BANASTHALI VIDYAPITH

Master of Science (Electronics)

Curriculum Structure

First Semester Examination, December, 2019
Second Semester Examination, April/May, 2020
Third Semester Examination, December, 2020
Fourth Semester Examination, April/May, 2021

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2019

No. F. 9-6/81-U.3

Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Programme Educational Objectives: The M.Sc. (Electronics) programme aims for the holistic development of students through the unique and innovative fivefold educational ideology of Banasthali Vidyapith. Electronics now become the integral part of our lives. As the world continues to rely on Electronics technology, there is a great requirement for the technically skilled personnel who are able to design, create, and maintain the many products and systems that support electronics technology. Electronics professionals develop innovative technology solutions in a wide range of areas from handheld communications to solar panels; from cardiac pacemakers to autonomous robots; from wireless networks to bio-engineered sensors that detect dangerous pathogens; and intelligent surveillance systems that perform face and motion recognition.

The program aims to deepen the knowledge and skills of the students on the basic concepts and theories that will equip them in their professional work involving analysis, systems implementation, operation, production, and maintenance of the various applications in the field of Electronics. The curriculum is designed in a way that it will equip students with a solid grasp of mathematical, scientific, and engineering concepts, through classroom education and laboratory exercises. Graduates of the program are expected to develop and use professional skills that facilitate their continued carrier growth well beyond their graduation.

The main objectives of the program are:

- To provide students solid foundation in mathematics and electronics fundamentals required to solve subject related problems and also to pursue advanced studies. This serves them lifelong in their professional domain as well as higher education.
- To prepare professionals to work in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities.
- Practice the ethics of their profession, consistent with a sense of social responsibility and develop their problem–solving skills and aptitude for innovations as they work individually and in multi-disciplinary teams.
- Inculcate a lifelong learning culture.
- To formulate problems and projects and to plan a process for solution.
- Communicate effectively and manage resources skilfully as members and leaders of the profession.

Programme Outcomes:

PO1. **Knowledge**: Apply the knowledge of mathematics, science and electronics fundamentals to the solution of related complex problems.

PO2. **Problem analysis:** Interpret, compare and analyze following rules of scientific methodology to arrive at a defensible conclusion of a problem.

PO3. **Design/development of solutions:** Develop solutions for complex electronics problems and design system components/processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems:** Use scientific knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage:** Apply appropriate techniques, resources, and modern electronics tools including MATLAB, LabView, Proteus, VHDL, Arduino and related hardware to complex electronics activities with an understanding of the limitations.

PO6. **The electronics professional and society:** Apply reasoning gained by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional electronics practice.

PO7. **Environment and sustainability:** Understand the impact of the professional electronics solutions in societal and environmental contexts, and demonstrate the knowledge for sustainable development.

PO8. **Ethics:** Apply ethical principles and commit to professional ethics responsibilities and norms of the professional practice.

PO9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary surroundings.

PO10. **Communication Skill:** Communicate effectively on complex electronics activities with the electronics professional community

and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the professional and management principles and apply as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Evaluation Scheme for Theory Courses

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max.	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

For laboratory and all non-classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will also be of 40 and 60 marks respectively. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed

NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

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Programme Scheme:

M.Sc. (Electronics) I Sem (December 2019)

Course Code	Course Name	L	T	P	C
CS 415	Computer Programming	4	0	0	4
CS 415L	Computer Programming Lab	0	0	8	4
	Analog Electronics	4	0	0	4
	Analog Electronics Lab	0	0	4	2
ELE 406	Principles of Digital Electronics	4	0	0	4
ELE 406L	Principles of Digital Electronics Lab	0	0	4	2
ECE 201	Signals, systems and Networks	4	0	0	4
ELE 205	Semiconductor Devices and Circuits	4	0	0	4
	Semester Wise Total	20	0	16	28

M.Sc.(Electronics) II Sem (April/May 2020)

Course Code	Course Name	L	T	P	C
	Microwave Engineering	4	0	0	4
	Microwave Engineering Lab	0	0	2	1
EIE 202	Electrical and Electronics Measurements	3	1	0	4
EIE 202L	Electrical and Electronics Measurements Lab	0	0	4	2
EIE 302	Control Systems	4	0	0	4
EIE 302L	Control Systems Lab	0	0	4	2
MGMT 209	Entrepreneurship	3	0	0	3
TSKL 403	Communication Skills	2	0	0	2
ELE 508S	Seminar	0	0	2	1
	Discipline Elective	4	0	0	4
	Semester Wise Total	20	1	12	27

M.Sc. (Electronics) III Sem (December 2020)

Course Code	Course Name	L	T	P	C
VLSI 401	VLSI Design	4	0	0	4
VLSI 401L	VLSI Design Lab	0	0	2	1
CS 209	Data Structures	4	0	0	4
CS 209L	Data Structures Lab	0	0	4	2
ECE 301	Analog Communication	4	0	0	4
ECE 301L	Analog Communication Lab	0	0	2	1
ELE 306	Microprocessors and Microcontrollers	4	0	0	4
ELE 306L	Microprocessors and Microcontrollers Lab	0	0	4	2
	Open Elective	4	0	0	4
	Project	0	0	4	2
	Semester Wise Total	20	0	16	28

M.Sc. (Electronics) IV Sem (April/ May 2021)

Course Code	Course Name	L	T	P	C
	UIL Project	0	0	48	24
	Reading Elective	0	0	0	2
	Semester Wise Total	0	0	48	26

Reading Electives:

Course Code	Course Name	L	T	P	C
	Professional Ethics	0	0	0	2
	Telecommunication Switching Systems and Networks	0	0	0	2
	Multimedia Compression and Communication	0	0	0	2
	Electronic Packaging	0	0	0	2
	Electric Vehicles	0	0	0	2
	Electromagnetic Compatibility	0	0	0	2
	IoT Sensors and Devices	0	0	0	2

List of Discipline Electives:

Course Code	Discipline Electives	L	T	P	C
ELE 403	Basics of Nanoelectronics	4	0	0	4
	Mechatronics	4	0	0	4
ELE 402	Audio and Video Systems	4	0	0	4
	Geoinformatics	4	0	0	4
	Robotics and Automation	4	0	0	4
	Antenna Analysis	4	0	0	4
	Biomedical Instrumentation	4	0	0	4
ECE 402	Fiber Optics and Communication	4	0	0	4
	Analytical Instrumentation	4	0	0	4
ELE 304	Digital Signal Processing	4	0	0	4
ECE 303	Communication Networks	4	0	0	4
EEE 304	Power Electronics	4	0	0	4
ECE 404	Optical Network	4	0	0	4
ECE 406	Satellite Communication	4	0	0	4
ECE 403	Mobile Communication	4	0	0	4
ECE 405	Radar Navigation	4	0	0	4

Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester in Semesters II, & III with prior permission of respective heads, time table permitting.

First Semester

Computer Programming

CS 415

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain fundamentals of computer systems and operating system.
- Code programs in 'C' using data types, control structures, functions arrays, pointers, and file handling.
- Demonstrate the ability to run, test, and debug 'C' programs.

Section A

Fundamentals of Computer System: Block Diagram, CPU, Memory, Input/output Devices. Hardware and Software, Booting Process and DOS Commands.

Steps in Program Development: Problem analysis, algorithms & flow charts, High level and low level programming languages.

Computer Programming Using C: History, Data types (simple and structured) and their representation, Constants and variables, Operators, Arithmetic's and logical expressions, Type casting, Input and output statements.

Section B

Control Statements: Sequencing, Conditional and unconditional branching and looping.

Arrays: Single and multidimensional arrays, Arrays and strings, String built-in functions, Applications of arrays: Searching (linear and binary), Sorting (bubble, selection and insertion).

Structured Programming: Function declaration and definition, Function call, Passing parameters to the functions: call by value, call by reference. Returning values, Recursive functions, Passing arrays to functions.

Section C

Storage classes in C: Automatic, Register, External, and Static.

Pointers: Pointer arithmetic, Pointers and arrays, Pointers and strings, Pointer to pointer, Dynamic Memory Allocation.

Derived Data Types: Structures, unions, Array of structure, Pointer to structure, enumerated data types.

File Handling in C: Types of files, Opening and closing a data file, reading and writing a data file, Random access in a file, Error handling during file I/O operations, Command line arguments.

Recommended Books:

1. Kanetkar,Yashavant P. (2009). *Let us C*. New Delhi: BPB Publications
2. Sinha,P. K. (2004). *Computer fundamentals: Concept, Systems and Application*. New Delhi: BPB Publications
3. Kernighan, Brain W.(1988). *The C programming Language*. New Delhi: PHI Publication
4. Kanetkar, Yashavant P. (2009). *Understanding pointers in C*. New Delhi: BPB Publications
5. Dromey, R. G.(2007). *How to solve it by Computer*. New Delhi: PHI Publication
6. Venugopal, K. R.(2005). *Programming with C*. New Delhi: Tata Mcgraw Hill Publications
7. Balagurusamy, E.(2010). *Programming in ANSI C*. New Delhi: Tata Mcgraw Hill Publication

Computer Programming Lab

CS 415L

L	T	P	C
0	0	8	4

Max. Marks: 100
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Code on formula based problems using constants and variables.
- Use different loop statements in coding.
- Use pointers, Parameter passing in functions, Recursion and union data type in coding.

List of Experiments:

Lab Number	Problems
L1-L3	Simple hands on computers and DOS Internal & External Commands
L4-L6	Simple Problems Using scanf and printf functions. Formula Based Problems using Constants, Variables and use of operators.
L7-L8	Use of Library Functions e.g. sqrt, sin, cos, log etc.
L9-L20	Loop Statement using for, while, do –while statement
L21-L25	Conditional Checking Using if statement, Nested if statement, switch statement and Unconditional goto
L26-L40	Problems based on array data types. Problems on One Dimensional Array-Searching (Linear, Binary), Sorting (Bubble, Selection, Insertion), Merging.
L41-L45	Problems on two Dimensional Array -Matrix Operation: Addition, Subtraction, Multiplication etc.
L46-L50	Problems based on pointers, Parameter passing in functions, Recursion
L51-L55	Declaration, Reading, Writing and manipulation on struct and union data type
L56-L62	File handling
L63-L64	Command line Arguments

Analog Electronics

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the operation and properties of Op-amp.

- Explain the design of differential amplifiers, active filters, oscillators, and other linear and non-linear circuits using linear integrated circuits.
- Design and analysis of single stage, multistage amplifiers and high frequency amplifiers.

Section- A

Operational Amplifier and its applications: BJT differential amplifier: DC and AC analysis, Transfer characteristics, Differential and Common mode gain, Ideal Op-amp, inverting and non-inverting amplifier, offset voltage, offset current, bias current, frequency response, slew rate, CMRR, summing amplifier, differential and instrumentation amplifier, design of integrator and differentiator, logarithmic and anti-logarithmic amplifiers, Active filters.

Section- B

Op-amp RC oscillator circuits: Wien bridge, Phase shift; square wave & triangular wave generator, voltage controlled oscillator, Phase locked loops: performance factors, Integrated circuit PLL (565) and its applications, Precision rectifier, comparator, Schmitt trigger and 555 IC Timer, Voltage Regulators: Voltage regulator basics, OP-AMP series voltage regulators, adjustable voltage regulators, ,short circuit protection and fold back current limiting circuits, IC voltage regulators , switching regulators.

Section- C

High frequency amplifiers, Hybrid –pi CE transistor model, Hybrid –pi conductance, Hybrid –pi capacitances, CE short circuit current gain, Current gain with resistive load, Single stage CE transistor amplifier response, Gain bandwidth product.

Multistage Amplifier: Frequency response, Effect of cascading on bandwidth, RC coupled amplifier; Low frequency response of an RC coupled stage, Effect of emitter bypass capacitor.

Recommended Books:

1. Gayakwad, Ramakant A. (2010). *OP-AMP & Linear Integrated Circuits*. New Delhi: Prentice Hall Publication.
2. Bell, David A. (2011) *Operational Amplifiers and Linear ICs*. New Delhi: Oxford University Press.
3. Parikh, Millman & Halkias. (2010) *Integrated Electronics: Analog & Digital Circuits and Systems*. New Delhi: McGraw Hill Education.
4. Sedra, Adel. & Smith, Kenneth. (2009).*Microelectronic Circuits Theory and Applications*. New Delhi: Oxford University Press.

Suggested E-Resources:

1. **Analog Electronic Circuits** by Prof. S. C. Dutta Roy, Indian Institute of Technology Delhi. https://nptel.ac.in/courses/108102095/

Analog Electronics Lab

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Design, construct, and analyse the various analog circuits to compare experimental results in the laboratory with theoretical analysis.
- Observe the amplitude and frequency responses of common amplification circuits
- Construct the desired Electronic design to meet specific requirements.

List of Experiments:

1. To design the Astable Multivibrator using 555
2. To design the Monostable Multivibrator using 555
3. To design summer using 741 IC
4. To design Integrator using 741 IC
5. To design Schmitt Trigger using 741/555 IC
6. To design Differentiator using 741 IC
7. To design peak detector using 741 IC
8. To design scalar using 741 IC
9. To study active filters: LPF, HPF, BPF.
10. To design Voltage to frequency converter.
11. To study phase locked loop.
12. To study frequency shift keying using PLL 565.

Principles of Digital Electronics

ELE 406

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to

- Describe and minimize various digital systems.
- Design steps for combinational and sequential circuits.
- Understand basic memory architectures and their functionality.

Section-A

Number system (binary, octal, decimal, hexadecimal) bits & bytes, representation of integers, real, positive and negative numbers. Binary Arithmetic, Simple concept of theorems of Boolean Algebra.
Representation of characters: BCD, ASCII, EBCDIC Codes. Weighted codes, self-complementary codes, Error detecting codes and error correcting codes (Parity, Gray, Hamming codes).
Logic Gates: Logic Gates and Boolean Algebra Representation and Simplification of functions by Karnaugh Maps. Combinational Circuits design. Combinational circuits - adder, sub tractor, decoder, demultiplexer, encoder, multiplexer, comparator.

Section-B

Sequential Logic Circuit & Design - flip flop, shift register, asynchronous and synchronous counters.
Digital Logic Families and Their Characteristics: RTL, DTL, TTL, Schottky TTL, ECL, MOS and CMOs, Fan in, Fan out.

Section-C

Semiconductor Memories: RAM ROM, PROM, EPROM, BJTRAM Cell, MOS RAM Cell, Organization of RAM, Charge Coupled devices (CCD), storage of charge and transfer of charge in CCD.
D/A Converter: Weighted resistance D/A, R-2R Ladder Converter. DAC 0800 D/A Chip, D/A Converter specification.
A/D Converter: Analog to Digital Converter, Parallel Comparator Converter, Counting Converter, Successive Approximation Converter, Dual Slop converter A/D converter specification, sampling and hold circuit, ADC 0804 Converter chip.

Recommended Books:

1. Malvino C.P., Leach D.P. & SahaGoutam (2014). *Digital Principles and Applications*. New Delhi: Tata Mc-Graw Hill Publication
2. Bartee T.C. (1979). *Digital Computer Fundamentals*. New York: McGraw-Hill Publication
3. Hayes John P. (1988). *Computer Architecture and Organization*. International edition: McGraw-Hill Publication
4. Stone, Harold S. (1976). *Introduction to Computer Architecture*. Paris: SRA Publications
5. Gaonkar, R.S. (1987). *Microprocessors Architecture, Programming & Applications with 8085/8080A*, Wiley Eastern Publication

Principles of Digital Electronics Lab

ELE 406L

L	T	P	C
0	0	4	2

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(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the basic digital circuits and to verify their operation.
- Explain the elements of digital system abstractions such as digital representations of information, digital logic, Boolean algebra, state elements and finite state machine (FSMs).
- Create a gate-level implementation of a combinational and sequential logic functions described by a truth table using and/or/inv gates, multiplexers.

List of experiments:

1. The study & verification of parameter of active & passive component.
2. To verify the truth table of various logic (AND, OR, NOT, NAND, XOR)
3. Verify the various theorems Boolean algebra.
4. Verify D' Morgan's theorem.
5. Implementation the Boolean expression and verify the truth table.
6. Design the various combinational circuits Half Adder, Half sub tractor, Full Adder, full sub tractor, parity Generator, parity Checker.
7. Design the advanced combinational circuits Multiplexer, Demultiplexer, Encoder Decoder.
8. Design the various code converters & verify the truth table - Binary to BCD converter, Binary to gray code and binary to EX-3.
9. Design the weighted code converter,
10. Design the flip-flop and verify the truth table R-S, D, J-K, T and Master Slave.
11. Design the various resisters using flip flop - Serial in serial out, Serial in Parallel out, parallel in serial out, parallel in parallel out.
12. Design the various synchronous counters using flip-flop - Binary up, Binary down and Mod-10.
13. Design the various asynchronous counters using flip-flop - Binary up, Binary down and Mod-10.
14. Design the special counters - Ring counter and twisted ring counter.
15. To study A/D & D/A converters also calculate resolution & error percentage in observation.
16. To design an Astable Multivibrator using 555 Timer.
17. To design a Bistable Multivibrator using 555 Timer.
18. To design a Monostable Multivibrator using 555 Timer.

Signals, Systems and Networks

ECE 201

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60

Learning Outcomes: After successful completion of the course, student will be able to

- Analyze linear time invariant system in time and frequency domain
- Apply concepts learned in Section A and Section B to solve circuit problems

Section-A

Introduction: Continuous and discrete time signals, Transformation of independent variables, Exponential and sinusoidal signals, Unit impulse and unit step functions, Continuous and discrete time systems, Basic system properties

Linear Time-Invariant System: Convolution for continuous and discrete time LTI system, Properties of LTI system, Causal LTI systems described by differential and difference equations, Singularity functions

Fourier Series: Fourier series representation of continuous time periodic signals, Convergence of Fourier series, Properties of continuous time Fourier series, Fourier series representation of discrete time periodic signals, Properties of discrete time Fourier series

Section-B

Continuous Time Fourier Transform: Representation of aperiodic signals, Fourier transform for periodic signals, Properties of continuous time Fourier Transform, Systems characterized by constant coefficient differential equations

Laplace Transform: Laplace transform, Region of convergence for Laplace transform, Inverse Laplace transform, Geometrical evaluation of Fourier Transform from pole-zero plot, Properties of Laplace transform, Analysis and characterization of LTI systems using Laplace transform

Initial Conditions in Networks: First order differential equations- General and Particular solutions, Time constants, Initial conditions in elements, geometrical interpretation of derivatives, A procedure to evaluate initial conditions

Section- C

Differential equation in circuits: Second order equations-Internal excitations, Networks excited by external energy sources, Response as related to the s-plane location of roots, General solutions in Terms of S, Q, ω_n

Impedance Functions and Networks Theorems: The concept of complex frequency, Transform impedance and transform circuits, Series and parallel

combinations of elements, Superposition and Reciprocity, Thevenin's Theorem and Norton's Theorem

Two port Parameters: Relationship of two port variables, Short circuit admittance parameters, Open circuit impedance parameters, Transmission parameters, Hybrid parameters, Relation between parameter sets, Parallel connection of two port networks

Recommended Books:

1. Oppenheim A. V., A. V. &Nawab S. H. (2015). *Signal and Systems (2/e)*, Boston: Pearson Publication
2. Valkenburg M.E. Van (2015). *Network Analysis (3/e)*. New Delhi: Pearson Publication
3. Proakis J. G. &Manolakis D. G. (2007). *Digital Signal Processing: Principles, Algorithms, and Applications (4/e)*. New Delhi: Pearson Publication
4. Kuo F. F. (2010). *Network Analysis and Synthesis (2/e)*. New Delhi: John Wiley & Sons Publication

Suggested E-resources:

1. **Circuit Theory** by Prof. S.C. Dutta Roy, Department of Electrical Engineering, Indian Institute of Technology, Delhi. https://nptel.ac.in/courses/108102042/
2. **Principles of Signals and Systems** by Prof. Aditya K. Jagannatham, Department of Electrical Engineering Indian Institute of Technology, Kanpur. https://nptel.ac.in/courses/108104100

Semiconductor Devices and Circuits

ELE 205

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the energy bands, temperature effects, carrier transport of semiconductor devices
- Explain the switching times, capacitance of PN junction, bipolar and unipolar transistor behavior and their differences
- Analyze the various feedback circuits and design power amplifiers.

Section A

P-N junction: thermal equilibrium condition, under forward and reverse bias, space charge region, junction capacitance, p-n junction current, small

signal model, diode current equation, junction breakdown, charge storage and transient behavior, metal semiconductor junction: Schottky Barriers and Ohmic Contacts, heterojuntion: energy band diagrams

Section B

Bipolar Junction Transistor: the transistor action, minority carrier distribution, low frequency common-base current gain, MOSFET: The MOS diode, Energy band diagrams, MOSFET fundamentals, MOS Transistor current, Threshold Voltage. FET biasing: fixed-Bias configuration, self-Bias configuration, Voltage-divider Bias configuration, FET small signal model, common source and common drain amplifiers.

Section C

Feedback amplifier: classifications of amplifiers, general feedback structure, properties of negative feedback, feedback topologies, Transfer gain with feedback, General Characteristics of negative feedback amplifiers, Input resistance, output resistance, Voltage series and current series feedback, Current shunt and voltage shunt feedback, Power amplifiers: Classification, operation, Analysis and design of Class A, Class B, Class-AB, Class C, Power dissipation and efficiency calculations, amplifier distortion.

Recommended Books:

1. S. Simon. M.(2002), *Semiconductor Devices Physics and Technology (2/e)* , New Jersey, USA: JOHN WILEY & SONS Publication
2. Millman. J, Halkias. C, Parikh. C. (2017). *Integrated Electronics. (2nd ed).* New Delhi: TMH Publications.
3. Streetman Ben. G. (2006). *Solid State Electronic Devices (6th ed)* New Delhi: PHI Publications.
4. Smith. S. (2008). *Microelectronics Circuits. (5th ed).* New Delhi: Oxford press.

Suggested E-Resources:

1. **Semiconductor Devices and Circuits** by Prof. Sanjiv Sambandan, Department of Instrumentation and Applied Physics, Indian Institute of Science, Bangalore. https://nptel.ac.in/courses/108108112/
2. **Analog Electronic Circuits** by Prof. S. C. Dutta Roy, Department of Electrical Engineering Indian Institute of Technology Delhi. https://nptel.ac.in/courses/108102095/

Second Semester
Microwave Engineering

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60

Learning Outcomes: After the completion of course student will be able to:

- Understand various parameters of waveguide and use of component as per applications
- Design impedance matching network for any transmission line or system
- Analyse and find applications and limitations of microwave tube Generators and Amplifiers

Section- A

Introduction to Microwaves & its application, Microwave Electromagnetic spectrum, Transmission Lines: General equation, input impedance, characteristic impedance, reflection and transmission coefficient, standing wave ratio, resonant and anti-resonant line impedance matching, Matching techniques: single stub, double stub, quarter wave transformer, baluns, coaxial transmission line, Planar transmission line: Strip line, Microstrip line, Slot line etc.

Section-B

Wave Guides: Wave propagation in rectangular wave guide: solution of TE and TM modes, Power Transmission and Attenuation, Excitation of modes in rectangular waveguide, Circular Waveguide: Basic idea of TE and TM modes, Rectangular and Circular cavity resonators, Q of cavity resonators, S parameters and its conversion with Z and Y parameters, Wave guide coupling, Microwave passive Components: S- parameter representation and analysis of microwave components such as Waveguide Tees, Two-hole directional coupler, attenuators, Phase shifters, Microwave propagation in ferrites: Faraday rotation, Isolators, Circulators.

Section-C

Microwave Tubes: Limitations of Conventional vacuum tubes at microwave, Klystron: Construction and operation of two cavity and multi-cavity klystrons, Applegate Diagram and application of two cavity klystron, Construction and working of Reflex klystron, Magnetron: Types of magnetron,Construction, Operation and Analysis of cavity or travelling wave magnetron, Traveling wave tubes (TWT): Construction, Operation and practical consideration of helical type TWT, Applications of TWT, Microwave Semiconductor Devices: Tunnel diodes, principle of operation and application of tunnel diodes, Transferred Electron devices: Gunn-Effect diodes, Two-valley theory, Mode of operations of Gunn diode, Avalanche Transit-Time devices: IMPATT, TRAPATT.

Recommended Books:

1. Liao, S.Y. (1995). *Microwave devices & Circuits*. New Delhi: Prentice Hall Publication.
2. Rizzi, P.A. (1998). *Microwave Engineering*. New Delhi: Prentice Hall Publication.
3. Collins, R. E. (1992). *Foundation of Microwave Engineering*. New Delhi: McGraw Hill Publication.
4. Pozar, David M. (2008). *Microwave Engineering*. New Delhi: Wiley Publication.

Suggested E- Recourses:

1. **Microwave Theory and Techniques** by Prof. Girish Kumar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101112/
2. **Basic Building Blocks of Microwave Engineering** by Dr Amitabha Bhattacharya, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105130/
3. **Transmission Lines and E.M. Waves** by Prof. R. K. Shivgaonkar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/117101056/

Microwave Engineering Lab

L	T	P	C
0	0	2	1

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the concept and working of microwave bench and different components connected on a bench.
- Analyse the behaviour of various microwave components.
- Verify properties/ characteristic of microwave source, tees and directional coupler.

List of experiments:

1. Determine the operating frequency of reflex klystron.
2. Draw the V-I characteristics of Reflex klystron
3. Draw the characteristics of attenuator
4. To verify the wave-guide law
5. To study the directivity and coupling coefficient of Directional Coupler.
6. To study the properties of magic Tea and also determine isolation and coupling coefficient.

7. To Measure the VSWR of (i) Short circuit (ii) Open circuit (iii) Matched Load (iv) Unmatched Load.
8. To study the properties of E-plane and H-plane Tea. Determine isolation and coupling coefficient

Electrical and Electronics Measurements

EIE 202

L	T	P	C
3	1	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to

- Measure various electrical parameters with precision and accuracy.
- Select appropriate transducers for measurement of physical parameter.
- Use suitable AC Bridge for relevant parameter measurement.

Section A

Measurements: Elements of Measurements, Performance characteristics, Error in measurements, True value, Static error, Static correction, Scale range, Scale span, Reproducibility, Drift, Repeatability, Accuracy and Precision, Indication of Precision, Significant figures, Range of doubt, Static sensitivity, Linearity, Hysteresis, Threshold, Dead Time, Dead zone, Resolution and Discrimination.

Measurement error: Types and analysis, Loading error due to series and shunt connected instruments, Standards and Calibration, Curve fitting, Dynamic characteristics of measurement systems, Mathematical models of measurement system (Mechanical and Electrical System).

Transducers: Classification and characteristics, Resistive, Capacitive, Inductive, Hall Effect. Measurement of Displacement: LVDT and RVDT, Strain Gauges and its types.

Measurement of Temperature: RTD, Thermistor and Thermocouples.

Section B

d'Arsonval Galvanometer- Construction, Torque Equation and Dynamic behavior of galvanometers, PMMC Instrument- Construction, Torque equation, Ammeter shunts, Voltmeter multipliers, Ohmmeter- Series and Shunt type, Moving Iron Instruments, Electrodynamometer Instrument. AC Bridges- Measurement of self-inductance (Maxwell's Bridge, Hay's Bridge, Owen's Bridge, Anderson's Bridge), capacitance (De Sauty's and Schering Bridge) and frequency (Wien's Bridge).

Section C

Measurement of low, medium and high resistance. Multimeter- Analog and Digital, Function generator, Wave Analyzer, Spectrum Analyzer, Q-meter and its applications, CRO- CRT, Time base generator, Measurement of Phase and Frequency (Lissajous Patterns), types of CRO (Dual Trace, Dual Beam, Sampling type and Storage CRO).

Recommended Books:

1. Sawhney A.K. (2015). *A Course in Electrical and Electronic Measurements and Instrumentation.* New Delhi: Dhanpat Rai & Co Publication
2. Jain R.K. (2008). *Mechanical and Industrial Measurement.* New Delhi: Khanna Publishers
3. Nakra B.C. & Chaudhry K.K. (2013). *Instrumentation, Measurement and Analysis.* New Delhi: Tata McGraw Hill Publication
4. Kalsi H.S. (2017). *Electronic Instrumentation.* New Delhi: Tata McGraw Hill Publication
5. Singh S.K.(2010). *Industrial Instrumentation and Control.* New Delhi: Tata McGraw Hill Publication

Suggested e-Resource:

1. **Industrial Instrumentation** by Prof. Alok Barua, Department of Electrical Engineering, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/108105064

Electrical and Electronics Measurements Lab

EIE 202L

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Develop an understanding of construction and working of different measuring instruments.
- Develop an ability to use measuring instruments and AC and DC bridges for relevant measurement.
- Select appropriate passive or active transducers for measurement of physical phenomenon.

List of experiments:

1. To study Hall Effect.
2. To study principle of Thermocouple.
3. To study principle of Load cell.

4. To study principle of Thermistor.
5. To study principle of strain guage.
6. To study Principle of LVDT
7. To study De Sauty bridge.
8. To study Wein AC bridge.
9. To study CRO circuitry in detail.

Control Systems

EIE 302

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Formulate mathematical model for physical systems and simplify representation of complex systems using reduction techniques.
- Use standard test signals to identify performance characteristics of first and second-order systems.
- Apply root locus technique for stability analysis.

Section A

Open loop and closed loop systems, servomechanism, mathematical model of systems, differential equations and transfer functions, Block diagram algebra, signal flow graphs; +ve and -ve feedback effects of feedback.

Standard test signals, time response of first and second order systems, steady state errors and error constants, Design specifications of second order systems.

Section B

Effects of derivative and integral error compensation, PID controller, Design considerations for higher order systems in brief, performance indices.

Concept of stability, necessary conditions for stability, Routh Hurwitz stability criterion, relative stability criterion, relative stability in terms of Routh Hurwitz criterion; Root-locus technique.

Correlation between time and frequency response specifications; Frequency domain plots, polar plots.

Section C

Bode plot, log magnitude versus phase plots; Gain-margin, Phase-margin, Nyquist stability criterion; Constant-M and constant-N circles; closed loop frequency response from these.

Preliminary considerations of classical design, cascade and feedback compensation, time-domain design using lag, lead and lag lead compensation, frequency domain design using lag.

State Variable model and solution of state equation of LTI systems.

Recommended Books:

1. Nagrath, I. J. (2006). *Control systems engineering*. New Delhi: New Age International.
2. Ogata, K., & Yang, Y. (2002). Modern control engineering (Vol. 4). India: Prentice hall.

Suggested e-resource:

1. **Control System** by Prof. S. D. Agashe, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101037/

Control Systems Lab

EIE 302L

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the concept of time response and frequency response of any physical system.
- Mathematical modeling of physical system to find out of transfer system.
- Analyze the stability of system with the help of system response.

List of experiments:

1. To study and controlling action using PID controller and calculate the first overshoot temperature and plot the graph.
2. To study the DC position controller and find out the tachometer gain.
3. To determine time domain response of a second order systems for step input and obtain performance parameters.
4. To convert transfer function of a system into state space form and vice-versa.
5. To plot root locus diagram of an open loop transfer function and determine range of gain ‘k for stability.
6. To plot a Bode diagram of an open loop transfer function.
7. To draw a Nyquist plot of an open loop transfers function and examine the stability of the system.

Entrepreneurship

MGMT 209

L	T	P	C
3	0	0	3

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the environment that fosters the creation of entrepreneurship ecosystem that includes the mechanisms and challenges underlying the phenomenon.

- Identify, assesses problems and recognize resources and create opportunities towards problem solving with entrepreneurial mindset through design thinking.
- Develop new models or ability to improvise the existing models

Section A

Concept of Entrepreneur, Traits and competencies and functions of an entrepreneur, Types of entrepreneur, Relation between Society, Technology and Entrepreneurship

Concept of Entrepreneurship , Myths about Entrepreneurship, Classification and types of Entrepreneurship, Gender and Entrepreneurship, Entrepreneurship as a career option, Role of Entrepreneurship in the wealth building and creating impact, case studies of Start ups

Creativity and Innovation, How to think through and think big, Effectuation Theory, Principles of Effectuation, Grassroots Innovation

Section B

Design Thinking – Introduction to the Design Thinking Process – Identification of the problem, Generation of Idea,

Identifying Customer Segments, Value proposition. Lean Canvas, Idea Validation,

Developing Business Model, Sizing the opportunity, Building MVP, Concept of Start-up, Incubation,

Section C

Entrepreneurial Finance and Venture Capital,

Concept of debit, credit, cost, Capital, Venture Capital, financial statement, cash flow, budget making, Concept of Unit Economics.

Financial and Non-financial Support: Revenue Streams; Pricing and Costs, Sources of Funds

Entrepreneurial Marketing

Marketing: Positioning; Channels and Strategy

Sales: Sales Planning

Team: Importance of Team building; Complimentary skill sets

Legal Issues: Brief Overview of Intellectual Property Rights, Patent, Trademarks, Copy Rights, Trade Secrets, Licensing and GI, Business Plan Writing

Programme and Policies to promote entrepreneurship Eco-system in India

Recommended Books:

1. Passiannte.G., Romano. A. (2016). *Creating Technology Driven Entrepreneurship: Foundations, Processes and Environment.* Palgrave Macmillan
2. Bygrave. W., Zacharakis.A. (2011) *Entrepreneurship*. John Wiley & Sons Inc.
3. Maurya. A. (2012). *Running Lean: Iterate from Plan A TO a Plan that Works* (2ND ed). O'Reilly.
4. Agarwal, R., Srinivasan. S.(2010). *Accounting Made Easy (2nd ed.)* McGraw Hill Education

5. Porter.R.H. (1982). *Understanding Company Financial Statements*. Penguin Books Ltd
6. Whittington. G.(2011). *The Elements of Accounting: An Introduction*. Cambridge University Press.

Suggested E-Resources

1. S.G.Blank (2015). The Path to Epiphany: The Customer Development Model. Retrieved from https://web.stanford.edu/class/archive/engr/engr140a/engr140a/cgi-bin/MFP/wp-content/uploads/2015/03/Session-4-Customer-Development.pdf
2. What makes entrepreneurs entrepreneurial? Saras D. Sarasvathy. Retrieved from https://www.effectuation.org/sites/default/files/research_papers/what-makes-entrepreneurs-entrepreneurial-sarasvathy_0.pdf
3. Design Thinking Guide Book by Royal Civil Service Commission, Bhutan. Retrieved from https://www.rcsc.gov.bt/wp-content/uploads/2017/07/dt-guide-book-master-copy.pdf
4. Why the Lean Start Up Changes Everything by Steve Blank Harvard Business Review, 2013, Retrieved from https://hbr.org/2013/05/why-the-lean-start-up-changes-everything
5. https://innovationenglish.sites.ku.dk/metoder/
6. http://www.startupwerkboek.nl/toolbox/week7/shortreader.pdf
7. https://alison.com/tag/entrepreneurial-skills
8. https://www.startupindia.gov.in/content/sih/en/learning-and-development_v2.html
9. https://www.coursera.org/specializations/business-entrepreneurship
10. https://www.edx.org/course/thinking-acting-like-an-entrepreneur-1

Communication Skills

TSKL 403

L	T	P	C
2	0	0	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Develop communicative competence and critical thinking abilities.
- Improve interpersonal skills which will enhance their presentation skills.
- Learn and apply the knowledge of report writing in formal situations.
- Prepare CV/Resume so as to highlight accomplishments while applying for jobs.

Section A

Communication: Meaning, Nature, Types, Models, Purpose, Barriers and Remedies. Body Language

Section B

Letter and Email Writing: Official Formal Letter, Types of Letters: Sales, Order, Enquiry, Complaint and Adjustment. Email Writing: Features, Etiquette

Drafting Circular, Agenda, Minutes and Inter-Office memorandum

CV/Resume Writing: Applying for a job. Letter of Application. Recommendation/Reference letters (Seeking and Giving), Acceptance and Resignation letters.

Section C

Report Writing: Definition, Scope, purpose, types, sections. Report Planning, Collecting Information and developing an outline. Mechanics of Writing.

Comprehension/Reading: Scan, Browse and Skim for information.

Comprehension passages for Vocabulary and Patterns (SV, SVC, SVOA, SVOC, SVOO, SVA, SVO)

Recommended Books:

1. Bovee, C., L., John V. Thill and Barbara E. Schatzman. (2004). *Business Communication Today*: *Seventh Edition.* Delhi: Pearson Education.
2. Diwan, P. (2004). *Effective Business Communication*. New Delhi: Excel Books.
3. Kaul, A. (2014). *Effective Business Communication*, New Delhi: PHI Learning Pvt. Ltd.
4. Lesikar, R. V. and John D. Pettit. (1998). *Report Writing for Business*. Boston: McGraw-Hill.
5. Lesikar, R. V and Marie E. Flatley. (2002). *Basic Business Communication: Skills for empowering the Internet Generation: Ninth Edition.* New Delhi: Tata McGraw-Hill Publishing Company Ltd
6. Pease, A. and Barbara Pease. (2005). *The Definitive Book of Body Language*. New Delhi: Manjul Publishing House.
7. Rupesh, J. and Weldon Kees.(1996). *Nonverbal Communication: Notes on Visual Perception of Human Relations*. Berkeley: University of California Press.
8. Sharma R.C. and Krishan Mohan. (2007) *Business Correspondence and Report Writing*. New Delhi: Tata Mc Graw Hll.

Suggested e-resources:

1. https://www.olmsteadassoc.com/resource-center/
2. http://www.bristol.ac.uk/arts/exercises/grammar/grammar_tutorial/index.htm
3. https://grammar-monster.com/
4. https://www.myenglishteacher.eu
5. http://www.people-communicating.com/

Seminar

ELE 508S

L	T	P	C
0	0	2	1

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- To identify promising new directions of various cutting edge technologies.
- Undertake a critical review of the literature.
- Deliver well-organized technical presentations and prepare a technical report.

Third Semester
VLSI Design

VLSI 401

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the basic theory of crystal growth, wafer fabrication and IC fabrication technology.
- Explain the different VLSI design styles, overview of ICs and fabrication steps of MOS, CMOS and BJT.
- Design and analyse the output characteristics of different MOS inverters.

SECTION A

Recapitulation of basics, semiconductor devices, orientation effect, impurities, defects, Fabrication: Crystal growth & wafer preparation, Epitaxial growth, oxidation, photo-lithography, etching technology (wet & dry), Diffusion Fick's law, chemical vapor deposition, CVD reactors, ion implantation, metallization & patterning, photo resistive material, packaging.

SECTION B

Overview of VLSI methodologies, VLSI design flow, type of ICs (monolithic, thick film, thin film, hybrid), Fabrication steps involve in, different type of resisters, capacitor, diode, transistor (Darlington etc), JFET, MOSFET, isolation technique used in fabrication, fabrication of typical circuits.

SECTION C

Digital CMOs circuit, MOS devices, V-I characteristics, Design & detailed analysis of MOS inverters (resistive load, enhancement load, depletion load, CMOS), delay & power analysis, Design layout of simple CMOS gates.

Circuit implementation of combinational circuit, circuit implementation of sequential circuits - FFs, SRAM, DRAM.

Recommended Books:

1. *Sze, S.M.(2017). VLSI Technology.* New Delhi*:* TMH Publication.
2. Kang, S.M., & Leblebici, Y. (2002). *CMOS digital Integrated Circuits Analysis & Design*. New Delhi: McGraw Hill Publications.
3. Botkar, K. R. (2004). *Integrated Circuits*. New Delhi: Khanna Publishers.
4. Gandhi, S.K. (1994). *VLSI Fabrication Principle Silicon and Gallium Arsenide*. New Delhi: Willey Publications.
5. Plummer, J., Deal, M., & Griffin, P. (2000). *Silicon VLSI Technology: Fundamentals, Practice and Modeling*. New Delhi: Pearson Publications.
6. Sarrafazadeh, M.,& Wong, C.K. (1996). *An introduction to VLSI Physical Design*. New Delhi: McGraw Hill Publication.
7. Ken, Martin. (1999). *Digital Integrated Circuits Design.* New York, United State: Oxford University Press.
8. Neil, H.E., Weste, &Eshraghian, Kamran (1994). *Principle of CMOS VLSI Design*. Boston, New York: Addison Wesley Publication.

Suggested E-Resources:

1. **VLSI Circuits** by Prof. S. Srinivasan, Department of Electrical Engineering, IIT-Madras. https://nptel.ac.in/courses/117106092/1
2. **VLSI Technology** by Dr. Nandita Das Gupta, Department of Electrical Engineering, IIT-Madras. https://nptel.ac.in/courses/117101058/

VLSI Design Lab

VLSI 401L

L	T	P	C
0	0	2	1

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Use VHDL for design of digital circuits

- Model complex digital systems at several level of abstractions; behavioral and structural, synthesis and rapid system prototyping.
- Develop and simulate register-level models of hierarchical digital systems

List of experiments:

1. Write a program for the implementation of half adder and Full adder.
2. Write a program for implementing half subtractor and full subtractor.
3. Write a program for implementing MUX 4x1 and DEMUX (1X4)
4. Write a program for implementing Encoder and Decoder.
5. Write a program to implement gray code to binary code converter and vice versa.
6. Write a program to implement COMPARATOR.
7. Write a program for the implementation of S-R Flip flop and D Flip flop.
8. Write a program for the implement up-counter and down-counter.
9. Write a program to design JK Flip-flop and write design summary.
10. Write a program to design T Flip-flop and write design summary.

Data Structures

CS 209

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the data type and different searching and sorting algorithms.
- Implement static and dynamic implementation of linked list.
- Understand nonlinear data structure namely tree.

Section-A

Concept of data types, Abstract data type, Data structures, running time of a program, asymptotic notations: Big-Oh, Theta, Little-oh, Omega. Linear data structures: Static implementation of stack, queue, and their applications Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

Section-B

Linked List: Linear, doubly or two way, circular, header and various operations; Representation of polynomial using linked list, addition and subtraction of polynomials. Dynamic implementation of stacks and queues. Dynamic memory management: fixed and variable block storage, storage

techniques: first-fit, best-fit, worst-fit, next-fit; data compaction, and garbage collection.

Section-C

Non-linear data structures: Tree concepts, General Tree, binary tree and types, binary search tree, implementation of various operations on Binary Search Tree (tree traversal, searching, insertion and deletion, counting leaf and non-leaf nodes, height), Heap and heap sort, Balanced tree: concepts, rotations, insertion and deletion.

Recommended Books:

1. Tanenbaum, A. M., Langsam, Y., & Augenstein, M. J. (2006). *Data structures using C and C++, 2/e*. Pearson Publication.
2. Tremblay, J. P., & Sorenson, P. G. (1976). *An introduction to data structures with Applications*. New York: McGraw-Hill Computer Science Series.
3. Horowitz, E., Sahni, S., & Anderson-Freed, S. (2008). *Fundamentals of data structures in C, 2/e,* Universities Press.
4. Aho, A. V., Ullman, J. D. & Hopcroft, J.E. (1983). *Data structure and Algorithms 1/e,* Pearson education.

Data Structures Lab

CS 209L

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Implement of stack, Applications of stacks and recursion.
- Implement of linear, circular, circular queue, priority queue.
- Implementation of doubly link list.

List of experiments:

Lab Number	Problems
L1-L4	Implementation of stack, Applications of stacks (parenthesis checker, postfix evaluation, infix to postfix), recursion
L5-L7	Implementation of linear, circular, circular queue, priority queue
L8-L12	Implementation of linear link list (creation, traversal, insertion, deletion, searching, sorting, merging, reverse)
L13-L14	Implementation of circular link list (creation, traversal, insertion, deletion, searching, sorting)
L15-L16	Implementation of doubly link list (creation, traversal, insertion, deletion, searching, sorting)
L17	Linked representation of stack and queue

L18	Polynomial arithmetic (Addition, Subtraction)
L19-L30	Implementation of binary search tree (creation, traversal, insertion, deletion, searching), Non recursive traversal (inorder, preorder, postorder)

Analog Communication

ECE 301

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain different blocks in communication system and how noise affects communication using different parameters.
- Distinguish between different amplitude modulation schemes with their advantages, disadvantages and applications and analyse generation and detection of FM signal and comparison between amplitude and angle modulation schemes.
- Identify different types of radio receiver circuits.

Section-A

Introduction to signals: Size of signals, Classification of signals, Some useful signal operations, Unit impulse function, Signals and vectors, Signal comparison- correlation, Signal representation by orthogonal signal set, Trigonometric Fourier series, Exponential Fourier series

Analysis and Transmission of Signals: Fourier transform of some useful signals, Some properties of Fourier Transform, Signal Transmission through linear system, Ideal and practical filters, Signal distortion over a communication channel, Signal energy and energy spectral density, Signal power and power spectral density

Section- B

Amplitude Modulation: Baseband and carrier communication, Double sideband modulation, Single sideband modulation, Quadrature amplitude modulation, Vestigial sideband modulation, Carrier acquisition, Superheterodyne receiver

Angle Modulation: Concept of instantaneous frequency, Bandwidth of angle modulated waves, Generation of FM waves, Demodulation of FM, Interference in angle modulated systems, FM receiver

Section-C

Random Signal and Noise: Gaussian Noise, Bandpass noise and its representation, Noise power, SNR ratio, PSD of white noise.

Analog Systems in The Presence of Noise: Baseband system, Double sideband modulation- Suppressed carrier, Single sideband modulation- Suppressed carrier, Amplitude modulation, Angle modulated systems-

Phase and Frequency modulation, Optimum preemphasis-deemphasis systems

Systems and Noise Calculations: Electrical Noise, Noise Figure, Equivalent Noise Temperature, Cascade Connection of Two-Port Networks, Free-Space Link Calculations

Recommended Books:

1. Lathi, B.P., Ding, Zhi.,& Gupta, Hari Mohan. (1998). *Modern Digital and Analog Communication Systems*. New Delhi: Oxford University Press
2. Haykin, S. & Moher, M. (2007).*Introduction to Analog and Digital Communication*. New York, United States: John Wiley & Sons.
3. Shilling, D.L., &Taub, H. (2008). *Principles of Communication Systems*. New Delhi: Mc Graw Hill Publication.

Suggested E-Resource:

1. **Analog Communication** by Prof. Goutam Das, G S Sanyal School of Telecommunications, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105143/

Analog Communication Lab

ECE 301L

L	T	P	C
0	0	2	1

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Demonstrate Amplitude modulation and demodulation techniques.
- Demonstrate frequency modulation and demodulation technique.
- Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes.
- Compare different modulations and demodulations to recognize the advantages and disadvantages of them.
- Identify different radio receiver circuits and role of AGC.

List of experiments:

1. To Study the Amplitude Modulation and measure modulation Index.
2. To Study the Amplitude Demodulation.
3. To Study the Frequency modulation.
4. To Study the Frequency Demodulation.
5. To Study the Balanced Modulator.
6. To Study the extraction of Single side band from double side bandwidth phase shifter method.

7. To study the extraction Single side band from double side bandwidth Weaver's method.
8. To study the Principle of Ratio Detector.
9. To study the Principle of Foster-Seeley discriminator.

Microprocessors and Microcontrollers

ELE 306

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Interface memory and different peripherals with Microprocessor and microcontroller
- Design and develop the system for real time applications

Section- A

8086/8088 Microprocessor: Pin Assignment, Architecture, Functional Diagram, Register Organization, Memory address space & data organization, Segment registers & Memory segmentation, Dedicated & general use of memory, Addressing modes, Instructions, Functional schematic, Minimum and Maximum mode operations of 8086, 8086 Control signal interfacing, Timing Diagrams, Interrupts, Bus timings, Demultiplexing. Assembly Language Programming of 8086: Instruction Format, Instruction Set, Data Transfer instructions, Arithmetic instructions, Logical instruction, Shift instructions, Rotate instructions, Flag control instructions, Compare instructions, Jump instructions, Subroutine & the subroutine handling instructions, Loop & loop handling instructions, String instructions.

Section- B

Peripheral Devices and Their Interfacing: Introduction, memory and I/O interfacing with 8086, data transfer schemes, programmable peripheral interface (8255), programmable DMA controller (8257), programmable interrupt controller (8259), programmable communication interface (8251), programmable counter/interval timer (8253 and 8254), special purpose interfacing devices, elements and circuits for interfacing. Communication Interface: Serial Communication Standards, USART Interfacing RS-232, IEEE-488, 20mA Current Loop, Prototyping and Trouble-shooting, Software Debugging tools, MDS.

Section- C

Introduction to Microcontrollers: Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Addressing modes and Instruction set of 8051, Simple Programs using Stack Pointer, Assembly language programming. 8051 Interrupts Communication: Interrupts, Timer/Counter and Serial Communication, Programming Timer Interrupts,

Programming External H/W interrupts, Programming the serial communication interrupts, Interrupt Priority in the 8051, Programming 8051 Timers, Counters and Programming. Interfacing & Industrial Applications: Applications of Micro Controllers, Interfacing 8051 to LED's, Push button, Relay's and Latch Connections, Keyboard Interfacing, Interfacing Seven Segment Display, ADC and DAC Interfacing.

Recommended Books:

1. Kenneth, J. Ayala.(2004). *The 8051 Micro Controller Architecture, Programming and Applications***.** New Delhi: Cengage Learning Publication
2. Hall, D.V. (2017). *Micro Processor and Interfacing***.** New Delhi: McGraw-Hill Publication.
3. Deshmukh, Ajay V. (2005). *Microcontrollers – Theory and Applications*. New Delhi: McGraw Hill Publication.
4. Ray, A.K., &Bhurchandi, B.H. (2017). *Advanced Micro Processors*. New Delhi: McGraw-Hill Publication.
5. Kenneth, J. Ayala. (2011). *The 8086 Micro Processors Architecture, Programming and Applications*. New Delhi: Prentice Hall India.
6. Liu, Yu Cheng., & Gibson, A. (1985). *Microcomputer Systems: The 8086/8086 Family: Architecture, Programming and Design.* New Delhi: Prentice Hall India.

Suggested E-Resources:

1. **Microprocessors and Microcontrollers** by Prof. Santanu Chattopadhyay, Department of E&EC Engineering, IIT Kharagpur. https://nptel.ac.in/courses/108105102/
2. **Microprocessors and Microcontrollers** by Prof. Krishna Kumar, IISC Bangalore https://nptel.ac.in/courses/106108100/

Microprocessors and Microcontrollers Lab

ELE 306L

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the different instructions of 8086 microprocessor assembly language.
- Coding in assembly language.
- Solve different real time problems.

List of experiments:

1. Write a program to calculate the addition of 16-bit No.

2. Write a program to calculate the addition of 32-bit No.
3. To transfer the content of one memory location to another memory location.
4. To exchange the content of one memory location to other memory location.
5. To find out the maximum of N give nos.
6. To generate the Fibonacci series.
7. To find location of given nos.
8. To find out the multiplication of two 16-bit nos.
9. To find out the minimum of N given.

Project

L	T	P	C
0	0	4	2

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Demonstrate effective project execution and control techniques that result in successful projects.
- Ability to identify, formulates, and solves engineering problems.
- Use the techniques, skills and modern engineering tools necessary for engineering practice

UIL Project

L	T	P	C
0	0	48	24

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilizing a systems approach.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.
- Demonstrate effective organizational leadership and change skills for managing projects, project teams, and stakeholders.

Discipline Electives

Basics of Nanoelectronics

ELE 403

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the fundamental science and quantum mechanics behind nanoelectronics.
- Explain the basic concepts behind the operation of nano scale MOSFET
- Describe the various techniques and approaches for the fabrication of nano-scale devices

Section A

The 'Top down' and 'Bottom up' approach, Nanotechnology potential, introductory quantum mechanics for Nanoscience: size effect in smaller systems, quantum behavior of nanometric world, Band structure and density of states at Nanoscale: energy bands, density of states at low dimensional structure. Semiconductor heterostructure quantum wells, quantum wires, and quantum dots.

Section B

MOS band structure, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, Tunnel junction and application of tunneling: Tunneling through a potential barrier, potential energy profiles of material interfaces, Classical and semi-classical transport, ballistic transport, carbon nanotubes, Single electron transistor, Coulomb Blockade, Resonant Tunneling diodes and transistors.

Section C

Buck minsterfullerence, Nanodiomond, Molecular Machine, Nanobiometrics. **Fabrication technology**: Top-down vs. bottom-up technology. **Lithographic process**: Lithography, Nanolithography, split gate technology, self-assembly, limitation of lithographic process. **Non-lithographic techniques:** Plasma arc discharge, sputtering, evaporation, chemical vapour deposition, pulsed laser deposition, molecular beam epitaxy, sol-gel technique, electro deposition and other process.

Recommended Books:

1. Hanson, G. W. (2008). *Fundamentals of Nanoelectronics*. New Delhi: Pearson Publication.
2. Chattopadhyay ,K. K.,& Banerjee, A. N. (2009). *Introduction to Nanoscience and Nanotechnology*. New Delhi: PHI Publication.
3. Mitin, Vlaadiniz.U. (2009). *Introduction to Nanoelectronics*. New Delhi: Cambridge University Press.

4. Dragman,M., &Dragman,D. (2008). *Nanoelectronics- Principles and Devices (2/e*): Artech House Publishers
5. Goser, Karl. (2004). *Nanoelectronics and Nanosystems*. Berlin: Springer Publication
6. Minoli, Daniel. (2005). *Nanotechnology Application to Telecommunication and Networking*. Hoboken, New Jersey: Wiley Publication.
7. Davis ,John. H. (1997). *Physics of Low Dimension Semiconductor*. New Delhi: Cambridge University Press.
8. Cosh, Carl.C. (1998). *Nanostructure Materials Processing Property and Applications*. Norwich, New York: Noyes Publications

Mechatronics

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Develop skills to monitor and control real world industrial systems
- Implement projects for industrial and home automations.
- Analyze and create own innovative filters and signal conditioning applications.
- Perform computer based controlling of industries using PLC, SCADA and HMI.

SECTION A

Mechatronics and its scope: Basic Structure and Evolution

Introduction of Transducer & Sensor: Displacement, Pressure, Flow, Level and Temperature Measurements. Signal conditioning: amplification, filtering

PC based Control: Smart Sensor, Data Acquisition System, PLC, SCADA, DCS and HMI System.

SECTION B

Pneumatic and Hydraulic actuation systems: Directional control valves, Pressure control valves and Process control valves and cylinders.

Mechanical actuation system- Kinematic chains, cams, gear-trains, Ratchet & Pawl, dampers, Bearings.

Electrical actuation system: Mechanical switches- solenoid operated solid state switches, DC, AC & stepper motors.

Electrical Drives: Conventional and Modern electrical drives, Classifications and Applications

Closed loop Controllers: Performance Specifications, Delayed First and Second order system, PID Controller, ZN Tuning.

SECTION C

Case Studies of Mechatronics Systems: Industrial Robot, Automobile Engine Control, Vehicle Suspension Control, MEMS, CNC Machine, Gyro system, 3-D Printer.

Recommended Books:

1. Isermann**,** Rolf (2005). *Mechatronics Systems*. Springer Publication
2. Bolton, W. (2003). *Mechatronics: electronic control systems in mechanical and electrical engineering*. Pearson Education.
3. Sawhney A.K. (2015). *A Course in Electrical and Electronic Measurements and Instrumentation.* Dhanpat Rai & Co Publication
4. Nakra B.C. & Chaudhry K.K. (2013). *Instrumentation, Measurement and Analysis.* Tata McGraw Hill Publication

ELE 402 Audio and Video Systems

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the fundamental concepts of television transmitter, receiver systems and the transmission of video signals and importance of television standards.
- Understand different colour television systems used worldwide and its compatibility.
- Principles of recording and reproduction of disc and video cassete recorders.

Section A

Audio Systems: Types of microphones and speakers, Monophonic, stereophonic and quadraphonic audio systems.

Disc and Magnetic Recording and Reproduction : Monophonic and stereophonic disc recording and reproducing systems, Magnetic recording , playback, Biasing & equalization, Recording medium, Magnetic heads-replay & eraser heads, Audio cassettes, Tape speed, Maximum usable frequency, Tape transport mechanism, Distortion & noise aspects, Hi-Fi stereo system.

Section B

Video Cassette Recorders: Video recording requirements, Video tape formats. Modulation-up conversion and down conversion of video signal, Servo systems, Functional Block diagram of VCR: video recording & playback.

Compact Disc Recording and Reproduction: advantages of Compact disc, & its Specifications, CD player, optical recording, CD technology & manufacturing, CDROM, CD video

Section C

Video Cameras: Image conversion principle, Plumbicon, Sidicon camera tubes, three tubes colored camera, Block diagram of color camera tube.

TV Engineering: Scanning process, Interlaced scanning, Composite video signals, Principle of black & white TV, color TV, Primary colours, Chrominance & luminance signals.

Recommended Books:

1. Bali, S.P.,&Bali, R. (2014). *Audio Video Systems Principles, Practices, and Troubleshooting***.** New Delhi: Khanna Book Publishing Co.
2. Sharma, Ajay. (1998). Audio *and Video Systems***.** New Delhi: Dhanpat Rai & Co.
3. Gupta, R.G. (2010). *Audio and Video Systems: Principles, Maintenance and Troubleshooting***.** New Delhi: Tata Mc-Graw Hill

Suggested e-resources:

1. **Digital Video Signal Processing** by Prof. Sumana Gupta, Department of Electrical Engineering, IIT Kanpur. https://nptel.ac.in/courses/117104020/1
2. **Audio System Engineering** by Prof. Shyamal Kumar Das Mandal, Department of Electronics and Communication Engineering, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105133/22

Geoinformatics

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Describe spatial database, Co-ordinate and projection system.
- Analyse vector and raster based analysis in Geographical Information Sciences.
- Describe different types of satellite system and digital image processing.

Section A

Geographical Information System: Definition, Components of GIS, Hardware and software requirements for GIS, Coordinate system and projections, Database structure and formats, Spatial data models - raster and

vector. Data inputting, Data base design - editing and topology creation. Linkage between spatial and Non spatial data, Query (Attribute/Spatial), Vector based analysis. Raster based analysis. Errors, Digital Elevation Model, Network analysis, O'pen source and WebGIS.

Section B

Remote Sensing: Definition - components of remote sensing - energy sensor, interacting body; Type - active and passive remote sensing. Satellite System - meteorological, communication and remote sensing. Platforms - aerial and space, synoptivity and repeativity. Electromagnetic Radiation (EMR) - EMR spectrum- visible, infrared [IR) middle IR, thermal IR and microwave. EMR interaction with earth surface material, radiance, irradiance, incident, reflected, absorbed and transmitted energy, spectral response pattern - spectral signature curves (water, soil and vegetation].

Digital Image Processing : Digital Image, Satellite Image - characteristics and formats. Resolution - spatial, spectral, radiometric and temporal; Introduction to rectification, enhancement; Classification - Unsupervised and Supervised classification.

Section C

Global Positioning System: Global Navigation Satellite System (GNSS), GPS, GLONASS, GALILEO, Segments - space, control, user, GPS Satellite signals, sources of errors and corrections.

Applications of Remote Sensing and GIS:

Applications of GIS and Remote Sensing in resource management (forestry, agriculture, urban telecommunication, transportation, water resources and environment).

Recommended Books:

1. Chor, Pang. Lo.,&Albert, K. W. Yeung (2006). *Concepts and Techniques-of Geographic Information Systems*. New Delhi: PHI Publication.
2. Heywood, D.I., Cornelius, S. & Carver, S. (2009). *An Introduction to Geographical Information Systems*. New Delhi: Pearson Publication.
3. Joseph, G. (2005). *Fundamentals of remote sensing*. Jaipur, Rajasthan: Universities Press.
4. Jensen, John. R. (2015). *Introductory Digital Image Processing: A Remote Sensing Perspective*. New Delhi: Pearson Publication.
5. Sabins, Floyd F. (2007). *Remote Sensing: Principles and Interpretation*. Long Grove, Illinois: Waveland Press

Suggested e-resources:

1. **Geoinformatics** by University of Twente. https://www.itc.nl/ilwis/applications-guide/
2. **Geographical Information System** by Dr A. K. Gosain, Indian Institute of Technology, Delhi. https://nptel.ac.in/courses/105102015/1

Robotics and Automation

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Develop skills of creating industrial and mobile robot projects
- Implement robots like KUKA, PUMA in real industrial world
- Create innovative robot designs using mathematical concepts of kinematics
- Develop autonomous mobile robots in surveillance, security, home and office services.

SECTION A

BASIC CONCEPTS- Automation and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system, Dynamic stabilization of Robotics.

POWER SOURCES AND SENSORS- Hydraulic, Pneumatic and electric drivers – Determination HP of motor and gearing ratio, variable speed arrangements, Path Determination - Machinery Vision – Ranging – Laser – Acoustic, Magnetic Fiber Optic and Tactile Sensor.

SECTION B

MANUPULATORS- Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators.

ACTUATORS AND GRIPPERS- Pneumatic, Hydraulic Actuators, Stepper Motor Control Circuits, End Effecter, Various types of Grippers, Design consideration.

Differential transformation and manipulators, Jacobians – problems .Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

SECTION C

KINEMATICS- Forward and Inverse Kinematic Problems, Solutions of Inverse Kinematic problems, Multiple Solution, Jacobian Work Envelop – Hill Climbing Techniques.

PATH PLANNING- Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion – Robot programming, languages and software packages.

CASE STUDY- Multiple Robots – Machine Interface – Robots in Manufacturing and Non-Manufacturing applications – Robot Cell Design Selection of a Robot.

Recommended Books:

1. Groover, M. P., Weiss, M., Nagel, R. N., & Odrey, N. G. (2017). *Industrial Robotics: Technology, programming, and Applications* (2/e). McGraw-Hill Education Publication
2. Niku, S. (2010). *Introduction to robotics*. John Wiley & Sons.
3. Fu, K. S., Gonzalez, R., & Lee, C. G. (1987). *Robotics: Control Sensing. Vis*. Tata McGraw-Hill Education.
4. Mittal, R. K., & Nagrath, I. J. (2003). *Robotics and control*. Tata McGraw-Hill.
5. Craig, J. J. (2009). *Introduction to robotics: mechanics and control, 3/E*. Pearson Education India.
6. Spong, M. W., & Vidyasagar, M. (2008). *Robot dynamics and control*. John Wiley & Sons.
7. Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2010). *Robotics: modelling, planning and control*. Springer Science & Business Media.

Biomedical Instrumentation

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Describe the principle of interfacing of Electrode-electrolyte and different types of electrodes which are used in biomedical field.
- Explain different types of recorders and photometers.
- Describe the method of measurement of BP and blood flow.

SECTION A

Electrode electrolyte interface, half-cell potential, polarization and non-polarisable electrode, calomel electrode, needle and wire electrode, microelectrode-metal micropipette. Ag/AgCl electrodes Microelectrodes, skin surface electrode, and lead for EG, ECG, EMG. Transducer for biomedical applications, factors governing the selection of transducer, pressure, temperature, flow, biomedical ultrasonic transducer.

SECTION B

Low-Noise preamplifier, main amplifier and driver amplifier, inkjet recorder, thermal array recorder, photographic recorder, magnetic tape recorder, X-Y recorder, medical oscilloscope. pH, PO2, PCO2, pHCO3, Electrophoresis, colorimeter, spectro photometer, flame photometer, auto analyzer.

SECTION C

Respiration, heart rate, temperature, pulse blood pressure, cardiac output, O2, CO2 measurements. Measurement of blood pressure, blood flow, and

heart sound, cardiograph: Phonocardiography, vector cardiograph, Echocardiography pacemaker, defibrillators, Ventilator, Computer patient monitoring system.

Recommended Books:

1. Cromwell L. (2007). *Biomedical Instrumentation and Measurement.* New Delhi: PHI Publication
2. Webster J.G.(1998). *Medical Instrumentation Application and Design*. New York: John Wiley and Sons
3. KhandpurR.S. (1997). *Handbook of Biomedical Instrumentation*. New Delhi: Tata McGraw-Hill Publication
4. Carr J. J. & Brown J. M. (1997). *Introduction to Biomedical Equipment Technology*. New York*:* John Wiley and Sons

Fiber Optics and Communication

ECE 402

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the light propagation through optical fibers.
- Explain the various light sources and optical detectors.
- Design fiber optic transmitter and receiver system.

Section A

Fiber optics: Introduction, optical fibers -geometrical Optics description, wave propagation, fiber modes, step index, graded index single and multimode fibers, dispersion, limitation on bit rate, fiber bandwidth, fiber loss, fiber manufacturing: design issue, fabrication methods, cables and connectors, fiber splicing and fiber couplers.

Section B

Optical Sources and detectors: Light-Emitting diodes: LED characteristics, modulation response, LED structures. Semiconductor Lasers: structures, Laser characteristics, single longitude mode operation, DFB and VCSEL laser, Receivers: photo detector design: P-N, PIN, Schottky barrier and Avalanche photodiode, Phototransistor, receiver noise: noise mechanisms in PIN and APD receivers, Receiver structures.

Section C

Optical Fiber Systems: optical transmitter circuit: source limitations, LED and Laser drive circuits, Optical receiver circuit, system design considerations, Digital systems, Digital optical receiver, BER, Optical power budgeting, rise time budget, line coding, analog systems: Direct

intensity modulation, subcarrier intensity modulation, coherent systems, computer, sensor and military applications.

Recommended Books:

1. Agarwal, Govind. P. (2007). *Fiber-Optic Communication Systems***.** New Delhi: Wiley India.
2. Senior, John.M. (2009). *Optical Fiber Communication Principles & Practice***.** New Delhi: PHI Publication.
3. Bhattacharya, Pallab. (2002). *Semiconductor Optoelectronics Devices***.** New Delhi: PHI Publication.
4. Keiser, Gerd. (1991). *Optical Fiber Communication***.** New Delhi: McGraw Hill Publication.

Analytical Instrumentation

L	T	P	C
4	0	0	4

(Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain majorly pH conductivity & dissolved component analyzer, dissolved oxygen analyzer, sodium analyzer, silica analyzer and moisture measurement.
- Evaluate the performance of Spectrophotometers, FTIR Spectrometers and their applications.
- Describe modern trends in NMR Spectrometers, X-ray Spectrometry, and Mass Spectrophotometers with their applications.

Section A

PH conductivity & dissolved component analyzer Sampling systems – ion selective electrodes – conductivity meters – pH meters - dissolved oxygen analyzer – sodium analyzer – silica analyzer – moisture measurement.

GAS ANALYSER Oxygen analyzer – CO monitor, CO2, O2, dust and smoke measurement, thermal conductivity type–thermal analyzer–industrial analyzers.

Section B

Spectro photometers: Spectral methods of analysis – Beer's law UV – visible spectrophotometers – single beam and double beam instruments – source and detectors – IR spectrophotometers – sources and detectors – FTIR spectrometers – atomic absorption spectrophotometer – flame emission spectrophotometers – sources of flame photometry – applications.

Section C

Nuclear magnetic resolance and radiation techniques

NMR – basic principle – NMR spectrometers – applications – introduction to mass spectrophotometers – nuclear radiation detectors – GM counter –

proportional counter – solid state detectors, X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer.

Recommended Books:

1. Willard., Merritt., Dean., & Settle. (2004). *Instrumental Methods of Analysis*. New Delhi: CBS Publishers & Distributors.
2. Ewing, Galen.W. (1985). *Instrumental Methods of Chemical Analysis*. New Delhi: McGraw-Hill Publication.
3. Liptak, B.G. (1995). *Process Measurement and Analysis*. Philadelphia: Chilton Book Company.
4. Settle,Frank.A. (1997). *Handbook of Instrumental Techniques for Analytical Chemistry*. New Delhi: PHI Publication.
5. Braun, Robert.D. (2012). *Introduction to Instrumental Analysis*. Hyderabad, Karnataka:BSP Books Pvt.Ltd.
6. Skoog., Holler.,& Crouch. (2017). Principles *of Instrumental Analysis*. New Delhi: Cengage Learning Publication.

Suggested e-resources:

1. **Modern Instrumental Methods of Analysis** by Prof. J. R. Mudakavi, Department of Chemical Engineering, Indian Institute of Science, Bangalore. https://nptel.ac.in/courses/103108100/

Digital Signal Processing

ELE 304

L	T	P	C
4	0	0	4

(Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Families with the most important methods in DSP.
- Families with design and functioning of digital filter design.
- Transform-domain processing.

Section A

Introduction of Signals, Systems and Signal Processing, Classification of Signals and Systems, Advantages of digital over analog Signal processing, Signal Models - Continuous Time versus Discrete time signals, Periodic and aperiodic Signals, Phasor Signals and Spectra, Energy and Power Signals, System Modeling Concepts, The superposition integral for Fixed and Linear Systems, Impulse Response of a Fixed and Linear System - Fourier Series - Trigonometric Series- Exponential Fourier Series-

Symmetry Properties of the Fourier Coefficients. Fourier Integral, Energy Spectral Density, Fourier Transforms in the Limit, Fourier Transform Theorems and Pairs, System Analysis with Fourier Transform, Lap lace Transform Theorems, Network Analysis using the Laplace Transform.

Section B

Discrete Time Signals and Systems - Review of Sampled Data Systems, Time Domain Representations of Discrete Time Signals, Frequency Domain Representation of Discrete Time Signals, Discrete Time Signals obtained by sampling, Discrete Fourier Transform. Z-Transform - Definition and Examples, Inverse Z-Transform, Properties of the Z-Transform, Introduction to Realization of Digital Systems - Block Diagrams and Signal Flow Graphs. Introduction to Realization of an IIR and FIR systems, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT).

Section C

Design of Digital Filters: Introduction to Filters, A comparison of IIR and FIR Digital Filters. Design of IIR Digital Filters –Impulse Invariant Transformation, Bilinear Transformation, Design of Digital Butter worth and Chebyshev Filters. Design of FIR Digital Filters - Windowing and Rectangular Window, Filter Designs using Windows, Frequency Sampling Technique. DSP tools and DSP techniques in various applications.

Recommended Books:

1. Johnson, Johnny. R. (1998). *Introduction to Signal Processing*. New Delhi: phi Publication.
2. Oppenheim, V. Alan. (1995). *Signal & Systems*. New Delhi: PHI Publication.
3. Proakis, G.John. (2002). *Digital Signal Processing*. New Delhi: PHI Publication.

Suggested E-resource:

1. **Digital Signal Processing** by Prof: S. C. Dutta Roy, Department of Electrical Engineering Indian Institute of Technology, Delhi. https://nptel.ac.in/courses/117102060/

Communication Networks

ECE 303

L	T	P	C
4	0	0	4

Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Recognize and describe about the working of Computer Networks.

- Illustrate reference models with layers, protocols and interfaces.
- Summarize functionalities of different Layers.

Section A

Introduction to communication systems and data communications. Introduction of network, requirement of Internet. Data Networking, Network history, Local area network topologies, WAN, MAN,VPN, (Virtual Private Network). Bandwidth, Bandwidth data rate. Multiplexing-TDM, FDM, CDMA, data encoding. Network model-layer structure of network model. OSI Model, OSI layers. TCP/IP Model layers. Arpanet, Peer to Peer communication. Communication Media and cable-structure-through wire-copper cable-STP, UTP, co-axial cable, optical fiber. Wireless media-wireless LAN, organization and standards. Wireless devices and topologies. Wireless communication, wireless security.

Section B

Network layer devices-Modem, NIC, hub, bridge, switch, router, firewall, gateway. Switching Networks-circuit switching, Packet Switching. Networks-Circuit Switching, Packet Switching. Networks addressing schemes-MAC Address, Subneting, Superneting. Routing Concept, Routing protocol (RIP), Routed protocols. Introduction to IPV6 Principles of Internetworking. Ethernet (CSMA/CD) Token Ring and FDDI, Fast Ethernet.

Section C

Layer protocol Structure. Data link control – Flow Control, Error Detection, Error Control. HDLC. Network layer-ARP, RARP, ICMP. Effect of Congestion and Congestion Control in Network-(Back pressure, choke packet, Implicit Congestion Signaling, Explicit Congestion Signaling. Traffic Management- Transport layer Protocols-connection oriented and connectionless services, TCP, TCP Congestion Control and Flow Control. UDP. Application Layer Protocols – HTTP, FTP, SMTP, SNMP, Telnet. Introduction to ISDN. Narrow Band and Broad Band. Introduction to WAN Technologies. ATM and Frame relay.

Recommended Books:

1. Jordan, E.C.(1986). *Electromagnetic Wave & Radiating System*. New Delhi: PHI Publication.
2. Tanenbaum, A.S. (1997). *Computer Networks*. New Delhi: Pearson Publication.
3. Stailling, W. (1997). *Data & Computer Communication*. New Delhi: PHI Publication.
4. Martin, J. (1998). *Computer Networks and Distributed Processing Software, Techniques, Architecture*. New Delhi: PHI Publication.

Suggested E-Resources:

1. **Computer Networks and Internet Protocol** by Prof. Soumya Kanti Ghosh Department of Computer Science and Engineering Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/106105183/

2. **Computer Networks** by Prof. Sujoy Ghosh, Department of Computer Science and Technology, IIT KG. https://nptel.ac.in/courses/106105081/
3. **Computer Networks** by Prof. Hema A Murthy, IIT Madras. https://nptel.ac.in/courses/106106091/
4. **Data Communication** by Prof. Ajit Pal, IIT KG. https://freevideolectures.com/course/2278/data-communication

Optical Network

ECE 404

L	T	P	C
4	0	0	4

Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Describe the important components such as multiplexer, filters.
- Explain the multiplexing technique
- Describe the protection technique in SONET/SDH and IP network

Section A

Introduction to Optical Networks, Characteristics of Optical Fiber (Emphasis on Non Linear Characteristics) Timing & Synchronization, Components: Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Tunable Lasers, Switches, Wavelength Converters, Networks SONET/SDH, Multiplexing, SONET/ SDH Layers, Frame, Structure, Frame Structure, Physical Layer, Elements of a SONET/SDH Infrastructure

Section B

ATM : Functions of ATM, Adaptation Layers, Quality of Service, Flow Control, Signaling and Routing, WDM Network Elements, Optical Line Terminals, Optical Line Amplifiers,

Optical Add/ Drop Multiplexers, Optical Cross Connects, WDM Network Design, Cost Trade-offs, Light path Topology Design, and Routing and wavelength assignment problems, Dimensioning Wavelength Routing Networks,

Section C

Network Survivability Basic Concepts, Protection in SONET/SDH, Protection in IP networks, Optical Layer Protection, Different Schemes, Interworking between Layers

Access Networks, Network Architecture Overview, Enhanced HFC, FTTC, Optical Switching, OTDM, Synchronization, Header Processing, Buffering, Burst Switching. Deployment Considerations

Recommended Books:

1. Ramaswami, Rajiv.,&Sivarajan, Kumar. N.(2009). *Optical Networks: A Practical Perspective*. San Francisco, California: Morgan Kaufmann Publisher.
2. Uyless, Black. (2009). *Optical Networks Third Generation Transport Systems***:** New Delhi: Pearson Publication.
3. Tanenbaum, Andrew. S. (2010). *Computer Networks***.** New Delhi: Pearson Publication.
4. Murthy, C. Siva Ram.,&Gurusamy Mohan. (2001). WDM, Optical Networks Concepts, Design & Algorithms**.** New Delhi: Pearson Publication.

Suggested e-resources:

1. **Introduction to Optical Networks** by Yatindra Nath Singh, Department of Electrical Engineering, Indian Institute of Technology, Kanpur. http://home.iitk.ac.in/~ynsingh/seminars/OptNets.pdf
2. **Optical Networks and Switching Systems** by Prof. Yatindra N Singh, Department of Electrical Engineering Indian Institute of Technology, Kanpur. https://nptel.ac.in/syllabus/117104021

Satellite Communication

ECE 406

L	T	P	C
4	0	0	4

Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Identify the fundamentals of orbital mechanics, the characteristics of common orbits used by communications and other satellites, and be able to discuss launch methods and technologies.
- Understand the systems required by a communications satellite to function and the trade-offs and limitations encountered in the design of a communications satellite system.
- Understand different Networks topologies and applications of networks, as well as the comparison to alternative communications systems.

Section A

Elements of Satellite Communication, Orbital mechanics, look angle and orbit determination, launches & launch vehicle, orbital effects, Geostationary Orbit, Satellite subsystems, attitude and orbit control systems, TTC&M, communication subsystem, satellite antenna, satellite link design: basic transmission theory, system noise temperature and G/T ratio, downlink design, uplink design, satellite systems using small earth station, design for specified C/N.

Section B

Modulation and multiplexing techniques for satellite links: FM, pre-emphasis and de-emphasis, S/N ratios for FM video transmission, digital transmission, digital modulation and demodulation, TDM.Multiple access: FDMA, TDMA, DAMA and CDMA.

Section C

Error control for digital satellite links: error detection and correction, channel capacity, error control coding, convolutional codes, linear and cyclic block codes. Propagation effects and their impact on satellite-earth links: attenuation and depolarization, atmospheric absorption, rain, cloud and ice effects etc. Introduction of various satellite systems: VSAT, low earth orbit and non-geostationary, direct broadcast satellite television and radio, satellite navigation and the global positioning systems.

Recommended Books:

1. Bostian,Charles., Pratt, Timothy., & Allnutt, Jeremy. (2006). *Satellite Communications***.** New Delhi: John Wiley & Sons.
2. Roddy, Dennis. (2017). *Satellite Communications***.** New Delhi: McGraw-Hill Publication
3. Ha, Tri. T. (1990). *Digital Satellite Communications.* New Delhi: McGraw-Hill Publication

Suggested e-resources:

1. **Satellite Communication Systems** by Prof. Kalyan Kumar Bandyopadhyay Department of Electronics and Electrical Communication Engineering Indian Institute of Technology, Kharagpur. http://textofvideo.nptel.ac.in/117105131/lec1.pdf
2. **Satellite Link Design** by Dr. Marwah Ahmed. https://net425site.files.wordpress.com/2017/02/net-425-d-feb-2016-lec-5.pdf

Mobile Communication

ECE 403

L	T	P	C
4	0	0	4

Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- To understand the various generations of mobile communications and basics of wireless communication
- To understand the concept of cellular communication
- Can conduct field experiments and measurements

Section A

Introduction to Wireless Communication System: Evolution of mobile radio communication, Mobile radiotelephony in U.S Mobile radio system around the world, second generation (2G) cellular network, evolution to 2 5G

wireless network evolution for 2.5G TDMA standards, third generation (3G) wireless network. The Cellular concept- System design fundamentals, frequency reuse channel, assignment strategies. Hand off strategies Interference and system capacity, improving coverage and capacity in cellular system.

Section B

Propagation model and Spread Spectrum Modulation Techniques: Longley rice model, kumara model hata model pcs extension to hata model, wolfish and betony model, Pseudo Noise (PN) sequence,. Direct sequence spread spectrum (DSSS), frequency hopped spread spectrum (FHSS). Multiple Access Techniques for Wireless Communication, Introduction to multiple access. Frequency division multiple access (FDMA) Time division Multiple access (TDMA).

Section C

Spread spectrum multiple access. Packet Radio. Global System for Mobile Communication, channel types, Example of a GSM cell. Frame structure of GSM, Data over low power wireless Re-cordless Network.

Recommended Books:

1. Rappaport,Theodre. S. (2014) *Wireless Communication***.** New Delhi: Pearson Publication.
2. Pandya, Raj. (1999). *Mobile and Personal Communication System and Services***:** New Delhi: PHI Publication.
3. Goddman, David.J. (1997). *Wireless Personal Communication System***:** Addition Wesley Publication.
4. Tesal, Joachim. (1997). *GSM cellular Radio***:** New Delhi: John Wiley Publication

Suggested E-Resources:

1. **Wireless Communications** by Prof. Dr.Ranjan Bose, Department of Electrical Engineering, IIT Delhi. https://nptel.ac.in/courses/117102062/

Radar Navigation

ECE 405

L	T	P	C
4	0	0	4

Max. Marks: 100)

(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the basic concept of Radar and applications of various types.
- Understand the different Radar Performance factors.
- Explain the operation of CW& FM Radar.

Section A

RADAR SIGNAL MODELS: Amplitude models, distributed target forms of range equation, radar cross section, statistical description of radar cross section, Swerling model, Clutter, signal to clutter ratio, temporal and spatial correlation of clutter, noise model and signal to noise ratio, frequency models, Doppler shift, simplifies approach to Doppler shift, stop and hop assumption, spatial model, variation with angle, variation with range, projections, multipath, spectral models.

RADAR WAVE FORMS: Waveform matched filter of moving targets, ambiguity function, ambiguity function of the simple matched pulse filter for the pulse burst, pulse by pulse processing, range ambiguity, Doppler response and ambiguity function of the pulse burst.

Section B

DETECTION FUNDAMENTALS: Radar detection as hypothesis testing, Neyman-Pearson detection rule, likelihood ratio test, threshold detection of radar signals, non-coherent integration of nonfluctuating targets, Albersheim and Shnidaman equations, Binary integration.

RADIO DIRECTION FINDING: loop direction finder, goniometer, errors in direction finding, adcock and automatic direction finders, commutated aerial direction finder. RADIO RANGES: LF/MF four course radio ranges, VOR, ground equipment & receiver, VOR errors.

HYBERBOLIC SYSTEM OF NAVIGATION: LORAN Decca & Omega system.DME & TECAN.

Section C

Aids to approach and landing: ILS, GCA & MLS

Doppler navigation: beam configuration, doppler frequency equation, track stabilisation and doppler spectrum, components of doppler navigation system, doppler radar equipment, CW & FMCW doppler radar, frequency trackers, doppler range equation.

Satallite navigation system: transit system, navstar, gps, basic principles of operation, signal structure of navstar broadcasts, data message, velocity determination, accuracy of GPS & differential navigation, navstar receiver.

Recommended Books:

1. Richards, Mark. A (2014). *Fundamentals of Radar Signal Processing*. New Delhi:TMH Publication.
2. Nagraja, N. S. (2009). *Elements of Electronics Navigation*: New Delhi:TMH Publication.
3. Peebles Jr. P. Z. (1998). *Radar Principles*. New Delhi: Wiley Publication.

Suggested E-Resources:

1. **Introduction to Radar Systems** by Dr. Robert O'Donnell, Massachusetts Institute of Technology. https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems-spring-2007

Power Electronics

EEE 304

L	T	P	C
4	0	0	4

Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- To explain various power semiconductor devices like Thyristor, GTO, MOSFET and IGBT
- Analyze the various rectifiers used in power circuits and DC to DC Converters
- Explain the inverter operation and how harmonics are reduced and explain the basic working principle of cyclo-converters

SECTION A

Need of power electronics, Introduction to power electronics devices (static and dynamic characteristics) power diodes, power transistor, power MOSFETS, IGBT, MCT, GTOs, Triac. Thyristor SCR: Operational characteristics, Turn ON methods, switching characteristics, thyristor protection: over voltage protection, over current protection, gate protection, snubber circuit. Firing circuits for Thyristors, heating, series and parallel combination of Thyristors.

SECTION B

Commutation Techniques: Load commutation, resonant- pulse commutation, complementary commutation, impulse commutation, line commutation. Phase controlled rectifier: Principal of phase control, single and three phase converters. Effect of source impedance on the performance of converters, dual converter (ideal and practical) DC choppers: Principle, control strategies, step-up and step-down choppers.

SECTION C

Inverters: Single-phase voltage source inverters, 180 and 120 mode operations, Fourier analysis of single-phase inverter output voltage. Pulse width modulated inverters, Reduction of harmonics in the inverter output, single-phase current source inverters with ideal switch. Cyclo-converters: Step-up and step-down cyclo-converter, Single phase to single-phase cyclo-converters three-phase half wave cyclo-converters.

Recommended Books:

1. Rashid, Mohammad. H. (2017). *Power Electronics Circuits, Devices and Applications*. New Delhi: PHI Publication.
2. Bimbhra, P.S. (2012). *Power Electronics***.** New Delhi: Khanna Publication.

3. Moorthy, Rama, (1991). *An Introduction to Thyristors and their Application***.** New Delhi: Affiliated East-West Press.

Suggested E-Resources:

1. **Power Electronics** by Prof. B.G. Fernandes, Department of Electrical Engineering, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101038/
2. **Power Electronics** by Prof. D. Prasad, Dr. D. Kastha, Prof. SabyasachiSengupta, Prof. N. K. De, Dept of Electrical Engineering, IIT Kharagpur. https://nptel.ac.in/courses/108105066/

Antenna Analysis

L	T	P	C
4	0	0	4

Max. Marks: 100)
(CA: 40 + ESA: 60)

Learning Outcomes: After successful completion of the course, student will be able to:

- Recall electromagnetic plane waves. Apply principles of electromagnetic to explain antenna radiation. Explain various antenna parameters.
- Explain antenna as a point source. Design antenna patterns for different cases.
- Explain dipole antennas. Establish mathematical equations for various parameters of thin linear antenna.

Section-A

Introduction to antenna, Radiation Mechanism, Current Distribution on a Thin Wire Antenna

Fundamental parameters of antenna: Radiation pattern, Radiation power density, Radiation intensity, Beamwidth, Directivity, Antenna efficiency, Gain, Beam efficiency, Bandwidth, Polarization, Input impedance, Antenna radiation efficiency, Antenna vector effective length, Maximum directivity and Maximum effective area, Friis transmission equation and radar range equation

Section-B

Radiation Integrals and Auxiliary Potential Functions: The Vector Potential A for an Electric Current Source J, The Vector Potential F for a Magnetic Current Source M, Electric and Magnetic Fields for Electric (J) and Magnetic (M)Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-field radiation, Duality theorem, Reciprocity and Reaction theorem, Image Theory

Linear wire antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, Half-wave dipole

Loop Antennas: Small circular loop, Square loop

Section-C

Introduction to Arrays, two-element array, N-element linear array: uniform amplitude and spacing, directivity, N-element linear array: uniform spacing, non-uniform amplitude
Traveling wave antennas: Long wire antenna, V-antenna, rhombic antenna
Broadband antennas: Helical antenna, Folded dipole, Yagi-uda array of linear elements
Log-periodic antenna, Introduction to Horn antenna: E-plane sectoral horn, H-plane sectoral horn, Pyramidal horn

Recommended Books:

1. Balanis, C. A. (2005). *Antenna Theory Analysis and Design.* New Delhi: John Wiley & Sons.
2. Eliott, Robert S. (2003). *Antenna Theory and Design*. New Delhi: Wiley-IEEE Press.
3. Kraus, J. D., & Marhefka, R. H. (2001). *Antennas for All Applications,* Singapore: McGraw-Hill Publication.
4. Harrington, R. F. (2001). *Time-Harmonic Electromagnetic Fields*. New Delhi: Wiley-IEEE Press.

Suggested E- resources:

1. **Advanced Antenna Theory** by Dr Amalendu Patnaik, Indian Institute of Technology, Roorkee. https://nptel.ac.in/courses/117107035/
2. **Analysis and Design Principles of Microwave Antennas** by Prof. Amitabha Bhattacharya, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/108105114/
3. **Antennas** by Prof. Girish Kumar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101092/

Reading Electives

Electronic Packaging

L	T	P	C
0	0	4	2

(Max. Marks: 100)

This course is designed to provide a basic knowledge of the technologies and processes required for the packaging of electronic products. The focus of the course will be on the mechanical, and materials aspects which are often neglected in the design phase with potentially catastrophic consequences. Students will be expected to explore the underlying scientific and technological knowledge-based needed to become proficient builders and users of electronic systems. The students will also be able to explain the fundamental principles for packaging active and passive electronic devices;

design of components, circuit boards, connectors, and assemblies; electromagnetic interference and its impact on packaging, thermal and mechanical design; and reliability assessment methods**.**

Suggested e-resource:

1. **Electronics Packaging and Manufacturing** by IIT Kharagpur https://onlinecourses.nptel.ac.in/noc18_me54.

Professional Ethics

L	T	P	C
0	0	4	2

(Max. Marks: 100)

The course is intended to provide participants with the ability to analyse ethical situations, such as how they interact and what can be expected from them as correct ethical behaviour. In turn, any professional will benefit from a critical scrutiny of their own ethics by those from other professions. The general principles of professional ethics will be examined, as well as the distinctive problems of the different fields. The participant will also be expected to explain the pertaining issues, such as professional codes of ethics, confidentiality, obligations and Moral Values in Professional Ethics, the limits of predictability and responsibilities of the engineering profession, research misconduct, and work place rights & responsibilities.

Suggested e-resources:

1. **Professional Ethics** by Rochester Institute of Technology. http://www.openculture.com/professional-ethics-a-free-online-course.
2. **Ethical Practice: Leading Through Professionalism, Social Responsibility, and System Design** by Prof. Leigh Hafrey, MIT, USA. https://ocw.mit.edu/courses/sloan-school-of-management/15-270-ethical-practice-leading-through-professionalism-social-responsibility-and-system-design-spring-2016.

Electric Vehicles

L	T	P	C
0	0	4	2

(Max. Marks: 100)

Electric vehicles are the future of transportation. Electric mobility has become an essential part of the energy transition, and will imply significant changes for vehicle manufacturers, governments, companies and individuals. This course prepare the students for product development positions in the automotive, communications, solar, wind turbine, and smart grid industries and service positions in the automotive industry. This course will be a first level course on electric vehicle. Students will be able to understand the operation of battery driven electric vehicle. The course will focus on areas that come under the umbrella of electric vehicles, such as

vehicle dynamics, Motors, Power Electronics, Batteries, Charging and etc. Students will explore the most important aspects of this new market, including state-of-the-art technology of electric vehicles and charging infrastructure.

Suggested e-resources:

1. **Electric Vehicles Part 1** by IIT Delhi. https://onlinecourses.nptel.ac.in/noc19_ee18/preview.
2. **Electric Cars: Introduction** by Delft University of Technology (TU Delft). https://www.edx.org/course/electric-cars-introduction-0.

Telecommunication Switching Systems and Networks

L	T	P	C
0	0	4	2

(Max. Marks: 100)

The course is intended to develop the good understanding of the fundamentals and application of telecommunication networks i.e. PSTN, PDN and ISDN, modern digital telecommunication switching and networks. The participants will be expected to explain the recent terminology, like switching systems, traffic management, time division switching systems, data communication Networks, routing, ISDN, voice data integration and importance of telephone traffic analysis and telephone networks.

Suggested e-resources:

1. **Computer Networks** by Department of CSE, IIT Kharagpur https://nptel.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Communication%20network/New index1.html
2. **Data Communication** by IIT Kharagpur. https://nptel.ac.in/courses/106105082/19.

Multimedia Compression and Communication

L	T	P	C
0	0	4	2

(Max. Marks: 100)

The purpose of this course is to understand the multimedia communication and compression. In this course students will be expected to explore various multimedia components and their characteristics, such as hardware, animation and graphics and able to explain the various audio and video compression techniques and apply these techniques in multimedia communication. The student will also be able to develop the understanding of network architecture, protocols, resource management, multimedia operating systems, scheduling and policing mechanisms.

Suggested e-resource:

1. **Multimedia Processing** by IIT Kharagpur. https://nptel.ac.in/syllabus/117105083/.

Electromagnetic Compatibility

L	T	P	C
0	0	4	2

(Max. Marks: 100)

This course describe the systems that generate or consume electrical energy can produce electromagnetic noise that may interfere with the operation of the system itself and/or other systems. The course will enable students to understand how the principles of electricity and magnetism can be applied to design electrical and electronic systems that can co-exist harmoniously, that is, to design systems that are electromagnetically compatible with each other. The students will also be expected to explain how electromagnetic disturbances are generated in systems, how they couple to other systems, and how systems can be protected.

Suggested e-resource:

1. **Electromagnetic Compatibility** by Daniel Mansson, KTH Royal Institute of Technology, Sweden https://onlinecourses.nptel.ac.in/noc19_ee17/preview.

IoT Sensors and Devices

L	T	P	C
0	0	4	2

(Max. Marks: 100)

This course is for practical learners who want to explore and interact with the IoT Bridge between the cyber- and physical world. Student will learn about the 'things' that get connected in the Internet of Things to sense and interact with the real world environment – from something as simple as a smoke detector to a robotic arm in manufacturing. This course is about the devices that feel and the devices that respond. The course also describe about IoT sensors, actuators and intermediary devices that connect things to the internet, as well as electronics and systems, both of which underpin how the Internet of Things works and what it is designed to do.

Suggested e-resources:

1. **IoT Sensors and Devices** by Curtin University. https://www.edx.org/course/sensors-and-devices-in-the-iot.
2. **Internet of Things: Sensing and Actuation** by University of California San Diego https://www.coursera.org/learn/internet-of-things-sensing-actuation.