operating system, RTOS).

Program Outcomes												
CO/PO	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	3	1	1	0	0	0	0	0	0	0	2
CO2	3	3	1	1	0	0	0	0	0	0	0	2
CO3	3	3	3	1	0	0	0	0	1	1	2	2
CO4	3	2	3	3	2	0	0	0	2	2	2	2
CO5	3	2	3	3	2	0	0	0	2	2	2	3

Course Title: Fundamentals of Machine Learning

Course Code:	ECL 462	**Course Title:**	Fundamentals of Machine Learning			
Category:	Departmental Elective (DE)	**Credit Assigned**	L	T	P	C
			3	0	2	4
Pre-Requisite (if Any)	Nil	**Type of Course**	Electronics and Communication Engineering			

Course Outcomes:

1. To explore different applications of machine learning and to get acquainted with basics of ML.
2. To understand formulation of regression and non-parametric classification algorithms.
3. To understand formulation of parametric classification algorithms.
4. To understand formulation of artificial neural network.
5. To understand formulation of different unsupervised learning algorithms along with applications.

Course Contents:

Module I :
Introduction to machine learning: Terminologies, Applications, Types of learning. Performance measures of classification: Confusion matrix, Area under RoC curve. Hypothesis space, Bias and variance, Bias-variance tradeoff, K-fold cross validation.

Module II :
Linear regression, Logistic regression, Bayesian decision theory, Bayesian networks, K nearest neighbor algorithm.

Module III :
Support vector machine classifier, kernel methods. Decision Trees: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting. Ensemble classifiers: stacking, bagging, boosting. Random forest, Ada Boost algorithm.

Module IV :
Artificial Neural Networks: Neurons and biological motivation. Perceptrons, Activation functions, Multilayer perceptron network, Gradient descent and error back-propagation. Weight initialization, Regularization.

Module V :
Unsupervised learning: Gaussian mixture model and Expectation maximization (EM) algorithm. K means clustering, Agglomerative clustering, Mean shift clustering, Fuzzy K means clustering. Semi supervised learning with EM.

Text Books:

1. T. M. Mitchell, Machine Learning. McGraw-Hill, 1997.
2. E. Alpaydin, Introduction to Machine Learning, 3rd Ed. MIT Press, 2014.

Reference Books:

1. T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning, 2nd Ed., Springer, 2008.
2. C. M. Bishop, Pattern Recognition and Machine Learning, 2nd Ed., Springer, 2006.
3. R. O. Duda, P. E. Hart, and D. G. Stork, Pattern Classification, 2nd Ed., Wiley, 2001.

List of Experiments:

1) To build good training set- Dataset preprocessing.
2) Data Compression via dimensionality reduction.
3) To implement multilayer ANN from scratch.
4) Support vector machine classification with different kernel methods using scikit learn.
5) To build a decision tree and combining multiple decision trees with random forest.
6) To combine different models for ensemble learning.
7) To perform simple and multiple linear regression.
8) To perform clustering analysis.
9) Embedding a machine learning model into a web application.
10) Case study: applying a machine learning model for sentiment analysis.

Program Outcomes												
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	2	2	1	1	0	1	2	0	2
CO2	3	3	2	2	3	2	2	1	1	2	2	2
CO3	3	3	2	2	3	2	2	1	1	2	2	2
CO4	3	3	3	3	3	2	2	1	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	2	3	2