Course Curriculum for B. Tech.

In

Electronics & Communication Engineering

(For students admitted in 2019-20 onwards)

National Institute of Technology
Arunachal Pradesh

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1.0 Semester wise Credit point distribution

Sl. No.	Year	Credit Point	
		ODD	EVEN
1	First	18.5	20.5
2	Second	22	20
3	Third	22	22
4	Fourth	17	18
Total Credit Point		**79.5**	**80.5**
		160	

2.0 Subject Category wise Credit point Distribution

Course Category	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Sem-VII	Sem-VIII	Total Credit Point
Core (Basic Science)	**7**	**10**	**4**	**--**	**--**	**--**	**--**	**--**	**21**
Core (Engineering Science)	**6**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**9**
Core (Professional)	**--**	**--**	**12**	**15**	**18**	**18**	**5**	**--**	**68**
Core (Humanities)	**3**	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**12**
Elective (Professional)	**--**	**--**	**--**	**--**	**--**	**--**	**3**	**--**	**3**
Open Elective	**--**	**--**	**--**	**--**	**--**	**--**	**3**	**--**	**3**
Elective (online course)	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**6**	**6**
Lab (Basic Science)	**1**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
Lab (Engineering Science)	**1.5**	**3.5**	**--**	**--**	**--**	**--**	**--**	**--**	**5**
Lab (Humanities)	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lab (Professional)	**--**	**--**	**3**	**2**	**4**	**4**	**3**	**--**	**16**
Internship	**--**	**--**	**--**	**--**	**--**	**--**	**3**	**--**	**3**
Academic Project	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**10**	**10**
Audit (NSS/NCC)	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**0**
Grand Viva	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**	**2**
Total Credit Point	**18.5**	**20.5**	**22**	**20**	**22**	**22**	**17**	**18**	**160**

3.0 Course Structure

IIIrd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MA-201	Probability and Statistics	3	1	0	4
2	MH-201	Introduction to Human Values& Ethics	3	0	0	3
3	EE-201	Electrical Circuit Analysis	3	0	0	3
4	CS-201	Data Structure & Algorithm	3	0	0	3
5	EC-201	Analog Circuits – I	3	0	0	3
6	EC-202	Digital Logic Design	3	0	0	3
7	CS-203	Data Structure & Algorithm Laboratory	0	0	2	1
8	EC-203	Analog Circuits-I Laboratory	0	0	2	1
9	EC-204	Digital Logic Design Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						22
IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MH-206	Entrepreneurship	3	0	0	3
2	CS-206	Computer Organization & Architecture	3	0	0	3
3	EC-221	Electromagnetic Field Theory	3	0	0	3
4	EC-222	Signals & Systems	3	0	0	3
5	EC-223	Analog Circuits-II	3	0	0	3
6	EC-224	Analog Communication	3	0	0	3
7	EC-225	Analog Circuits-II Laboratory	0	0	2	1
8	EC-226	Analog Communication Laboratory	0	0	2	1
Contact Hours			18	0	4	
Total Credits						20
Vth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE 305	Linear Control Systems	3	0	0	3
2	EE-307	Power Electronics	3	0	0	3
3	EC-301	Linear Integrated Circuits	3	0	0	3
4	EC-302	Digital Communication	3	0	0	3
5	EC-303	Microprocessor & Interfacing	3	0	0	3
6	EC-304	Digital Signal Processing	3	0	0	3
7	EC-305	LIC Laboratory	0	0	2	1
8	EC-306	Digital Communication Laboratory	0	0	2	1
9	EC-307	Microprocessor & Interfacing Laboratory	0	0	2	1
10	EC-308	Digital Signal Processing Laboratory	0	0	2	1
11	EC-390	Internship - I	0	0	0	0
Contact Hours			18	0	8	
Total Credits						22
VIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	CS-306	Computer Networking	3	0	0	3
2	EC-321	Information Theory & Coding	3	0	0	3

3	EC-322	Instrumentation & Measurement	3	0	0	3
4	EC-323	Microcontrollers & Embedded Systems	3	0	0	3
5	EC-324	Microwave Engineering	3	0	0	3
6	EC-325	VLSI Design	3	0	0	3
7	EC-326	Instrumentation & Measurement Laboratory	0	0	2	1
8	EC-327	Microcontrollers & Embedded System Laboratory	0	0	2	1
9	EC-328	Microwave Engineering Laboratory	0	0	2	1
10	EC-329	VLSI Design Laboratory	0	0	2	1
11	EC-391	Internship – II	0	0	0	0
Contact Hours			18	0	8	
Total Credits						22
VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	OE-XXX	Open ELECTIVE	3	0	0	3
2	EC-401X	Elective-I	3	0	0	3
3	EC-402	Wireless Communication	3	0	0	3
4	EC-403	Antenna & Wave Propagation	3	0	0	3
5	EC-404	Advance Communication Laboratory	0	0	2	1
6	EC-405	Antenna & Wave Propagation Laboratory	0	0	2	1
7	EC-490	Internship – III	0	0	0	3
Contact Hours			12	0	6	
Total Credits						17
VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EC-421X	Elective-II (Swayam/ NPTEL)	3	0	0	3
2	EC-422X	Elective-III (Swayam/ NPTEL)	3	0	0	3
3	EC-491	Grand Viva	0	0	4	2
4	EC-499	Project & Dissertation	0	0	20	10
Contact Hours			6	0	24	
Total Credits						18

4.0 List of subjects offered under Elective-I

Course Code (EC-401X)	Course Title
EC - 401A	Optical Communication
EC - 401B	Wireless Sensor Network
EC - 401C	Image processing
EC – 401D	Machine Learning

5.0 Open elective (offered by other department) — [OE - XXX]

- Students are free to choose any subjects of their interest offered as open electives by other department of the Institute.
- The course has to be of 3 credits.
- During the beginning of the 7th semester, HoD, Electronics & Communication will notify the specific subject offered as an open elective for other departments.

6.0 Elective-II & III

- These two courses will be chosen from NPTEL (https://nptel.ac.in/) / SWAYAM portal (https://swayam.gov.in).
- Student can enrol in 4^{th} year (7^{th} & 8^{th} semester). However, the courses will be credited in 8^{th} semester only.
- Courses will be of completely student's choice and should be of at least of 12 weeks including tutorials which will be considered as 3 credit course.
- The choice of courses should be from outside the core and electives offered / opted.

7.0 Internship

- Internship - I: Student will go for internship during summer vacation (after 4^{th} semester) for a period of 4 weeks. The assessment will be done on 7^{th} semester
- Internship - II: Student will go for internship during winter vacation (after 5^{th} semester) for a period of 4 weeks. The assessment will be done on 7^{th} semester
- Internship - III: Student will go for internship during summer vacation (after 6^{th} semester) for a period of 4 weeks. The assessment will be done on 7^{th} semester
- At least one internship has to be done in Industry preferably during Internship - III.

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INSTITUTE VISION

"To transform into an acclaimed institution of higher learning with creation of an impact on the north eastern region in terms of innovation and entrepreneurship."

INSTITUTE MISSION

- ✓ *To generate new knowledge through state of the art academic program and research in multidisciplinary field*
- ✓ *To identify regional, Indian and global need to serve the society better.*
- ✓ *To create an ambience to flourish new ideas, research and academic excellence to produce new leaders and innovators*
- ✓ *To collaborate with other academic, research institutes and industries for wholistic growth of the students*
- ✓ *Utilization of available big resources to encourage entrepreneurship through formation of startups*

DEPARTMENT MISSION

"To pursue excellence in education and research in Electronics and Communication Engineering"

DEPARTMENT MISSION

The mission of the Department of Electronics and Communication Engineering are:

- *To impart strong theoretical and experimental foundation in Electronics and Communication Engineering*
- *To educate students with state of art technologies to meet the growing challenges of industry as well as society*
- *To produce and disseminate theory, principles, practice and know – how of various fields of Electronics such as Communication, signal processing, VLSI, Nanotechnology and many more in tune with the needs and demands of changing times.*

Programme Outcomes (POs)

The students who have undergone the B.Tech. programme in Electronics and Communication Engineering (ECE) will be able to:

PO1	Apply basic science and mathematics to analyze complex engineering problems
PO2	Gather requirement specifications, design and test electronic systems.
PO3	Apply EDA tools to design linear and digital IC systems.
PO4	Analyze and design noise-free analog and digital communication systems
PO5	Evaluate strengths and weaknesses of evolving state of art communication systems.
PO6	Understand and practice professional ethics.
PO7	Work in a team using technical skills, common tools and environments to achieve project objective.
PO8	Communicate effectively with peers and others.

B. Tech. 2nd Year, Semester III

III rd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MA-201	Probability and Statistics	3	1	0	4
2	MH-201	Introduction to Human Values& Ethics	3	0	0	3
3	EE-201	Electrical Circuit Analysis	3	0	0	3
4	CS-201	Data Structure & Algorithm	3	0	0	3
5	EC-201	Analog Circuits – I	3	0	0	3
6	EC-202	Digital Logic Design	3	0	0	3
7	CS-203	Data Structure & Algorithm Laboratory	0	0	2	1
8	EC-203	Analog Circuits-I Laboratory	0	0	2	1
9	EC-204	Digital Logic Design Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						22

Name of the Module: Analog Circuits - I
Module Code: EC-201
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in widely used and important applications

B. Course Content

Introduction to Semiconductor: Review of quantum mechanics, Electrons in periodic lattices, E-k diagrams, Quasi particles in semiconductors, Evolution and uniqueness of semiconductor technology, Equilibrium carrier concentration, Thermal equilibrium and wave particle duality, Bond and band models of Intrinsic and Extrinsic semiconductors.

Carrier transport: Random motion drift and diffusion, Excess carriers, Injection level lifetime direct and indirect semiconductors, Procedure for analyzing semiconductor devices, Basic equations and approximations.

P-N Junction: Device structure and fabrication, Equilibrium picture, DC forward and reverse characteristics, Small-signal equivalent circuit, Switching characteristics, Schottky, Homo and hetero-junction band diagrams, I-V characteristics and small signal switching models.

Bipolar Junction Transistor: History, Device structures and fabrication, Transistor action and amplification, Common emitter DC characteristics, Small-signal equivalent circuit, Ebers-Moll model and SPICE model.

Transistor Biasing and Thermal Stabilization: Graphical analysis of transistor circuits, Bypass capacitor, Coupling capacitors, Need for biasing, Operating point, Load line analysis, BJT biasing methods, Stabilization against V_{BE}, Ic, and β, Stability factors, (S, S', S"), Bias

compensation, Thermal runaway, Thermal stability, Introduction to FET, biasing methods and analysis.

Transistor Amplifiers: BJT & FET amplifier circuits, Small signal analysis, Hybrid parameters, CE, CB, CS and CD Configuration, Impedance, reflections, Phase splitter
Frequency Response: Low frequency and high frequency response of CE / CS amplifiers, Miller's theorem, High frequency response of CG and cascode amplifiers

C. Text Books

1. B G. Streetman & S K Banerjee, Solid State Electronic Devices, 7th edition, Pearson Education, 2015
2. D.L. Schilling & C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill, 1989.

D. Reference Books

1. S.M. Sze, Physics of Semiconductor Devices, 3rd edition, Wiley Eastern, 2008
2. Kevin F. Brennan,The Physics of Semiconductors, Cambridge Univ. Press., 1999.
3. J. Millman & A Grabel, Microelectronics, 2nd edition, Tata McGraw Hill, 2017.
4. A.S. Sedra & K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Apply the knowledge of basic semiconductor material physics
CO2. Characterize semiconductors, diodes, transistors and amplifiers
CO3. Analyze the characteristics of various electronic devices like diode, transistor etc.
CO4. Design simple analog circuits

Name of the Module: Digital Logic Design
Module Code: EC-202
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The course is designed to meet the following objectives:

- To build a solid foundation about Boolean algebra
- To study Digital Logic Gates and Circuits
- To provide a clear foundation of Modern Digital Systems

B. Course Content

Number systems: Decimal, Binary, Octal and Hexadecimal systems, Conversion of a number from one base to another, Introduction to logic gates.
Boolean algebra: Theorems and operations, Boolean expressions and truth tables, Duality and inversion, Multiplying out and factoring expressions, Exclusive-OR and equivalence operations, Positive and negative logic.

Combinational logic design using truth table: Minterms and maxterms expressions.
Minimization techniques: Algebraic method, Karnaugh maps (including 5 and 6 variables), Quine-McCluskey method, Multi-output circuits, Multi-level circuits, Design of circuits with universal gates.
Codes: BCD, Excess- 3, Gray, ASCII, EBCDIC.

***Combinational circuits*:** Arithmetic circuits: adders and subtractor-ripple carry adders, Carry look ahead adders, Adder cum subtractor, BCD Adder and Subtractor, Comparator, Decoder, Encoder, Priority encoder, MUX/DEMUX and their structures.
Combinational logic design: using ROM array, Applications of MSI designs.

Sequential circuits: Latches and Flip-Flops: SR latch, SR Flip-Flop, JK Flip-Flop, D Flip-Flop, T Flip-Flop, Flip-Flops with preset and clear inputs, Triggering methods and their circuits, Conversion of one type of flip flop to another, Excitation table, Applications of Flip Flops. Difference between synchronous and asynchronous circuits.
Shift Registers: Right shift, Left shift, Bidirectional, SISO, SIPO, PISO, PIPO, Universal shift registers.
Counters: Operation; up counter, Down counter, up/down counter, mod *n* counters, Other types of Counters: Ring counter, Johnson counter, BCD counter.
Finite State Machines: Mealy & Moore types, Basic design steps, Design of counters using sequential circuit approach.
Asynchronous sequential circuits: Analysis and synthesis, State reduction and state assignment, Hazards.

Introduction to digital logic families: Characteristics, Basic working of TTL NAND gate, ECL gate and CMOS logic gate, Memory Devices: types of memories, RAM BJT cell and MOS RAM cells, Organization of a RAM
Introduction to HDL

C. Text Books

1. A Malvino & D Leach, Digital Principles and Applications, 7th edition, Tata McGraw Hill, 2010.
2. M. Morris Mano, "Digital Design", Prentice Hall, 2018.

D. Reference Books

1. C. H. Roth (Jr.), Larry L. Kinney, Raghunandan G. H, Fundamentals of Logic Design, Cengage Learning India Pvt. Ltd, 2019.
2. R L Morris & J R. Miller, Designing with TTL Integrated Circuits, McGraw Hill, 1971.
3. R. P. Jain, Modern Digital Electronics, 4th edition, Tata McGraw Hill, 2009.
4. Anand Kumar, Fundamentals of Digital Circuits, 3rd edition, Prentice Hall, 2014.
5. J Crowe & B. Hayes-Gill, Introduction to Digital Electronics, 1st edition, Butterworth-Heinemann, 1998.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Design and analyse combinational and sequential logic circuits.
CO2. Optimize combinational and sequential logic circuits
CO3. Analyse a memory cell and apply for organizing larger memories

Name of the Module: Analog Circuits-I Laboratory
Module Code: EC-203
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To understand and verify the characteristics of electronic devices.
- To learn to apply these devices in popular and important applications

B. List of Experiments

Expt. No. 1. Study of V-I characteristics of PN junction and Zener diodes.
Expt. No. 2. Study and design of Half wave and Full wave rectifier circuits.
Expt. No. 3. Study of BJT characteristics.
Expt. No. 4. Study of BJT biasing methods.
Expt. No. 5. Study of FET characteristics.
Expt. No. 6. Study of FET biasing methods.
Expt. No. 7. Study of MOSFET inverter.
Expt. No. 8. Study of BJT and FET amplifier circuits

C. Text Books

1. B G. Streetman & S K Banerjee, Solid State Electronic Devices, 7th edition, Pearson Education, 2015
2. D.L. Schilling & C.Belove, Electronic Circuits: Discrete and Integrated, McGraw Hill, 1989.

F. Reference Books

1. S.M. Sze, Physics of Semiconductor Devices, Wiley Eastern, 2008
2. A.S. Sedra & K.C. Smith, Microelectronic Circuits, Oxford, 2017.

G. Course Outcomes

At the end of the course, a student will be able to:

CO1. Plot the characteristics of electronic devices to understand their behavior.
CO2. Characterize and classify diodes and transistors
CO3. Analyze the characteristics of various electronic devices like diode, transistor etc
CO4. Design simple analog circuits

Name of the Module: Digital Logic Design Laboratory
Module Code: EC-204
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To build a solid foundation about Boolean algebra
- To study the applications of Digital Logic Gates and Circuits

B. List of Experiments

Expt. No. 1.

A**.** Verification of truth tables of logic gates -OR, AND, NOT, NAND, NOR and Ex-OR.

B**.** Verification of NAND and NOR as universal gates.

Expt. No. 2.

A**.** Design and verification of the truth tables of half and Full adder circuit using universal gates only.

B. Design and verification of the truth tables of Half and Full subtractor circuits using universal gates only.

Expt. No. 3.

Minimize the following logic system with SOP/POS by tabular technique & implement the circuit.

i. SOP: $f(A,B,C,D) = m_0 + m_1 + m_2 + m_3 + m_5 + m_6 + m_{10} + m_{13} + m_{15}$

ii. POS: $f(X,Y,Z) = M_0.M_1.M_3.M_7$

Expt. No. 4. Design Gray to Binary and Binary to Gray code Converter & test the circuit.

Expt. No. 5. Design and verify BCD to Excess-3 code converter using logic gates.

Expt. No. 6. Design and test of SR flip-flop using NOR/NAND gates.

Expt. No. 7.

A. Verification of the truth table of the Multiplexer using IC 74150

B. Verification of the truth table of the Demultiplexer using IC 74154.

Expt. No. 8. Basic GATEs implementation in HDL

Expt. No. 9. Design and implementation of 3-bit synchronous up/down counter in HDL.

Expt. No. 10. Construction and verification of 4 bit ripple counter and Mod-10 / Mod-12 Ripple counters using JK flip-flop in HDL.

C. Text Books

1. A Malvino & D Leach, Digital Principles and Applications, Tata McGraw Hill, 2010.
2. M. Morris Mano, Digital Logic Design, Prentice Hall, 2018.

D. Reference Books

1. H. Roth (Jr.), “Fundamentals of Logic design”, Cengage Engineering, 2013.
2. R L Morris & J R Miller, “Designing with TTL Integrated Circuits”, McGraw Hill, 1971.
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill, 2009.

4. Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall, 2014.
5. J Crowe & B. Hayes-Gill, Introduction to Digital Electronics, Butterworth-Heinemann, 1998.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Design and analyse combinational and sequential logic circuits.
CO2. Optimize combinational and sequential logic circuits

B. Tech. 2nd Year, Semester IV

IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MH-206	Entrepreneurship	3	0	0	3
2	CS-206	Computer Organization & Architecture	3	0	0	3
3	EC-221	Electromagnetic Field Theory	3	0	0	3
4	EC-222	Signals & Systems	3	0	0	3
5	EC-223	Analog Circuits-II	3	0	0	3
6	EC-224	Analog Communication	3	0	0	3
7	EC-225	Analog Circuits-II Laboratory	0	0	2	1
8	EC-226	Analog Communication Laboratory	0	0	2	1
Contact Hours			18	0	4	
Total Credits						20

Name of the Module:* *Electromagnetic Field Theory

Module Code: EC-221

Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

B. Course Content

Electrostatics: Sources and effects of electromagnetic fields, Coordinate systems, Vector fields, Gradient, Divergence, Curl, theorems and applications, Coulomb's Law, Electric field intensity, Field due to discrete and continuous charges, Gauss's law and applications. Electric potential, Electric field and equipotential plots, Uniform and non-uniform field, Utilization factor, Electric field in free space, Conductors, Dielectrics, Dielectric

polarization, Dielectric strength, Electric field in multiple dielectrics, Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

Magnetostatics: Lorentz force, Magnetic field intensity (H), Biot–Savart's law, Ampere's circuit law, H due to straight conductors, Circular loop, Infinite sheet of current, Magnetic flux density in free space, Conductors, Magnetic materials, Magnetization, Magnetic field in multiple media, Boundary conditions, Scalar and vector potential, Poisson's equation, Magnetic force, Torque, Inductance, Energy density, Applications.

Features of electromagnetic waves: Magnetic circuits, Faraday's law, Transformer and motional EMF, Displacement current, Maxwell's equations (differential and integral form), Relation between field theory and circuit theory, Applications, Electromagnetic wave generation and equations, Wave parameters: Velocity, Intrinsic impedance, Propagation constant, Waves in free space, Lossy and lossless dielectrics, Conductors, Skin depth, Poynting theorem and vector, Plane wave reflection and refraction, Standing wave, Applications.

Guided Waves: Waves between parallel planes, TE and TM waves, Characteristics of TE and TM waves, TEM waves, Velocities of propagation, Attenuation in parallel plane guides, Wave impedance, Electric field and current flow within the conductor.

C. Text Books

1. David J. Griffiths, Introduction to Electrodynamics, Pearson, 2015.
2. John David Jackson, Classical Electrodynamics, Wiley, 2007.
3. E.C. Jordan & G. Balmain, Electromagnetic Waves and Radiating Systems, PHI, 1995.

D. Reference Books

1. P. C. Rakshit, D. Chattopadhyay, Electricity and Magnetism, 9th edition, New Central Book Agency, 2011.
2. M N O Sadiku, Elements of Electromagnetics, Oxford University Press, 2008.
3. Staelin, Morgenthaler & Kong, Electromagnetic Waves, Pearson, 1993.
4. Hayt, Buck, Engineering Electromagnetics, McGraw Hill, 2017.
5. Inan, Engineering Electromagnetics, Pearson, 2010.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Recognize and classify the basic Electrostatic theorems and laws and to derive them.

CO2. Discuss the behavior of Electric fields in matter and Polarization concepts.

CO3. Classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.

CO4. Summarize the concepts of electrodynamics & to derive and discuss the Maxwell's equations.

CO5. Students are expected to be familiar with Electromagnetic wave propagation and wave polarization.

Name of the Module: Signals and Systems
Module Code: EC-222
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- Understanding the fundamental characteristics of signals and systems.
- Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
- Analyze the spectral characteristics of signals using Fourier analysis.
- development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling

B. Course Content

***Signal and Systems*:** Introduction, Operations on signals, Classification of signals, Classification of systems, System model- input output description

***Time Domain Analysis of Continuous Time Systems*:** Introduction, Convolution, System response to internal conditions - Zero input response, Unit impulse response, System response to external input- Zero state response, Classical solution of differential equations, System stability.

***Continuous Time Signal Analysis - The Fourier Series*:** Periodic signal representation by trigonometric Fourier series, Existence and convergence of the Fourier series, Exponential Fourier series, properties, LTIC system response to periodic inputs

***Continuous Time Signal Analysis - The Fourier Transform*:** Aperiodic signal representation by Fourier integral, Properties of FT, Transforms of some useful function, Frequency response of LTIC system.

***Continuous Time System Analysis Using the Laplace Transform*:** Laplace transform, Relation to FT, Properties of Laplace transform, Solution of differential equations, Unilateral Laplace transform: Properties of the unilateral Laplace transform.

***Sampling*:** Sampling theorem, Signal reconstruction.

***Discrete Time System Analysis Using the Z-Transform*:** Discrete-time signals and systems, Z-transform (BZT & UZT) and its properties, Analysis of LTI systems using Z – transform.

C. Text Books

1. A.V.Oppenheim, A. Willsky, S. Hamid Nawab, Signals and Systems, 2nd edition, Pearson 2000.
2. S.Haykin and B.VanVeen, Signals and Systems, Wiley, 2012.

D. Reference Books

1. S. S. Soliman & M. D. Srinath, Continuous and Discrete Signals and Systems, Prentice- Hall, 1998.

2. M.Mandal and A.Asif, Continuous and Discrete Time Signals and Systems, Cambridge, 2007.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Analyse the spectral characteristics of continuous-time periodic and a periodic signal using Fourier analysis.
CO2. Classify systems based on their properties and determine the response of LSI system using convolution.
CO3. Analyze system properties based on impulse response and Fourier analysis.
CO4. Apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.
CO5. Understand the process of sampling and the effects of under sampling

Name of the Module: Analog Circuits-II
Module Code: EC-223
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To make the students understand the fundamentals of electronic circuits.
- To train them to use the basic in important applications like Feedback network, oscillator and power amplifier

B. Course Content

Wave-shaping Circuits: Linear wave shaping circuits, RC high pass and low pass circuits with phase and frequency analysis, RC integrator and differentiator circuits, Piece-wise linear model of diode, Nonlinear wave shaping circuits, Rectifier, Series-shunt and two-level diode clipper circuits, Clamping circuits

Feedback Amplifier: Introduction, Basic concepts of feedback, Effect of negative feedback, Different topologies, Method of identifying feedback topology and feedback factor, Stability of feedback amplifier, Frequency response of the feedback amplifiers.

Oscillators: Conditions for oscillations, RC and LC type oscillators, Crystal oscillators, Frequency and amplitude stability of oscillators, Generalized analysis of LC oscillators, Quartz, Hartley, Colpitts, RC-phase shift and Wien-bridge oscillators.

Power Amplifiers: Amplifier terms, Two load lines, Class-A & Class-B operation, Class-B push pull emitter follower, Biasing class B/AB Amplifiers, Class B/AB driver, Class-C operation

C. Text Books

1. J. Millman and Halkias, Integrated Electronics, 2nd Edition, TMH, 2010
2. J. Millman and A. Grabel, Micro Electronics, 2nd Edition, TMH, 2017.

D. Reference Books

1. A.S. Sedra & K.C. Smith, Microelectronic Circuits, 7th edition, Oxford, 2017.
2. D.L. Schilling & C. Belove, Electronic Circuits: Discrete and Integrated, McGraw Hill, 1989.
3. K.V. Ramanan, Functional Electronics, Tata McGraw Hill ,1984

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Apply the knowledge of basic BJT and diode-based circuits
CO2. Characterize wave shaping circuits
CO3. Analyze the characteristics of oscillators, power amplifiers and feedback circuit
CO4. Design of test circuits for real time applications

Name of the Module: Analog Communication
Module Code: EC-224
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance.

B. Course Content

Elements of communication system: Transmitters, Transmission channels & receivers, Concept of modulation.

Amplitude Modulation**:** AM, DSB-SC, SSB-SC and VSB-SC, Methods of generation and detection, FDM, Super heterodyne receivers.

Angle Modulation**:** Basic definitions, FM, PM, narrow band FM, wide band FM, transmission bandwidth of FM waves, Generation of FM waves: indirect FM and direct FM, Demodulation/detection of FM waves, FM stereo multiplexing, Phase-locked loop, Nonlinear effects in FM systems.

Random Process**:** Random variables, Several random variables, Statistical averages, Function of random variables, Moments, Mean, Correlation and covariance function, Principles of autocorrelation function, Cross – correlation functions, Central limit theorem, Properties of Gaussian process.

Noise - Internal and external noise, Noise calculation, Noise figure, Noise in linear and nonlinear AM receivers, Threshold effect.

Noise in FM receivers, Threshold effect, Capture effect, FM threshold reduction, Preemphasis and de-emphasis.

Sampling Theorem: Nyquist sampling theorem, Low pass and band pass sampling theorems, ***Pulse Modulation***: Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM) their generation and detection.

C. Text Books

1. Simon Haykin, Communication Systems, 4th Edition, Wiley publication, 2004.
2. H Taub and D. L. Schilling, Principles of Communication System, 3rd Edition, McGraw Hill New Delhi, 2007

D. Reference Books

1. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th edition Oxford University Press India, 2017.
2. John Proakis, Digital Communications, 5th Edition, Tata Mc Graw Hill, 2007.
3. Bernard Sklar, Digital Communication-Fundamentals and Applications, 2nd Edition Pearson Education India, 2009.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Understand the basics of communication system and analog modulation techniques

CO2. Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.

CO3. Apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system

CO4. Understand the effect of noise performance of FM system.

CO5. Understand TDM and Pulse Modulation techniques.

Name of the Module: Analog Circuits-II Laboratory
Module Code: EC-225
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To make the students understand the fundamentals of electronic circuits.
- To train them to use the basic in important applications like Feedback network, oscillator and power amplifier

B. List of Experiments

Expt. No. 1. Study and Implement RC Low Pass and High Pass Filter Circuits.
Expt. No. 2. Study and Implement RC Integrator Circuits.
Expt. No. 3. Study and Implement RC Differentiator Circuits.
Expt. No. 4. Study and Implement RC-Phase shift and wien-bridge oscillator.
Expt. No. 5. Study and Implement Class A/B/AB/C amplifier
Expt. No. 6. Study and Implement push pull amplifier

C. Text Books

1. A. Malvino and D. Bates, Electronic Principles, McGraw-Hill, 2015
2. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.

3. J. Millman and A. Grabel, Micro Electronics, 2nd Edition, TMH, 2017.

D. Reference Books

1. A.S. Sedra &K.C.Smith, Microelectronic Circuits, 7th edition, Oxford, 2017.
2. D.L. Schilling & C.Belove, Electronic Circuits: Discrete and Integrated, 3rd edition, McGraw Hill, 2002.
3. K.V. Ramanan, Functional Electronics, Tata McGraw Hill ,1984

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Design and implement filters
CO2. Design and implement integrators and differentiators.
CO3. Design and implement oscillators, power amplifiers and feedback circuit

Name of the Module: Analog Communication Laboratory
Module Code: EC-226
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To make the students to understand different types of modulation and demodulation techniques.

B. List of Experiments

Expt. No. 1. Study of Amplitude Modulation & Demodulation.
Expt. No. 2. Measurement of output power with varying modulation index an AM signal.
Expt. No. 3. Study of voltage-controlled oscillator (VCO) using IC 4046.
Expt. No. 4. Study the performance of a phase locked loop.
Expt. No. 5. Study of Frequency Modulation and Demodulation System.
Expt. No. 6. Study of pre-emphasis & de-emphasis
Expt. No. 7. Study of Double Side Band Suppressed Carrier (DSB-SC) Modulation & Demodulation Technique.
Expt. No. 8. Study of Single Side Band Suppressed Carrier (SSB-SC) Modulation & Demodulation Technique
Expt. No. 9. Study functioning of Superheterodyne AM Receiver.
Expt. No. 10. Measurement of Noise Figure using a noise generator.
Expt. No. 11. Study the characteristics of Pulse Amplitude Modulation & Demodulation.
Expt. No. 12. Study the characteristics of Pulse Width Modulation & Demodulation.
Expt. No. 13. Study the characteristics of Pulse Position Modulation & Demodulation.

C. Text Books

1. Simon Haykin, Communication Systems, 4th Edition, Wiley publication, 2004.
2. H Taub and D. L. Schilling, Principles of Communication System, 2nd Edition, McGraw Hill New Delhi, 2017.

D. Reference Books

1. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th edition Oxford University Press India, 2011.
2. John Proakis, Digital Communications, 5th Edition, Tata McGraw Hill, 2007.
3. Bernard Sklar, Digital Communication-Fundamentals and Applications, 2nd Edition Pearson Education India, 2009.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Characterize analog modulation techniques

CO2. Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.

CO3. Understand TDM and characterize Pulse Modulation techniques.

B. Tech. 3rd Year, Semester V

Vth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE 305	Linear Control Systems	3	0	0	3
2	EE-307	Power Electronics	3	0	0	3
3	EC-301	Linear Integrated Circuits	3	0	0	3
4	EC-302	Digital Communication	3	0	0	3
5	EC-303	Microprocessor & Interfacing	3	0	0	3
6	EC-304	Digital Signal Processing	3	0	0	3
7	EC-305	LIC Laboratory	0	0	2	1
8	EC-306	Digital Communication Laboratory	0	0	2	1
9	EC-307	Microprocessor & Interfacing Laboratory	0	0	2	1
10	EC-308	Digital Signal Processing Laboratory	0	0	2	1
11	EC-390	Internship - I	0	0	0	0
Contact Hours			18	0	8	
Total Credits						22

Name of the Module: Linear Integrated Circuits

Module Code: EC-301

Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To introduce the theoretical & circuit aspects of Op-amp and other integrated circuits

B. Course Content

Differential & Multistage Amplifiers: BJT differential pair, DC offset, Common mode rejection, Differential operation with current mirror load, Common mode gain and CMRR, Multistage behaviour, Basic introduction to op-amp.

Basics of Operational Amplifiers: Basic information about op-amps, Ideal operational amplifier, General operational amplifier stages, DC & AC performance characteristics, Slew rate, Open and closed loop configurations.
Applications of Operational Amplifiers: Sign changer, Scale changer, Phase shift circuits, Voltage follower, V-to-I and I-to-V converters, Adder, Subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, Peak detector.
Active Filters: Introduction, RC active filters, Chebyshev & Butterworth filters, State variable filter, Switched capacitor filter

Waveform Generators & PLL: Sine-wave generators, Multivibrators and triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC555, IC voltage regulators, Three terminal fixed and adjustable voltage regulators, IC 723 general purpose regulator, Monolithic switching regulator. Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, Application of PLL for AM detection, FM detection, FSK modulation and demodulation and frequency synthesizing.

ADC & DAC: Analog and digital data conversions, D/A converter: Specifications, Weighted resistor type, R-2R ladder type, Voltage mode and current mode R-2R Ladder types, Switches for D/A converters, High speed sample-and-hold circuits, A/D Converters: Specifications, Flash type, Successive approximation type, Single slope type, Dual slope type, A/D converter using voltage-to-time conversion, Over-sampling A/D converters.

C. Text Books

1. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 3rd Edition, Tata Mc Graw-Hill, 2007.
2. Ramakant A. Gayakwad, OP-AMP and Linear ICs, 4th Edition, Prentice Hall / Pearson Education, 2001.

D. Reference Books

1. D. Roy Choudhury, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
2. Robert F.Coughlin, Frederick F.Driscoll, Operational Amplifiers and Linear Integrated Circuits, Sixth Edition, PHI, 2001.
3. B. S. Sonde, System design using Integrated Circuits, 2nd Edition, New Age Pub, 2001
4. Gray and Meyer, Analysis and Design of Analog Integrated Circuits, Wiley International, 2005.
5. Michael Jacob, Applications and Design with Analog Integrated Circuits, Prentice Hall of India,1996.

6. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson Education, 2004.
7. S. Salivahanan & V. S. Kanchana Bhaskaran, Linear Integrated Circuits, TMH, 2008.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Design op-amp circuits to perform arithmetic operations.
CO2. Analyze and design linear and non-linear applications using op-amps.
CO3. Explain and compare the working of multi vibrators using special application IC 555 and general-purpose op-amp.
CO4. Classify and comprehend the working principle of data converters.
CO5. Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication

Name of the Module: Digital Communication
Module Code: EC-302
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To understand the building blocks of digital communication system.
- To prepare mathematical background for communication signal analysis.
- To understand and analyze the signal flow in a digital communication system.
- To analyze error performance of a digital communication system in presence of noise and other interferences.
- To understand concept of spread spectrum communication system.

B. Course Content

Source coder: Pulse code modulation, Quantization noise, Linear and non-linear quantization, Companding (μ -law and A-law), Differential pulse code modulation, Delta modulation, Adaptive delta modulation, Delta sigma modulation, Linear predictive coders, Vocoder.

Waveform coder: Unipolar, Polar, Bipolar – RZ/NRZ, Manchester, Miller, Differential encoding and their spectral characteristic, B3ZS, HDB3, Calculation of PSD.

Base band signal receiver: Integrate and dump type filter, Probability of error calculations, Optimum filters, Coherent reception, Matched filter and its transfer function, Probability of error of matched filter, Regenerative repeater.
Inter symbol interference (ISI), Purpose of equalization, Eye pattern, Nyquist criterion for zero ISI, Fixed equalizer, Design of equalizer, Partial response signalling.

Digital Modulation: ASK, FSK, PSK, DPSK, M-ary PSK, QPSK, M-ary FSK, MSK, Error calculation.

Spread Spectrum Modulation: Pseudo-noise sequence, Motion of spread spectrum, Direct-sequence spread spectrum with coherent binary phase shift keying, Processing gain, Probability of error, Frequency-hop spread spectrum, OFDM.

C. Text Books

1. Simon Haykin, Communication Systems, 4th Edition, Wiley publication, 2004.
2. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 4th edition Oxford University Press India, 2011.

D. Reference Books

1. Bernard Sklar, Digital Communication-Fundamentals and Applications, 2nd Edition Pearson Education India, 2009.
2. John Proakis, Digital Communications, 5th Edition, Tata Mc Graw Hill, 2007.
3. H Taub and D. L. Schilling, Principles of Communication System, 2nd Edition, McGraw Hill New Delhi, 2017.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
CO2. Perform the time and frequency domain analysis of the signals in a digital communication system.
CO3. Select the blocks in a design of digital communication system.
CO4. Analyze performance of spread spectrum communication system.

Name of the Module: Microprocessor & Interfacing
Module Code: EC-303
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

- To introduce students to basic concepts of microprocessor
- To give a knowledge on Assembly Level Language.
- To introduce interfacing of peripheral with microprocessor.

B. Course Content

Introduction*:* Microcomputer structure and operation, 8086 microprocessor family, Overview, Architecture of processor 8085 and 8086.

Assembly Language Programming*:* Programming development steps, Constructing machine development codes for 8085 and 8086 instructions, Assembly language program development tools.

Strings, Procedure and Macros*:* String instructions, Writing and using procedures, Writing and using assembler macros

Instruction Description and Assembler Directives*:* Instruction descriptions, Assembler directives systems connections, Timing and troubleshooting: Basic 8086 microcomputer systems connections, Logic analyzer to observe microprocessor bus signals, Troubleshooting simple 8086-based microcomputer.

Peripheral Interfacing Applications: Basic interfacing concepts, Memory / IO interfacing, Non-programmable peripheral interface, 8255 programmable peripheral interface, Interfacing display, Keyboards, 8279 programmable keyboard / display interface, 8253/54 programmable timer, DMA controller, Interrupt controller, ADC and DAC interfacing, 8086 interrupts and types, 8259A priority interrupt controller, Software interrupt applications.

Memories, Coprocessors and EDA Tools: 8086 maximum mode and DMA data transfer, Interfacing and refreshing dynamic RAMs, Coprocessor - 8087 Math coprocessor, Computer based design and development tools.

C. Text Books

1. Sunil Mathur, Microprocessor 8085 and its Interfacing, 2nd edition, PHI, 2011.
2. Sunil Mathur, Microprocessor 8086: Architecture, Programming and Interfacing, PHI, 2011.
3. R. S. Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International, 2013.

D. Reference Books

1. Ram B., Fundamental of Microprocessor & Microcomputers, Dhanpat Rai Publications, 2012.
2. Leventhal Lance, Introduction to Microprocessor - Software, Hardware and Programming, PHI, 2017.
3. Mathur A. P., Introduction to Microprocessor, 3rd edition, Tata McGraw-Hill, 2017.
4. Short K. L., Microprocessors and Programmed Logic, Pearson Education,
5. Hall D., Microprocessor and Interfacing, 2nd edition, Tata McGraw-Hill, 1992.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Students will have the thorough understanding of the evolution of microprocessor

CO2. Students will get to know the interfacing knowledge to get a kick start in embedded world

CO3. Students will get the idea of doing lively embedded design projects

Name of the Module: Digital Signal Processing
Module Code: EC-304
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

- To understand the basic concept of frequency in continuous-time and discrete-time signals

- To understand various transformation algorithm related to signals and systems

B. Course Content

***Introduction*:** Review of signals and systems, Concept of frequency in continuous-time and discrete-time signals, Analog to digital conversion.

Discrete time signals and systems: Discrete time signals, Discrete time systems, Analysis of discrete time linear time invariant systems, Convolution, Discrete time systems described by differential equations, Implementation of discrete time systems, Correlation of discrete time signals.

Discrete Time Fourier Transform (DTFT): DTFT **and its** Properties
Discrete Fourier Transform: Frequency domain sampling, Properties of DFT, Linear filtering methods based on DFT.

Efficient computation of the DFT: FFT algorithms, Linear filtering, Approach to computation of the DFT.

Implementation of Discrete-Time System: FIR system, IIR system
Design of Digital Filters: Design of FIR filters Design of IIR filters from analog filters, Frequency transformations.

C. Text Books

1. J.G.Proakis, D.G. Manolakis, Digital Signal Processing, 4th edition, Pearson, 2007.
2. A.V.Oppenheim & R.W.Schafer, Discrete Time Signal processing, 2nd edition , Pearson Education, 2003.
3. S.K.Mitra, Digital Signal Processing , Tata McGraw Hill, 2006

D. Reference Books

1. P. Ramesh Babu, Digital Signal Processing, Scitech Publications (India) Pvt. Ltd, 2003.
2. P.S.R.Diniz, E.A.B.da Silva and S.L.Netto, Digital Signal Processing, Cambridge, 2002.
3. E.C.Ifeachor & B.W.Jervis, Digital Signal Processing, 2nd edition , Pearson Education, 2002.
4. J.R.Johnson, Introduction to Digital Signal Processing, Prentice-Hall, 1989

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Classify different signals and systems and perform time domain analysis of LTI DTS.
CO2. Compute Convolution, Correlation of the signals
CO3. Find DFT of a given signal through Fast Fourier Transform Techniques
CO4. Design FIR and IIR type digital filters
CO5. Identify filter structures and evaluate the coefficient quantization effects

Name of the Module: LIC Laboratory
Module Code: EC-305
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To design and study circuits based on Op-amp and other ICs

B. List of Experiments

Expt. No. 1. Study the characteristics of Operational Amplifiers (IC741)
Expt. No. 2. Study and implement circuits using IC741 for many applications: Voltage Follower, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector
Expt. No. 3. Waveform Generation using Op-Amp (IC741).
Expt. No. 4. Applications of Timer IC555.
Expt. No. 5. Design of Active filters.
Expt. No. 6. Study and application of PLL IC's

C. Text Books

1. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 3rd Edition, Tata Mc Graw-Hill, 2007.
2. Ramakant A. Gayakwad, OP-AMP and Linear ICs, 4th Edition, Prentice Hall / Pearson Education, 2001.

D. Reference Books

1. D.Roy Choudhury, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
2. B. S. Sonde, System design using Integrated Circuits , 2nd Edition, New Age Pub, 2001
3. Gray and Meyer, Analysis and Design of Analog Integrated Circuits, Wiley International, 2005.
4. Michael Jacob, Applications and Design with Analog Integrated Circuits, Prentice Hall of India, 1996.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Design op-amp circuits to perform arithmetic operations.
CO2. Analyze and design linear and non-linear applications using op-amps.
CO3. Explain and compare the working of multi vibrators using special application IC 555 and general purpose Op-amp.
CO4. Classify and comprehend the working principle of data converters.
CO5. Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

Name of the Module: Digital Communication Laboratory
Module Code: EC-306
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To understand the building blocks of digital communication system.
- To understand and analyze the signal flow in a digital communication system.
- To understand and analyze different digital modulation and demodulation techniques.
- To understand concept of time division multiplexing in communication system.

B. Course Content

Expt. No. 1. Study of pulse code modulation and demodulation
Expt. No. 2. Study of delta modulation and demodulation
Expt. No. 3. Study of pulse data coding techniques for NRZ formats
Expt. No. 4. Study of amplitude shift keying modulator and demodulator
Expt. No. 5. Study of frequency shift keying modulator and demodulator
Expt. No. 6. Study of phase shift keying modulator and demodulator
Expt. No. 7. Study of quadrature phase shift keying modulator and demodulator
Expt. No. 8. Study of time division multiplexing.

C. Text books

1. Simon Haykin, Communication Systems, 4th Edition, Wiley publication, 2004.
2. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press India, 2011.

D. Reference books

1. Bernard Sklar Digital Communication-Fundamentals and Applications, 2nd Edition Pearson Education India, 2009
2. John Proakis, Digital Communications, 5th Edition, Tata Mc Graw Hill, 2007.
3. H Taub and D. L. Schilling, Principles of Communication System, 2nd Edition, McGraw Hill New Delhi, 2017.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
CO2. Perform the time and frequency domain analysis of the signals in a digital communication system.
CO3. Select the blocks in a design of digital communication system.
CO4. Analyze performance of time division multiplexing in communication system.

Name of the Module: Microprocessor & Interfacing Laboratory
Module Code: EC-307
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- To introduce students to basic concepts of microprocessor
- To give a knowledge on Assembly Level Language.
- To introduce interfacing of peripheral with microprocessor.

B. Course Content

Expt. No. 1. Introduction to 8085 / 8086 Kit and Peripheral Boards.
Expt. No. 2. Program set for Architecture Operations.
Expt. No. 3. Program set for Logical and Decimal.
Expt. No. 4. Program set for Subroutines and Delay.
Expt. No. 5. Program set for Program Control.
Expt. No. 6. Interfacing with 8255.
Expt. No. 7. Interfacing with 8279.
Expt. No. 8. Interfacing with 8253.
Expt. No. 9. Interfacing with ADC/DAC

C. Text books

1. Sunil Mathur, Microprocessor 8085 and its Interfacing, 2nd edition, PHI, 2011.
2. Sunil Mathur, Microprocessor 8086: Architecture, Programming and Interfacing, PHI, 2011.
3. Gaonkar R. S., Microprocessor Architecture, Programming and Applications with 8085, Penram International, 2013.

D. Reference Books

1. Ram B., Fundamental of Microprocessor & Microcomputers, Dhanpat Rai Publications, 2012.
2. Leventhal Lance, Introduction to Microprocessor - Software, Hardware and Programming, PHI, 2017.
3. Mathur A. P., Introduction to Microprocessor, 3rd edition, Tata McGraw-Hill, 2017.
4. Short K. L., Microprocessor and Programming Logic, Pearson Education.
5. Hall D., Microprocessor and Interfacing,2nd edition, Tata McGraw-Hill, 1992.

E. Course Outcomes

CO1. Students will have the thorough understanding of the evolution of microprocessor
CO2. Students will get to know the interfacing knowledge to get a kick start in embedded world
CO3. Students will get the idea of doing lively embedded design projects

Name of the Module: Digital Signal Processing Laboratory
Module Code: EC-308
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The objective of the course is:

- Study properties of discrete signals
- Obtain Z-Transform of various signals
- Obtain DFT of various signals
- Design FIR and IIR filters

B. List of Experiments

Expt. No. 1. To analyze various properties of discrete signals and verify them on MATLAB.

Expt. No. 2. To analyze unilateral and bilateral z transforms of various signals. Also to analyze how unilateral z transform can be used to obtain system responses with initial conditions or changing inputs.

Expt. No. 3. To form a routine of discrete time Fourier transform on MATLAB and find discrete time Fourier transform of various signals on MATLAB. Also analyze different application of discrete time Fourier transforms.

Expt. No. 4. To study various properties of discrete time Fourier transform and verify these properties on various signals on MATLAB.

Expt. No. 5. To form a routine of discrete Fourier transform on MATLAB and find discrete Fourier transform of various signals on MATLAB. Also analyze different properties of discrete Fourier transform.

Expt. No. 6. To analyze fast Fourier algorithms and see how it can efficiently be used to calculate discrete Fourier transforms.

Expt. No. 7. To design and simulate Chebychev and Butterworth filters and analyze their responses on MATLAB.

Expt. No. 8. To design and simulate Infinite Impulse Response (IIR) filters and Finite Impulse Response (FIR) filters and analyzes their responses on MATLAB.

Expt. No. 9. To give basic introduction of DSP boards, their applications and implementation of some applications on DSP boards.

C. Text books

1. S. W. Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists, Elsevier, 2005
2. A.V.Oppenheim & R.W.Schafer, Discrete Time Signal processing, 2nd edition, Pearson Education, 2003.

D. Reference books

1. P.S.R.Diniz, E.A.B.da Silva and S.L.Netto, Digital Signal Processing, Cambridge, 2002.
2. E.C.Ifeachor & B.W.Jervis, Digital Signal Processing, 2nd edition, Pearson Education, 2002.
3. J.R.Johnson, Introduction to Digital Signal Processing, Prentice-Hall, 1989.

E. Course Outcomes

After completion of the course, a student can:

CO1. Write a code to obtain Z-transform and Inver Z-transform
CO2. Analyse frequency spectrum of any signal
CO3. Design and implement digital FIR & IIR filter

B. Tech. 3rd Year, Semester VI

VIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	CS-306	Computer Networking	3	0	0	3
2	EC-321	Information Theory & Coding	3	0	0	3
3	EC-322	Instrumentation & Measurement	3	0	0	3
4	EC-323	Microcontrollers & Embedded Systems	3	0	0	3
5	EC-324	Microwave Engineering	3	0	0	3
6	EC-325	VLSI Design	3	0	0	3
7	EC-326	Instrumentation & Measurement Laboratory	0	0	2	1
8	EC-327	Microcontrollers & Embedded System Laboratory	0	0	2	1
9	EC-328	Microwave Engineering Laboratory	0	0	2	1
10	EC-329	VLSI Design Laboratory	0	0	2	1
11	EC-391	Internship – II	0	0	0	0
Contact Hours			18	0	8	
Total Credits						22

Name of the Module: Information Theory & Coding
Module Code: EC-321
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To equip students with the basic understanding of the fundamental concept of entropy and information as they are used in communications.
- To make students equip with various data compression technique.
- To apply various linear block codes and convolution codes for error detection and correction

B. Course Content

Information Theory: Information, channel capacity, The concept of amount of information, entropy, Information rate, Conditional and joint entropies

Source Coding: Noise less coding, Shannon's first fundamental theorem, Discrete memoryless channels, Mutual information, sources with finite memory, Markov sources,

Shannon's second fundamental theorem on coding, Huffman coding, Lempel-Ziv algorithm, Shannon-Fanon algorithm

Channel Coding: Error detecting codes, Hamming distance, Error correcting codes, Repetition codes, Linear block codes, Binary cyclic codes, BCH codes, Reed-Solomon codes, Golay codes

Convolutional Codes: Code tree, State diagram, Trellis diagram, Maximum likelihood decoding-Viterbi's algorithm, Sequential decoding

C. Text books

1. T. M. Cover and J. A. Thomas, Elements of Information Theory, 2edition, John Wiley, 2013.
2. R. E. Blahut, Algebraic Codes for Data Transmission, 2nd edition, Cambridge University Press, 2003.

D. Reference books

1. Simon Haykin, Communication Systems, 3rd edition, John Wiley, 2007.
2. JB Proakis, Digital Communications, 5th edition, Mc Graw Hill, 2018.
3. S Roman, Coding and Information Theory, New York: Springer-Verlag, 1992.

E. Course Outcomes

At the end of the course student will be able

CO1. Students will be introduced to the basic notions of information and channel capacity

CO2. Students will be introduced and equipped with the convolutional and block codes, decoding techniques

CO3. Students will understand how error control coding techniques are applied in communication systems.

CO4. Students will understand the basic concepts of cryptography.

Name of the Module: Instrumentation & Measurement
Module Code: EC-322
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To build a solid foundation about basics of measurement techniques.
- To understand the measurement parameters and criteria of measurement.
- To build a solid foundation of the Moving coil, Moving Iron, dynamometer, Wattmeter.
- To understand various measurement techniques of CRO.
- To understand different signal conditioning methods.

B. Course Content

Introduction: Introduction to instrumentation; Static characteristics of measuring devices; Error analysis, standards and calibration; Dynamic characteristics of instrumentation systems;

Electromechanical indicating instruments: AC/DC current and voltage meters, ohmmeter; Loading effect; Measurement of power and energy; Instrument transformers; Measurement of resistance, inductance and capacitance; AC/DC bridges; Transducers classification; ***Measurement of non-electrical quantities***: Displacement, strain, temperature, pressure, flow, and force

Signal Conditioning: Instrumentation amplifier, isolation amplifier, and other special purpose amplifiers, Electromagnetic compatibility, Shielding and grounding, Signal recovery, Data transmission and telemetry, Data acquisition system;

Modern Electronic Test Equipment: oscilloscope, DMM, frequency counter, wave/ network/ harmonic distortion/ spectrum analyzers, logic probe and logic analyzer; programmable logic controller; Virtual instrumentation.

C. Text books

1. E. O. Deobelin, Measurement Systems - Application and Design. Tata McGraw-Hill, 2003.
2. M. M. S. Anand, Electronic Instruments and Instrumentation Technology. Prentice-Hall of India, 2009.
3. D. A. Bell, Electronic Instrumentation and Measurements. Oxford University Press India, 2013.

D. Reference books

1. R. P. Areny and T. G. Webster, Sensors and Signal Conditioning, Wiley-Interscience, 2012.
2. R. A. Witte, Electronic Test Instruments, Pearson Education, 2011.
3. C. F. Coombs, Electronic Instruments Handbook, McGraw-Hill, 2000.
4. B. G. Liptak, Instrument Engineers' Handbook: Process Measurement and Analysis, CRC Press, 2012.

E. Course Outcomes

After finishing this course students will be able to:

CO1. Clear understanding & utilization of major test instruments.
CO2. Design and develop different instruments.
CO3. Measure their performances to apply in particular systems.
CO4. Know about different Transducers and actuators.
CO5. Understand the measurement techniques of various parameters by CRO.

Name of the Module: Microcontrollers & Embedded Systems
Module Code: EC-323
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To understand microcontrollers and concept of embedded system
- To understand the operation of 8051 and PIC
- To get familiar with ARM processor family, Raspberry Pi and Arduino processor

B. Course Content

Introduction to Microcontroller and Embedded Processors: Introduction to microcontrollers, types of microcontrollers, Concept of embedded systems, embedded system classifications, Use of embedded systems software and its applications, scheduling algorithms, RTOS- Inter process communication, Interrupt driven input and output.

8051 Microcontroller Programming: Bit wise handling of registers, Timers and counter, Normal mode, Match mode, PWM mode.

Interrupts*:* Theory, Vectored and nested vectored interrupts, Internal and external interrupts, Non-maskable interrupt, Software interrupt for different microcontrollers.
Models of computation, GPIO programming.

Embedded Controller Arduino Family**:** Introduction and its variety, Intel Galileo, Reading data from analog and digital sensors on serial monitor/LCD monitor, Work with LED controlled by switch/potentiometer, 7 segment LED display/control, Interfacing relays and servomotors to Arduino and Galileo.

Raspberry Pi**:** Introduction, Configuration and applications.

ARM: Assembly instructions and modes, ARM ISA and processor variants, ARM instruction sets, Program control flow.

Interrupt: Instruction, Latency, Handling schemes.

C. Text Books

1. Prasad K.V.K.K, Embedded /Real-Time Systems: Concepts, Design and Programming—The Ultimate reference, Dreamtech Press, New Delhi, 2003.
2. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.

F. Reference Books

1. Thomas W Schultz, C and the 8051: Building efficient applications, Volume II, Prentice hall, 1999.
2. Kirk Zurell, C Programming for Embedded systems, CMP, 2000.

3. Thomas W. Schultz, C and the 8051 Programming for Multitasking, 1st edition, Prentice Hall, September 1992.
4. Steven Holzner, C with assembly language, BPB publication, 2017.
5. Thomas W. Schultz, C and the 8051: Hardware, Modular Programming and Multitasking Vol 1, 2nd edition, Prentice Hall, 1997.
6. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Prentice Hall, 2020.
7. Davin Poole, Alan Mackworth, and Randy Goebel, Computational Intelligence: A logical Approach, 1st edition, Oxford University Press, 1998.

D. Course Outcomes

After the completion of this course, students will be able:

CO1. Understand microcontrollers and embedded systems
CO2. Use microcontroller in different applications
CO3. Understand ARM processor family, Raspberry Pi and Arduino processor

Name of the Module: Microwave Engineering
Module Code: EC-324
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To make the students to study the microwave spectrum, tubes, components, diodes and device
- To study the operation, functions of microwave sources, diodes and devices and to know about the application of these devices for microwave circuits & systems, radar and satellite communication
- To expose students to the measurement of microwave & RF circuits
- To make the students to learn about EMI and EMC
- To understand and study in depth of the theory and the technology of microwave components, devices, diodes, tubes and sources
- To know about the microwave circuit measurement & communication system design; and to understand EMI & EMC

B. Course Content

Transmission line theory: Primary and secondary constants, Phase and group velocities, Transmission line equations, Distortion, Loading of lines, Characteristics of LF lines.

RF lines: RF lines, Lossless lines, Reflection coefficient and VSWR, Quarter-wave, Half-wave and 1/8 wave lines, Smith chart: Impedance matching with single and double stub.

***Microwave waveguides and components*:** Rectangular waveguide and circular waveguide – mode structure, Cut-off frequency, Wall current, Attenuation, Microwave cavities – rectangular cavity resonator, Q factor, Scattering matrix and transmission matrix, Return

loss, Gain considerations, Noise figure, Attenuator, Phase shifter, Directional coupler, Bethe hole coupler, Magic tee, Hybrid ring, Circulator, Isolator.
***Microwave Tubes*:** Limitations of conventional tubes, Multicavity klystron, Reflex klystron, Magnetron, Travelling wave tube, Backward wave oscillator

***RF Circuit*:** Low pass filter, High pass filter, Band pass filter, RF amplifier - low noise consideration.

***EMI / EMC*:** EMI standard, Radiated and conducted EMI and susceptibility, Wire antenna, EMI sensor, Antenna factor, Cable to cable coupling, Electrostatic discharge.

***Applications of Microwave*:** Principles of radar systems and applications, Radar range equations, Satellite communication system, Industrial applications of microwave.

***Microwave Measurement*:** VSWR measurement, Power measurement, Impedance measurement, Frequency measurement.

C. Text & Reference Books

1. S Y Liao, Microwave Devices and Circuits, Prentice Hall of India, 2006.
2. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design, Prentice Hall, 2000
3. Matthew M Radmanesh, Radio Frequency and Microwave Electronics Illustrated, 1st edition, Pearson Education Asia, 2001.

D. Reference Books

1. David M Pozar, Microwave Engineering, John Willy & Sons. Inc, 2011.
2. Peter A. Rizzi, Microwave Engineering – Passive Circuits, Prentice Hall of India, 1988.
3. M L Sisodia, Microwave Active Devices – Vacuum and Solid State, New Age Int. Publication, 2003.
4. M N O Sadiku, Elements of Electromagnetics, Oxford University Press, 2008.
5. K C Gupta, Microwaves, New Age Int. Publication New Delhi, 1983.
6. M I. Skolnik, Introduction to Radar Systems, 3rd edition, Tata McGraw Hill, 2017.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Recognize the limitations of existing vacuum tubes and solid-state devices at microwave frequencies

CO2. Know the operation, functions of microwave sources, diodes and devices and also know about the application of these devices for microwave circuits & systems, radar and satellite communication

CO3. Analyse microwave & RF circuits.

CO4. Know in depth of the theory and the technology of microwave components, devices, diodes, tubes and sources

CO5. Have clear understanding of the microwave circuit measurement & communication system design; and understand EMI & EMC

Name of the Module: VLSI Design
Module Code: EC-325
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To introduce students to basic concepts of digital VLSI chip design using the simpler VLSI technology

B. Course Content

Basics of MOS device physics: Semiconductor surfaces, The ideal and non-ideal MOS capacitors and diagrams and CVs;

***Metal Oxide Field Effect Transistor*:** Device structures and fabrication, Energy band diagram, MOS I/V characteristics, Effects of oxide charges, Defects and interface states; Threshold voltage, Body effect, Differences between a MOSFET and a BJT, Common source DC characteristics, Small-signal equivalent circuit SPICE level-1 model

***MOS Inverters**:* Static characteristics, Inverter types. Switching characteristics: Delay times, Power dissipation and super buffer design.

Combinational MOS Logic Circuits: CMOS logic circuits, Complex logic circuits, CMOS transmission gates, Pseudo-nMOS, Sequential MOS logic circuits, Behaviour of bi-stable elements, Latch, Clocked latch and flip-flop circuits.

Dynamic Logic Circuits: Principle of pass transistor, Dynamic circuit techniques, High performance dynamic CMOS.

Single Stage Amplifiers: Common source stage, Source follower and common gate.

Differential Amplifiers: Single ended and differential operations, Basic differential pair.

Current Mirror: Basic current mirror, Cascode current mirror- large signal and small signal analysis. Operational amplifiers: One stage op-amps, Two stage op-amps.

***Analog Multiplier*:** Gilbert multiplier cell, Variable trans-conductance technique, Analog multiplier ICs and their applications.

Overview of Digital Design with Verilog HDL: Typical design flow, Hierarchical modelling concepts: Design methodologies, Modules and ports, Instances, Components of a simulation, Data types, Arrays, Memories and parameters. Data low modelling & Behavioural modelling

C. Text books

1. S. M. Kang , Y. Leblebici, CMOS Digital Integrated Circuits, 3rd edition, Tata McGraw Hill, 2012
2. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits, 2nd edition, Pearson, 2003.

D. Reference books

1. A. S. Sedra and K. C. Smith, Microelectronic Circuits, 8th edition, Oxford University Press, 2019
2. S. Palnitkar, Verilog HDL- A Guide to Digital Design and Synthesis, 2nd edition, Pearson, 2007.

E. Course Outcomes

Upon completion of the subject, the student will have:

CO1. An ability to design logic circuit layouts for both static CMOS and dynamic clocked CMOS circuits.

CO2. An ability to extract the analog parasitic elements from the layout and analyze the circuit timing using a logic simulator and an analog simulator.

CO3. An ability to build a cell library to be used by other chip designers.

Name of the Module: Instrumentation & Measurement Laboratory
Module Code: EC-326
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objective of the course is:

- To study different test instruments and get familiarize with those instruments.
- To be familiar with calibration of measuring instruments such as ammeter, voltmeter, energy meter
- To know the measurement techniques of different parameters using electronic instruments
- To know the statistical analysis of errors in measurement using computer simulation

B. List of Experiments

Expt. No. 1. Instrument workshop – observe the construction of PMMC, Dynamometer, Electro thermal and Rectifier type instrument, Oscilloscope and digital multimeter.

Expt. No. 2. To calibrate moving iron and electrodynamometer type ammeter/voltmeter by potentiometer

Expt. No. 3. To calibrate dynamometer type wattmeter by potentiometer

Expt. No. 4. Study of voltage shunt and series ammeter behavior.

Expt. No. 5. To calibrate A. C. energy meter

Expt. No. 6. Measure the resistivity of material using Kelvin double bridge

Expt. No. 7. Measurement technique of power using instrument transformer

Expt. No. 8. Measurement technique of in polyphase circuits

Expt. No. 9. Measurement technique of frequency by Wien bridge using oscilloscope

Expt. No. 10. Measurement technique of by Anderson bridge

Expt. No. 11. Measurement technique of capacitance by De Sauty bridge

Expt. No. 12. To study of static characteristic (accuracy, precision, hysteresis, repeatability, linearity) of a measuring instrument.

Expt. No. 13. To study of dynamic characteristic (fidelity, speed of response)
Expt. No. 14. To acquaintance with basic structure of DMM and measurement of different electrical parameters.
Expt. No. 15. To statistical analysis of errors in measurement using computer simulation
Expt. No. 16. To study of advanced A/D converter along with its associate circuitry
Expt. No. 17. To study of advanced D/A converter
Expt. No. 18. Realization of data acquisition system
Expt. No. 19. Wave and spectrum analysis using digital storage oscilloscope & spectrum analyzer.

C. Text books

1. E.O. Doebelin; Measurement Systems, Application and Design, McGraw Hill International Edition, Singapore, 2008.
2. J.P. Bentley, Principles of Measurement Systems, 3rd edition, Longman Pub Group, 1995.

D. Reference books

1. A.K. Ghosh, Introduction to Measurement and Instrumentation, 3rd edition, PHI Learning, New Delhi, 2009.
2. A.K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, 19th edition, Dhanpat Rai Co, 2014.

E. Course Outcomes

After the completion of this course, students will

CO1. Know calibration of different measurement instruments
CO2. Know the techniques of measurement
CO3. Be able to perform statistical analysis of errors in measurement using computer simulation

Name of the Module: Microcontrollers & Embedded System Laboratory

Module Code: EC-327

Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objectives of the course is:

- To study and apply microcontrollers to generate waveforms
- To learn the applications of Arduino and Raspberry Pi
- To get familiarize with Proteus design suit

B. List of Experiments

Expt. No. 1. To study development tools/environment for ATMEL microcontroller programs and architecture
Expt. No. 2. Generate square wave of desire frequency using Timer, PWM.
Expt. No. 3. Interface seven segments with Arduino and display 0-9 on it.
Expt. No. 4. Control joint movement of Robot arm by using Gallio.
Expt. No. 5. Using Proteus design suit, develop IoT circuits to control different switches.

Expt. No. 6. Model-based design using uKeil
Expt. No. 7. Interfacing Raspberry Pi with camera module.
Expt. No. 8. Hardware implementation using any advanced controller

C. Text books

1. Prasad K.V.K.K, Embedded /Real-Time Systems: concepts, Design and Programming—The Ultimate reference, Dreamtech Press New Delhi, 2003.
2. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st edition, CRC Press, 2017.

D. Reference books

1. Thomas W Schultz, C and the 8051 Volume II, Building Efficient Applications, Prentice Hall, 1999
2. Zurell, Kirk, C Programming for Embedded Systems, CMP, 2000
3. Schultz, Thomas W, C and the 8051 Programming for Multitasking, 1st edition, Prentice Hall, 1992.
4. Steven Holzner, C with assembly language, BPB publication, 2017
5. Schultz, Thomas W, C and the 8051: Hardware, Modular Programming and Multitasking Vol 1, 2nd edition, Prentice Hall, 1997
6. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Prentice Hall, 2020.
7. Davin Poole, Alan Mackworth, and Randy Goebel, Computational Intelligence: A logical Approach, 1st edition, Oxford University Press, 1998.

E. Course Outcomes

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

CO1. Understand microcontrollers and embedded systems
CO2. Use microcontroller in different applications
CO3. Understand ARM processor family, Raspberry Pi and Arduino processor

Name of the Module: Microwave Engineering Laboratory
Module Code: EC-328
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objective of the course is:

- To make the hands-on of students on matching stub
- To make the hands-on of students on reflex klystron
- To make the hands-on of students on waveguide
- To make an understanding on smith chart

B. List of experiments

Expt. No. 1. To study how a matching stub is used to match the frequency.
Expt. No. 2. To study the characteristics of the Reflex Klystron Tube and to determine its electronic tuning range. Measure frequency from microwave bench

Expt. No. 3. To determine the unknown frequency by using slotted line.
Expt. No. 4. To determine the Voltage Standing Wave Ratio (VSWR) and Reflection Coefficient.
Expt. No. 5. To observe load impedance affects on VSWR using slotted waveguide.
Expt. No. 6. To determine when a waveguide is properly terminated.
Expt. No. 7. To measure unknown load impedance attached to a waveguide using the smith chart.

C. Text books

1. S Y Liao, Microwave Devices and Circuits, Prentice Hall of India, 2006.
2. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design, Pearson Education, Inc., 2006
3. Matthew M Radmanesh, Radio Frequency and Microwave Electronics Illustrated,1st edition, Pearson Education Asia, 2001.

D. Reference books

1. David M Pozar, Microwave Engineering, John Willy & Sons. Inc, 2011.
2. Peter A Rizzi, Microwave Engineering – Passive Circuits, Prentice Hall of India, 1998.
3. M N O Sadiku, Elements of Electromagnetics, Oxford University Press, 2008.
4. K C Gupta, Microwaves, New Age Int. Publication New Delhi, 1983.

E. Course Outcomes

CO1. Clear understanding & utilization of matching stub and reflex klystron.
CO2. Clear understanding and utilisation of waveguide.
CO3. Clear understanding of smith chart.

Name of the Module: VLSI Design Laboratory
Module Code: EC-329
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objective of the course is:

- To introduce students to electronic design automation tools of digital VLSI chip design using the simpler VLSI technology

B. List of Experiments

Expt. No. 1. Study and characterization of I/V plot of NMOS and PMOS
Expt. No. 2. Design of CMOS inverter to study voltage transfer characteristic plot and to determine critical points.
Expt. No. 3. Delay estimation of CMOS inverter and to study the effect of design parameters on delay.
Expt. No. 4. Design and study of basic gates and adders with timing diagram.
Expt. No. 5. Design and study of latch and clocked latch with timing diagram.
Expt. No. 6. Design of CMOS differential amplifier with different gate size and input with different slew rate for the generation I/V plot.

Expt. No. 7. Design and study of common source, source follower and common gate amplifiers in order to understand input output characteristics.
Expt. No. 8. Design of study differential amplifier with input output plots and to understand the difference from single stage amplifiers
Expt. No. 9. Layout of basic gates, adders, latch, clocked latch and to observe the performance in pre and post layouts.
Expt. No. 10. Design of adders and subtractor using behavioral level in Verilog.
Expt. No. 11. Design of latch and clocked latch using behavioral level in Verilog.

C. Text books

1. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits, 3rd edition , TMH, 2012
2. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits, 2nd edition, PHI, 2003.

D. Reference books

1. A. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford University Press, 2004
2. S. Palnitkar, Verilog HDL- A Guide to Digital Design and Synthesis, 2nd edition, Pearson, 2007.

E. Course Outcomes

Upon completion of the subject, the student will have:

CO1. An ability to design logic circuit layouts for both static CMOS and dynamic clocked CMOS circuits.
CO2. An ability to extract the analog parasitic elements from the layout and analyze the circuit timing using a logic simulator and an analog simulator.
CO3. An ability to build a cell library to be used by other chip designers.

B. Tech. 4th Year, Semester VII

VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	OE-XXX	Open ELECTIVE	3	0	0	3
2	EC-401X	Elective-I	3	0	0	3
3	EC-402	Wireless Communication	3	0	0	3
4	EC-403	Antenna & Wave Propagation	3	0	0	3
5	EC-404	Advance Communication Laboratory	0	0	2	1
6	EC-405	Antenna & Wave Propagation Laboratory	0	0	2	1
7	EC-490	Internship – III	0	0	0	3
Contact Hours			12	0	6	
Total Credits						17

Name of the Module: Wireless Communication
Module Code: EC-402
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The Objective of the course is:

- To expose the students to understand mobile radio communication principles
- To study the recent trends adopted in cellular systems and wireless standards.
- To provide an overview of Wireless Communication networks area and its applications in communication engineering.
- To appreciate the contribution of Wireless Communication networks to overall technological growth.
- To understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.

B. Course Content

Introduction to wireless communication: Evolution of mobile radio communication, Examples of wireless communication system.

The cellular engineering fundamentals: Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity.

Mobile Radio Propagation models: Free space propagation models, Two Ray model, Knife edge diffraction model, Log-distance path loss model, Outdoor propagation model, Indoor propagation model, Small scale multipath propagation, Small scale fading

Modulation techniques for mobile radio: Analog modulation techniques, Line Coding, Pulse shaping, Linear modulation techniques, Constant envelope modulation techniques, Combined modulation techniques, Spread spectrum modulation techniques
Multiple access techniques**:** TDMA, FDMA, CDMA, SDMA, CSMA, OFDMA

GSM, 3G, 4G (LTE), NFC systems, WLAN technology, WLL, HiperLAN, Ad hoc networks.

C. Text books

1. T. S. Rappaport, Wireless Communications, 2nd edition, PHI, 2010.
2. A Goldsmith, Wireless Communications, Cambridge publication, 2012.

D. Reference books

1. K. Feher, Wireless Digital Communications: Modulation and Spread Spectrum Applications, 1st edition, Pearson Education India, 2015.
2. J. G. Proakis, Digital Communications, 5th edition, McGraw Hill, 2018.
3. W. C.Y. Lee, Mobile Communications Engineering, 2nd edition, 1998.
4. S. Haykin and M. Moher, Modern Wireless Communications, 1st edition, 2011.

E. Course Outcomes

After completion of this course students will be able to:

CO1. Understand the cellular system design and technical challenges.
CO2. Analyse the Mobile radio propagation, fading, diversity concepts and the channel modelling.
CO3. Analyse the design parameters, link design, smart antenna, beam forming and MIMO systems.

CO4. Analyse Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts.
CO5. Clearly know the principles and applications of wireless systems and standards

Name of the Module: Antenna & Wave Propagation
Module Code: EC-403
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The course is designed to meet the outcomes of:

- To make the students to study Antennas& their characteristics and propagation patterns
- To expose students to application of particular antenna in particular communication system,
- To make students aware of EM wave propagation under different modes

B. Course Content

***Radiation Theory and Pattern*:** Review of Maxwell wave equation and Faraday's law, Radiation, Hertzian dipole, Different field components.

***Antenna Fundamentals*:** Antenna concept, Different types of antenna, Directivity, Beam Width, Gain, Radiation resistance, Application of network theorems, Basic terminology, Field radiated by dipole & loop antennas, Monopole antenna, Parabolic antenna, Effect of ground, Travelling wave antennas, Antenna impendence & bandwidth, Array analysis & synthesis special arrays like Binomial Yagi etc.

***Advanced Antenna*:** Introduction to adaptive & retro directive arrays, Circularly polarized antennas, Helical antennas, Broadband antennas and arrays (Log periodic & other), Secondary source & Aperture antenna, Microwave antennas, Horn, Slot, Paraboloidal Reflector, Lens & Microstrip antenna, Smart antennas. Remote sensing application of antennas, Radar range equations. Propagation effect to Link on EM.

***Wave propagation*:** Wave propagation in different frequency ranges, Interference effects of ground, Antennas located over flat & spherical earths' magnetic fields, Troposphere scatter, Ducts & nonstandard refraction, EIF propagation using earth-ionosphere waveguide model, Scattering & absorption at microwave frequencies, Introduction to propagation modeling and predictive studies on propagation, Fading, Friis transmission formula, Brightness & temperature of antenna and their role in link calculation.

C. Text books

1. J D Kraus,R. J. Marhefka, A. S Khan, Antennas and Wave Propagation, 4th Edition, Tata McGraw Hill, 2011.
2. C. A. Balanis, Antenna Theory: Analysis and Desig, 3rd Edition, Wiley India, 1989.
3. J D Kraus, Electromagnetics with Applications, 5th Edition, McGraw Hill, 2010.

D. Reference books

1. G Kennedy, Electronic Communication Systems, 5th edition, McGraw-Hill, 2011.
2. Hayt, Engineering Electromagnetics, Tata McGraw Hill, 2001.
3. John D Ryder, Networks Lines and Field, 2nd Edition, Prentice Hall of India, 2006.
4. E C Jordan and K G Balmain, Electromagnetic Waves and Radiating Systems, 2nd edition, Prentice Hall of India, 1964.
5. S Y Liao, Microwave Devices and Circuits, Prentice Hall of India, 2006.
6. Matthew M Radmanesh, Radio Frequency and Microwave, Electronics Illustrated, Pearson Education Asia, 2001.
7. David M Pozar, Microwave Engineering, 4th edition, John Willy & Sons. Inc, 2011.
8. Peter A Rizzi, Microwave Engineering – Passive Circuits, Prentice Hall of India, 1998.
9. M L Sisodia, Microwave Active Devices – Vacuum and Solid State, New Age Int. Publication, 2003.
10. M N O Sadiku, Elements of Electromagnetics, Oxford University Press, 2008.
11. K C Gupta, Microwaves, New Age Int. Publication, New Delhi, 1983.
12. M I Skolnik, Introduction to Radar Systems, 3rd edition, Tata McGraw Hall, 2017.

E. Course Outcomes

At the end of this module, students are expected to be able to:

CO1. Understand and utilize antenna as required in different communication systems.

CO2. Know about EM wave propagation effects & pattern in different media.

Name of the Module: Advance Communication Laboratory
Module Code: EC- 404
Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objective of the course is:

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- To understand the different kind of losses, signal distortion, SM fibers.
- To learn the various optical sources
- To learn the fiber optical receivers and noise performance in photo detector.

B. List of Experiments

Expt. No. 1. Experimental characterization of all the major components of a fibre optic communications link (i.e. the transmitter, the optical fibre and the receiver) and investigation of the overall system performance of a 1, 2 & 3km link using a laser diode and LED transmitter

Expt. No. 2. Determination of the receiver noise and sensitivity

Expt. No. 3. Measurement of connector loss, attenuation along optical fibre links, and determination of the fibre attenuation coefficient

Expt. No. 4. Results analysis to determine the material and intermodal dispersion coefficients, the bit rate/bandwidth distance products and the upper limits

on the link length, bandwidth and bit rate as determined by attenuation and dispersion in the fibre.

Expt. No. 5. Examination of the narrowband wavelength response and characterization of Bragg grating and DWDM modules

Expt. No. 6. Examination of a two channel DWDM system, channel add/drop, and measurement of system crosstalk / channel isolation

Expt. No. 7. Investigation of crosstalk effects on the eye diagram / BER in DWDM systems

Expt. No. 8. Assembly and characterization of a two channel 1310nm & 1550nm WDM system

C. Text books

1. R.P. Khare, "Fiber Optics and Optoelectronics", Oxford University Press, 2004.
2. John M. Senior, "Optical Fiber Communications: Principles and Practice ", Third edition, Pearson Education India, 2010.

D. Reference books

1. P. Bhattacharya, Semiconductor Optoelectronic Devices, 2nd edition, Pearson, 2017.
2. Franz and Jain, Optical Communication System, Narosa Publications, New Delhi, 1995.
3. Gerd Keiser, Optical Fiber Communication, 5th edition, McGraw Hill Education, 2010.
4. Endel Uiga, Optoelectronics, 1st edition, Prentice Hall, 1995
5. Govind P. Agrawal, Fiber-Optic Communication System, Third edition, Wiley, 2012.

E. Course Outcomes

Upon completion of the subject, the student will:

CO1. Recognize and classify the structures of Optical fiber and types.

CO2. Discuss the channel impairments like losses and dispersion.

CO3. Classify the optical sources and detectors and to discuss their principle.

CO4. Be familiar with different optical devices such as Optical isolators, Circulators, Attenuators, Filters

CO5. Be familiar with Design considerations of fiber optic systems.

CO6. Perform characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software and hardware, analyze the results to provide valid conclusions.

Name of the Module: Antenna & Wave Propagation Laboratory

Module Code: EC-405

Credit Value: 1 {L = 0, T = 0, P = 2}

A. Course Objectives

The Objective of the course is:

- To make an understanding and utilisation of horn antenna.
- To make an understanding and utilisation of Yagi antenna.
- To make an understanding and utilisation of Printed antenna.
- To become familiar with the Parabolic antenna.

B. List of Experiments

Expt. No. 1. To describe the characteristics of the Horn antenna. To carry out gain measurements using method of comparison. Measurement of the gain of Horn Antenna using Method of the two antennas.

Expt. No. 2. To investigate the properties of a system comprising a dipole and a parasitic element. Understand the terms "driven element", "reflector", "director". To know the form of a Yagi antenna and examine multi element Yagi. To see how gain and directivity increase as element numbers increase.

Expt. No. 3. To investigate the Radiation Pattern of Printed antennas

Expt. No. 4. Be familiar with the Parabolic/Dish form of antenna. To investigate the gain and directivity of the dish antenna. Appreciate the advantages and disadvantages of a dish antenna as compared with a Yagi.

Expt. No. 5. Be familiar with the Log Periodic form of antenna. To investigate the gain, and directivity of the log Periodic antenna over a wide frequency range. Appreciate the advantages and disadvantages of a log periodic Antenna as compared with a Yagi.

Expt. No. 6. Understand the terms "baying" and "stacking" as applied to antennas. To investigate stacked and bayed Yagi antennas. To compare their performance with a single Yagi.

Expt. No. 7. Study and show variation in the radiation strength at a given distance from the antenna and detector will show a higher strength when it is nearer to the transmitting antenna and shall reduce gradually with increasing distance.

C. Text books

1. C. A. Balanis "Antenna Theory: Analysis and Design" 3rd Edition, Wiley India, 1989.
2. J D Kraus, "Electromagnetics with Applications", 5th Edition, McGraw Hill, 2010.

D. Reference books

1. G Kenedy, Electronic Communication Systems, 5th edition, McGraw Hill, 2011.
2. Hayt, Engineering Electromagnetics, Tata McGraw Hill, 2001.
3. John D Ryder, Networks Lines and Fields, 2nd Edition, Prentice Hall of India, 2006.
4. E C Jordan and K G Balmain, Electromagnetic Waves and Radiating Systems, 2nd edition, Prentice Hall of India, 1964.
5. S Y Liao, Microwave Devices and Circuits, Prentice Hall of India, 2006.
6. Matthew M Radmanesh, Radio Frequency and Microwave, Electronics Illustrated, Pearson Education Asia, 2001.
7. David M Pozar, Microwave Engineering, John Willy & Sons. Inc, 2011.

E. Course Outcomes

At the end of this module, students are expected to be able to:

CO1. Understand and realize antenna structures for practical communication systems

CO2. Understand and utilize antenna radiation pattern.

Name of the Module: Optical Communication
Module Code: EC-401A
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- To understand the different kind of losses, signal distortion, SM fibers.
- To learn the various optical sources, materials and fiber splicing
- To learn the fiber optical receivers and noise performance in photo detector.
- To learn link budget, WDM.

B. Course Content

Fiber Structures and Types, Rays and modes, Single-mode and multimode fibers, Refractive index profiles, Graded index fiber, Numerical aperture, Acceptance angle, V-parameter, Loss mechanisms in fibers, Loss vs. wavelength plot and its significance, Dispersion mechanisms in Fibers: Intermodal and intramodal (chromatic) dispersions, Components of intramodal dispersions, Dispersion vs. wavelength plots and their significance.

Optical Sources: LED and LASER structures, Operating principle and modulation characteristics.

Photo Detectors: PIN diode and avalanche photodiode (APD) as photo detector: Structure, operating principle, Shot noise, Avalanche multiplication (excess) noise.

Optical isolators, polarizer, Circulators, Attenuators, Oscillators, Filters, Add/drop multiplexers, Optical modulators. Optical amplifiers: Basic applications and types, Semiconductor optical amplifiers, EDFA.

Wave division multiplexing and demultiplexing, Intensity modulation/direct detection system, Link budget using direct detection, Coherent system, Wavelength converters, Coherent and WDM systems.

C. Text books

1. R.P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2004.
2. John M. Senior, Optical Fiber Communications: Principles and Practice - Principles and Practice, Third edition, Pearson Education India, 2010.

D. Reference books

1. P. Bhattacharya, Semiconductor Optoelectronic Devices, 2nd edition, Pearson, 2017.
2. Franz and Jain, Optical Communication System, Narosa Publications, New Delhi, 1995.
3. Gerd Keiser, Optical Fiber Communications, 5th edition, McGraw Hill Education, 2010
4. Endel Uiga, Optoelectronics, 1st edition, Prentice Hall, 1995.
5. Govind P. Agrawal, Fiber-Optic Communication Systems, Third edition, Wiley, 2007.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Recognize and classify the structures and types of Optical fiber.
CO2. Discuss the channel impairments like losses and dispersion.
CO3. Classify the optical sources and detectors and discuss their principle.
CO4. Be familiar with different optical devices such as Optical isolators, polarizer, Circulators, Attenuators, Oscillators, Filters
CO5. Familiar with Design considerations of fiber optic systems.
CO6. Perform characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software and hardware, analyze the results to provide valid conclusions.

Name of the Module: Wireless Sensor Network
Module Code: EC-401B
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To understand wireless sensor nodes and wireless sensor network
- To understand the challenges in wireless sensor network
- To understand the architecture and applications of sensor network
- To understand the infrastructure establishment of sensor network
- To understand the taxonomy of routing in WSN

B. Course content:

Introduction: Constraints and Challenges, Opportunities and Challenges in Wireless Sensor Networks, Advantages of Sensor Networks (Energy Advantage and Detection Advantage), Sensor Network Applications, Smart Transportation, Collaborative Processing, Key Definitions

Sensor Network Architecture and Applications: Introduction, Functional Architecture for Sensor Networks, Sample Implementation Architectures, Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks, Location in Wireless Sensor Networks, Data Gathering and Processing

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Localization Services

Sensor Network Platforms and Tools: Individual Components of SN Nodes, Sensor Network Node, WSNs as Embedded Systems, Sensor Node Hardware, Sensor Network Programming Challenges, Node-Level Software Platforms, Node-Level Simulators, Programming beyond Individual Nodes: State-Centric Programming.

Taxonomy of Routing Techniques: Routing Protocols, Future Directions, Applications/Application Layer Protocols, Localization Protocols, Time Synchronization Protocols, Transport Layer Protocols, Network Layer Protocols, Data Link Layer Protocols

C. Text Books:

1. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks: An Information Processing Approach, Morgan Kaufmann, 2004.
2. Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge University Press, 2005.
3. Mohammad Ilyas, Imad Mahgoub, Hand book of Sensor Networks, CRC Press, 2005.

D. Reference Books:

1. C.S Raghavendra, Krishna M, Sivalingam, TaiebZnati, Wireless Sensor Networks, Springer, 2005.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, Wireless Sensor Networks: Technology, Protocols, and Applications, 1st edition, Wiley Inter Science, 2007.

E. Course Outcomes

At the end of the course, a student will be able to:

CO1. Identify the components of Wireless Sensor Networks
CO2. Understand the challenges in network coverage and routing for energy efficiency
CO3. Define node Architecture for specific applications
CO4. Program sensor network platforms using specialized operating system
CO5. Recognize upcoming challenges in Sensor Networks

Name of the Module: Image Processing
Module Code: EC-401C
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To understand digital image processing systems and its elements.
- To understand digital image fundamentals
- To understand various steps involved in image enhancement
- To understand image compression and segmentation

B. Course Content:

Introduction: Digital Image Representation, Fundamental Steps in Image Processing, Elements of Digital Image Processing Systems.

Digital Image Fundamentals: Elements of Visual Perception, A Simple image model, Sampling and Quantization, Neighbourhood of Pixels, Pixel Connectivity, Labeling of Connected

Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging.

Image Enhancement: Spatial Domain Methods, Frequency Domain Methods, Point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Enhancement in the Frequency Domain, Low Pass Filtering, High Pass Filtering, Homomorphic filtering, Pseudo-Color Image Enhancement.

Image Compression: Fundamentals of Compression, Image Compression Model, Error free Compression, Lossy Predictive Coding, Transform Coding.

Image Segmentation: Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing , Region Splitting and Merging, Use of motion in Segmentation.

Image Representation and Description: Chain Codes, Polygonal Approximations, Signatures, Skeleton, Boundary Descriptions, Shape Numbers, Fourier descriptors, Moments, Topological Descriptors.

Image Recognition and Interpretation: Elements of Image Analysis, Pattern and Pattern Classes, Minimum Distance Classifier, Matching by Correlation, Bayes Classifier, Neural Network Training Algorithm, Structural methods.

C. Text Books:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education Asia New Delhi, 2000.
2. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI New Delhi, 2000.
3. A.K. Jain, Fundamentals of Digital Image Processing, PHI New Delhi, 2001.

D. Reference Books:

1. Alan C. Bovik, Handbook of image and video processing, Elsevier Academic press, 2005.
2. S. Sridhar, Digital Image processing, Oxford University press, 2011
3. Milan Sonka et al, Image Processing, Analysis and Machine vision, Brookes/Cole, Vikas Publishing House, 1999.

E. Course Outcomes:

At the end of the course, a student will be able to:

CO1. Understand the need for image transforms and their properties.
CO2. Choose appropriate technique for image enhancement both in spatial and frequency domains.
CO3. Identify causes for image degradation and apply restoration techniques
CO4. Compare the image compression techniques in spatial and frequency domains
CO5. Select feature extraction techniques for image analysis and recognition

Name of the Module: Machine Learning
Module Code: EC-401D
Credit Value: 3 {L = 3, T = 0, P = 0}

A. Course Objectives

The objective of the course is:

- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To understand the basic theory underlying machine learning

B. Course content:

Introduction: Introduction to Machine Learning, Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis (VC) Dimension.

Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple classes, Model Selection and Generalization, Dimensionality reduction- Subset selection, Principle Component Analysis

Classification: Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance- Precision, recall, ROC curves, Bayes Theorem, Bayesian classifier, Maximum Likelihood estimation, Density functions, Regression.

Decision Trees: Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Classification by Regression (CART), Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation.

Kernel Machines: Support Vector Machine- Optimal Separating hyper plane, Soft-margin hyperplane, Kernel trick, Kernel functions. Discrete Markov Processes, Hidden Markov models, Three basic problems of HMMs- Evaluation problem, finding state sequence, Learning model parameters, Combining multiple learners, Ways to achieve diversity, Model combination schemes, Voting, Bagging, Booting.

Unsupervised Learning: Clustering Methods - K-means, Expectation-Maximization Algorithm, Hierarchical Clustering Methods, Density based clustering.

C. Text Books:

1. Gopinath R, Ajay Ravi, “An introduction to machine Learning”, Springer, 2019

2. M. Gopal, “Applied Machine Learning”, Mc Grew Hill, 2019
3. Paul Wilmott**, “**Machine Learning: An Applied Mathematics Introduction”, Panda Ohana Publishing, 2019.

D. Reference Books:

1. Ethem Alpaydin, An introduction to machine Learning, The MIT Press; 2014
2. Richard S. Sutton, Reinforcement Learning: An Introduction, A Bradford Book, 1998.

E. Course Outcomes:

At the end of the course, a student will be able to:

CO1. Apply knowledge of computing and mathematics to machine learning problems and algorithms.

CO2. Analyse a problem and identify the computing requirements appropriate for its solution.

CO3. Design, implement and evaluate an algorithm to meet desired needs.

CO4. Apply mathematical foundations, algorithmic principles and computer science theory to the modelling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.

B. Tech. 4th Year, Semester VIII

VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EC-421X	Elective-II (Swayam/ NPTEL)	3	0	0	3
2	EC-422X	Elective-III (Swayam/ NPTEL)	3	0	0	3
3	EC-491	Grand Viva	0	0	4	2
4	EC-499	Project & Dissertation	0	0	20	10
Contact Hours			6	0	24	
Total Credits						18