

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**  
**KAKINADA – 533 003, Andhra Pradesh, India**

**DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING**

**COURSE STRUCTURE AND SYLLABUS**

**For**

**B. TECH ELECTRONICS AND INSTRUMENTATION ENGINEERING**

*(Applicable for batches admitted from 2019-2020)*



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**III Year - I Semester**

S.No.	Subjects	Category	L	T	P	Credits
1	Signal Conditioning Circuits	PC	3	0	0	3
2	Integrated Circuits and applications	PC	3	0	0	3
3	Microprocessor and Microcontrollers	PC	3	0	0	3
4	Process Control Instrumentation	PC	3	0	0	3
5	Professional Elective (PE1)	PE	3	0	0	3
6	Process control Instrumentation Lab	LC	0	0	3	1.5
7	Integrated Circuits and applications - Lab	LC	0	0	3	1.5
8	Microprocessor and Microcontrollers Lab	LC	0	0	3	1.5
9	Professional Ethics & Human Values	MC	3	0	0	0
10	Mini Project with Hardware Development	PR	0	0	3	1.5
	Total Credits					<b>21</b>

**III Year -II Semester**

S.No.	Subjects	Category	L	T	P	Credits
1	Digital Signal Processing	PC	3	0	0	3
2	VLSI Design	PC	3	0	0	3
3	Industrial Instrumentation	PC	3	0	0	3
4	Professional Elective (PE-II)	PE	3	0	0	3
5	Open Elective (OE-I)	OE	3	0	0	3
6	Data Acquisition System	PC	3	0	0	3
7	Digital Signal Processing Lab	LC	0	0	3	1.5
8	Industrial Instrumentation Lab	LC	0	0	3	1.5
9	Intellectual Property Rights (IPR) & Patents	MC	3	0	0	0
	Total Credits					<b>21</b>

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<b>III Year- II Semester</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL SIGNAL PROCESSING</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- Analyze the discrete-time signals and systems in time and frequency domains.
- Know the importance of FFT algorithm for computation of Discrete Fourier Transform.
- Understand the various implementations of digital filter structures.
- Learn the FIR and IIR Filter design procedures.
- Learn the concepts of DSP Processors.

**UNIT-I:**

**INTRODUCTION:** Introduction to Digital Signal Processing: Discrete-time signals & sequences, Classification of discrete-time systems, stability and causality of LTI systems, Response of LTI systems to arbitrary inputs. Solution of linear constant coefficient difference equations. Discrete-time Fourier Transform (DTFT), Frequency domain representation of discrete-time signals and systems. Review of Z-transforms, solution of difference equations using Z-transforms, Systemfunction.

**UNIT-II:**

**DISCRETE FOURIER SERIES & FOURIER TRANSFORMS:** Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT)-Radix-2 decimation-in-time and decimation-in-frequency FFT Algorithms, Inverse FFT, Circular convolution and linear convolution using DFT.

**UNIT-III:**

**DESIGN OF IIR DIGITAL FILTERS & REALIZATIONS:** Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

**UNIT-IV:**

**DESIGN OF FIR DIGITAL FILTERS & REALIZATIONS:** Characteristics of FIR Digital Filters, Frequency response, Design of FIR Digital Filters using Window technique and Frequency Sampling technique, Comparison of IIR & FIR filters. Basic structures of FIR systems.

**UNIT-V:**

**INTRODUCTION TO DSP PROCESSORS:** Introduction to programmable DSPs: Multiplier and Multiplier Accumulator, Modified bus structures and memory access schemes in P-DSPs, Multiple Access Memory, Multiport memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.

**ARCHITECTURE OF ARM PROCESSORS:** Technical details of ARM Processors, Introduction to Cortex-M3 and cortex M4 processors - Processor type, processor architecture, instruction set, block diagram, memory systems.

**TEXT BOOKS:**

1. Digital Signal Processing, Principles, Algorithms and Applications: John G. Proakis, Dimitris G.



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Manolakis, Pearson Education/PHI, 2007.

2. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI.
3. Digital Signal Processors, Architecture, Programming and Applications, B. Venkataramani, M. Bhaskar, TMH, 2002.
4. Digital Signal Processing Using the ARM Cortex M4, Donald S. Reay.

**REFERENCES:**

- 1 Digital Signal Processing: MH Hayes, Schaum's Outlines, TMH, 2007.
- 2 Fundamentals of Digital Signal Processing using MATLAB – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.
- 3 Digital Signal Processing, Alan V. Oppenheim, Ronald W. Schaffer, PHI Edition 2006.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Formulate engineering problems in terms of DSP operations.
- Analyze digital signals and systems.
- Analyze discrete time signals in frequency domain.
- Design digital filters and implement with different structures.
- Understand the key architectural features of Digital Signal Processors.

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	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>VLSI DESIGN</b>				

**OBJECTIVES:**

**The main objectives of this course are:**

- To learn the MOS Process Technology
- To understand the operation of MOS devices
- Understand and learn the characteristics of CMOS circuit construction.
- Describe the general steps required for processing of CMOS integrated circuits.
- To impart in-depth knowledge about analog and digital CMOS circuits.

**UNIT-I:**

**INTRODUCTION AND BASIC ELECTRICAL PROPERTIES OF MOS CIRCUITS: VLSI**

Design Flow, Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS.  $I_{ds}$  versus  $V_{ds}$  Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology, MOS Layers, Stick Diagrams, Design Rules and Layout, Layout Diagrams for MOS circuits

**UNIT-II:**

**BASIC CIRCUIT CONCEPTS:** Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, some area Capacitance Calculations, The Delay Unit, Inverter Delays, driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.

**SCALING OF MOS CIRCUITS:** Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

**UNIT-III:**

**BASIC BUILDING BLOCKS OF ANALOG IC DESIGN:** Regions of operation of MOSFET, Modelling of transistor, body bias effect, biasing styles, single stage amplifier with resistive load, single stage amplifier with diode connected load, Common Source amplifier, Common Drain amplifier, Common Gate amplifier, current sources and sinks.

**UNIT-IV:**

**CMOS COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUIT DESIGN:**

**Static CMOS Design:** Complementary CMOS, Rationed Logic, Pass-Transistor Logic.

**Dynamic CMOS Design:** Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Gate Design in the Ultra Deep-Submicron Era.

Latch Versus Register, Latch based design, timing decimation, positive feedback, instability, Metastability, multiplexer-based latches, Master-Slave Based Edge Triggered Register, clock to q delay,

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setup time, hold time, reduced clock load master slave registers, Clocked CMOS register. Cross coupled NAND and NOR, SR Master Slave register, Storage mechanism, pipelining.

**UNIT-V:**

**FPGA DESIGN:** FPGA design flow, Basic FPGA architecture, FPGA Technologies, Introduction to FPGA Families.

**INTRODUCTION TO ADVANCED TECHNOLOGIES:** Giga-scale dilemma, Short channel effects, High-k, Metal Gate Technology, FinFET, TFET.

**TEXTBOOKS:**

1. Essentials of VLSI Circuits and Systems - Kamran Eshraghian, Douglas and A. Pucknell And Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 2003
3. Digital Integrated Circuits, Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2<sup>nd</sup> edition, 2016.

**REFERENCES:**

1. "Introduction to VLSI Circuits and Systems", John P. Uyemura, John Wiley & Sons, reprint 2009.
2. Integrated Nanoelectronics: Nanoscale CMOS, Post-CMOS and Allied Nanotechnologies Vinod Kumar Khanna, Springer India, 1<sup>st</sup> edition, 2016.
3. FinFETs and other multi-gate transistors, Colinge JP, Editor New York, Springer, 2008.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
- Apply the design Rules and draw layout of a given logic circuit.
- Design MOSFET based logic circuit.
- Design basic building blocks in Analog IC design.
- Analyze the behaviour of amplifier circuits with various loads.
- Design various CMOS logic circuits for design of Combinational logic circuits.
- Design amplifier circuits using MOS transistors.
- Design MOSFET based logic circuits using various logic styles like static and dynamic CMOS.
- Analyze the behaviour of static and dynamic logic circuits.





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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>INDUSTRIAL INSTRUMENTATION</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- Understand the basic knowledge of the physical parameters like Pressure, Temperature, flow, level, density and viscosity employed in different Industries.
- Acquire sound knowledge about various techniques used for the measurement of industrial parameters.
- Understand the construction and working of measuring instruments.
- Analyze need and necessity of measuring instruments.

**UNIT-I:**

**METROLOGY:** Measurement of length - Gauge blocks – Plainness – Area using Simpson’s rule, Planimeter Diameter – Roughness – Angle using Bevel protractor, sine bars and Clinometer – Mechanical, Electrical, Optical and Pneumatic Comparators. Optical Methods for length and distance measurements using Optical flats and Michelson Interferometer.

**VELOCITY AND ACCELERATION MEASUREMENT:** Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers -Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications.

**UNIT-II:**

**FORCE MEASUREMENT:** Force measurement – Different methods –Gyroscopic Force Measurement – Vibrating wire Force transducer.

**PRESSURE MEASUREMENT:** Basics of Pressure measurement –Manometer types – Force-Balance and Vibrating Cylinder Transducers – High- and Low-Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauge, Thermal Conductivity Gauge, Ionization Gauge, Dual Gauge Techniques, Deadweight Gauges, Hydrostatic Pressure Measurement

**UNIT-III:**

**FLOW MEASUREMENT AND LEVEL MEASUREMENT:** Flow Meters- Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vortex shedding type, Hotwire anemometer type, Laser Doppler Velocity-meter. Basic Level measurements – Direct, Indirect, Pressure, Buoyancy, Weight, Capacitive Probe methods

**UNIT-IV:**

**DENSITY, VISCOSITY AND OTHER MEASUREMENTS:** Density measurements – Strain Gauge load cell method – Buoyancy method - Air pressure balance method Gamma ray method – Vibrating probe method.

Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of



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measuring consistency and Viscosity – Two float viscosimeter – Industrial consistency meter. Sound-Level Meters, Microphones, Humidity Measurement

**UNIT-V:**

**CALIBRATION AND INTERFACING:** Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density Viscosity Sensors, Variable Frequency Drive

**TEXT BOOKS:**

1. Measurement Systems – Applications and Design – by Doebelin E.O., 4/e, McGraw Hill International 1990.
2. Principles of Industrial Instrumentation – Patranabis D. TMH. End edition 1997.

**REFERENCES:**

1. Process Instruments and Control Handbook – by Considine D.M., 4/e, McGraw Hill International, 1993.
2. Mechanical and Industrial Measurements – by Jain R.K., Khanna Publishers 1986.
3. Instrument Technology, vol. I – by Jones E.B., Butterworths 1981.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Analyze various process transducers.
- Compare and distinguish temperature standards, thermocouples and pyrometry techniques.
- Analyze area flow meters, mass flow meters and perform calibration.
- Compare various types of level measurements adopted in industry environment.

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<b>DIGITAL CONTROL SYSTEMS (PROFESSIONAL ELECTIVE-II)</b>				

**OBJECTIVES:**

**The main objectives of this course are:**

- Understand and learn stability analysis of Digital control systems.
- To design the controllability and observability of digital control systems.
- To study Digital PID Controllers.

**UNIT-I:**

**SAMPLING AND RECONSTRUCTION:** Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal.

**THE Z – TRANSFORMS:** Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms.

**Z-P LANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEM:** Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.

**UNIT-II:**

**STATE SPACE ANALYSIS:** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.

**UNIT-III:**

**CONTROLLABILITY AND OBSERVABILITY:** Concepts of Controllability and Observability, Tests for controllability and Observability, Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.

**STABILITY ANALYSIS:** Stability Analysis of closed loop systems in the Z-Plane, Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion, Stability analysis using Lyapunov theorems.

**UNIT-IV:**

**DESIGN OF DISCRETE TIME CONTROL SYSTEM BY CONVENTIONAL METHODS:** Design of digital control based on the frequency response method – Bilinear Transformation and Design procedure in the W-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.



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**UNIT-V:**

**STATE FEEDBACK CONTROLLERS AND OBSERVERS:** Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula, State Observers – Full order and Reduced order observers. Introduction to Kalman filters, State estimation through Kalman filters, introduction to adaptive Controls.

**TEXTBOOKS:**

1. "Discrete-Time Control systems" K. Ogata - - Pearson Education/PHI, 2nd Edition.
2. "Digital Control and State Variable Methods" M. Gopal - - TMH

**REFERENCES:**

1. "Digital Control Systems"-Kuo - Oxford University Press, 2nd Edition, 2003.
2. "Digital Control Engineering"- M. Gopal -

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Distinguish between observability and controllability.
- Design PID controllers.
- Design controllers and observers for linear discrete time control systems so that their performance meet design metrics criteria.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>VIRTUAL INSTRUMENTATION (PROFESSIONAL ELECTIVE-II)</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- Develop virtual instruments for specific application using Lab VIEW software.
- Ease the programming required to make computer interact with real world.
- To acquire, analyze and display the throughput of any compactable system.
- Knowledge to connect with third party software and hardware.

**UNIT-I:**

**VIRTUAL INSTRUMENTATION:** An introduction, Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming.

**UNIT-II:**

**PROGRAMMING TECHNIQUES:** VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, and math script.

**UNIT-III:**

**INTERFACE REQUIREMENTS:** Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI, VISA and IVI, Data Acquisition Hardware.

**UNIT-IV:**

**APPLICATION OF VIRTUAL INSTRUMENTATION:** Application of Virtual Instrumentation: Instrument Control using RS-232C and IEEE488, Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, Active X programming, publishing measurement data in the web.

**UNIT-V:**

**TOOLSETS:** Distributed I/O modules, Control Design and Simulation, Digital Signal processing tool kit, Image acquisition and processing, Motion control.

**TEXTBOOKS:**

1. LabVIEW Graphical Programming, Gary Johnson, Second edition, McGraw Hill, New York, 1997.
2. LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

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**REFERENCES:**

1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
2. LabVIEW advanced programming technique, Rick Bitter, 2<sup>nd</sup> Edition, CRC Press, 2005
3. Virtual Instrumentation using LabVIEW, Jovitha Jerome, 1st Edition, PHI, 2001.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Create Virtual Instrument using LabVIEW software for various fields of applications like Control system, Signal Processing and Image processing etc.
- Create effective Virtual Instrument that shall use minimum memory space and work effectively with any processor.
- Interface the computer with DAQ to monitor process and control real world applications.
- Analyze the throughput using the tools in Lab VIEW software.

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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>TELEMETRY AND TELECONTROL (PROFESSIONAL ELECTIVE-II)</b>					

**OBJECTIVES:**

**The main objective of this course is:**

- Able to design telemetry system.
- To make students understand the application of telemetry techniques to Instrumentation.
- Analyze the frequency and time division multiplexed systems.

**UNIT-I:**

**TELEMETRY PRINCIPLES:** Introduction, Functional blocks of Telemetry system, Methods of Telemetry – Non-Electrical, Electrical, Pneumatic and Frequency.

**SYMBOLS AND CODES:** Bits and Symbols, Time function pulses, Line and Channel Coding, Modulation Codes. Inter symbol Interference.

**UNIT-II:**

**FREQUENCY & TIME DIVISION MULTIPLEXED SYSTEMS:** FDM, IRIG Standard, FM and PM Circuits, Receiving end, PLL, TDM - PAM, PAM /PM and TDM – PCM Systems. PCM reception. Differential PCM Introduction, QAM, Protocols.

**UNIT-III:**

**SATELLITE TELEMETRY:** General considerations, TT & C Service, Digital Transmission systems, TT & C Subsystems, Telemetry, and Communications.

**MODERN TELEMETRY:** Zigbee, Ethernet.

**UNIT-IV:**

**OPTICAL TELEMETRY:** Optical fibers Cable – Sources and detectors – Transmitter and Receiving Circuits, Coherent Optical Fiber Communication System.

**UNIT-V:**

**TELECONTROL METHODS:** Analog and Digital techniques in Telecontrol, Telecontrol apparatus – Remote adjustment, Guidance, and regulation – Telecontrol using information theory – Example of a Telecontrol System.

**TEXTBOOKS:**

1. Telemetry Principles – D. Patranabis, TMH
2. Telecontrol Methods and Applications of Telemetry and Remote Control – by Swoboda G., Reinhold Publishing Corp., London, 1991



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**REFERENCES:**

1. Handbook of Telemetry and Remote Control – by Gruenberg L., McGraw Hill, New York, 1987.
2. Telemetry Engineering – by Young R.E., Little Books Ltd., London, 1988.
3. Data Communication and Teleprocessing System – by Housley T., PH Intl., Englewood Cliffs, New Jersey, 1987.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Design phase locked loop, mixers and Time division multiplexed systems.
- Appreciate the application of different telemetry systems and control to any process.
- Compare the performance of various wired and wireless communication protocols.

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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DIGITAL IC DESIGN (PROFESSIONAL ELECTIVE-II)</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- The student will be able to understand the MOS Design.
- Students can learn and understand Combinational MOS Logic Circuits and Sequential MOS Logic Circuits.
- To motivate the graduate students to design and to develop the Digital Integrated Circuits for different Applications.
- The concepts of Semiconductor Memories, Flash Memory, RAM array organization.

**UNIT-I:**

**MOS DESIGN:** Pseudo NMOS Logic – Inverter, Inverter threshold voltage, output high voltage, Output Low voltage, gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

**UNIT-II:**

**COMBINATIONAL MOS LOGIC CIRCUITS:** MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

**UNIT-III:**

**SEQUENTIAL MOS LOGIC CIRCUITS:** Behaviour of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

**DYNAMIC LOGIC CIRCUITS:** Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

**UNIT-IV:**

**INTERCONNECT:** Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques.



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**UNIT-V:**

**SEMICONDUCTOR MEMORIES:** Memory Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NANDflash.

**TEXTBOOKS:**

1. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, 2<sup>nd</sup>Ed., PHI.
2. Digital Integrated Circuit Design – Ken Martin, Oxford University Press,2011.

**REFERENCES:**

1. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3<sup>rd</sup> Ed., 2011.
2. CMOS VLSI Design – Neil H.E Weste, David Harris, Ayan Banerjee 3<sup>rd</sup> Edition, Pearson

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Understand the concepts of MOS Design.
- Design and analysis of Combinational and Sequential MOS Circuits.
- Extend the Digital IC Design to Different Applications.
- Understand the Concepts of Semiconductor Memories, Flash Memory, RAM array organization

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	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DATA MINING (OPEN ELECTIVE-1)</b>				

**OBJECTIVES:**

**The main objectives of this course are:**

- Students will be enabled to understand and implement classical models and algorithms in data warehousing and data mining.
- They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.
- They will further be able to assess the strengths and weaknesses of various methods and algorithms and to analyze their behavior.

**UNIT-I:**

**INTRODUCTION:** Need of Data Warehouse, Need and Usage of Data Mining Technologies, Types of Data and Patterns to be mined, In Real Time Applications. Brief Introduction of Pattern Recognition: Pattern, Feature, Database Query Vs Mining, Curse of Dimensionality, Need for Efficiency. Major Issues in Data Mining. Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity

**UNIT-II:**

**DATA PRE-PROCESSING:** Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization

**UNIT-III:**

**CLASSIFICATION:** Basic Concepts, General Approach to solving a classification problem, Decision Tree Induction: Working of Decision Tree, building a decision tree, methods for expressing an attribute test conditions, measures for selecting the best split, Algorithm for decision tree induction. Bayes' Theorem, Naïve Bayesian Classification, Bayesian Belief Networks

**UNIT-IV:**

**ASSOCIATION ANALYSIS: BASIC CONCEPTS AND ALGORITHMS:** Problem Defecation, Frequent Item Set generation, Rule generation, compact representation of frequent item sets, FP-Growth Algorithm. (**Tan & Vipin**)

**UNIT-V:**

**CLUSTER ANALYSIS: BASIC CONCEPTS AND ALGORITHMS: OVERVIEW:** Basics and Importance of Cluster Analysis, Clustering techniques, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Bisecting K-means, Strengths and Weaknesses; Agglomerative Hierarchical Clustering: Basic Agglomerative Hierarchical Clustering Algorithm



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DBSCAN: Traditional Density Center-Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. (Tan & Vipin)

**TEXT BOOKS:**

1. Introduction to Data Mining: Pang-Ning Tan & Michael Steinbach, Vipin Kumar, Pearson.
2. Data Mining concepts and Techniques, 3/e, Jiawei Han, Michel Kamber, Elsevier.

**REFERENCE BOOKS:**

1. Data Mining Techniques and Applications: An Introduction, Hongbo Du, Cengage Learning.
  2. Data Mining: Vikram Pudi and P. Radha Krishna, Oxford.
  3. Data Mining and Analysis - Fundamental Concepts and Algorithms; Mohammed J. Zaki, Wagner Meira, Jr, Oxford
  4. Data Warehousing Data Mining & OLAP, Alex Berson, Stephen Smith, TMH.
  5. [http://onlinecourses.nptel.ac.in/noc18\\_cs14/preview](http://onlinecourses.nptel.ac.in/noc18_cs14/preview)  
(NPTEL course by Prof. Pabitra Mitra)
  6. [http://onlinecourses.nptel.ac.in/noc17\\_mg24/preview](http://onlinecourses.nptel.ac.in/noc17_mg24/preview)  
(NPTEL course by Dr. Nandan Sudarshanam & Dr. Balaraman Ravindran)
- [http://www.saedsayad.com/data\\_mining\\_map.htm](http://www.saedsayad.com/data_mining_map.htm)

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Understand Data Mining Principles
- Identify appropriate data mining algorithms to solve real world problems
- Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining

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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>POWER ELECTRONICS (OPEN ELECTIVE-1)</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- To study the characteristics of various power semiconductor devices and gate drive circuits.
- To understand the operation of single phase full-wave converters and analyze harmonics in the input current.
- To study the operation of three phase full-wave converters.
- To understand the operation of different types of DC-DC converters.
- To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

**UNIT-I:**

**POWER SEMICONDUCTOR DEVICES:** Operation of SCR, power MOSFET and power IGBT and their characteristics–Gate drive circuits for SCR, IGBT and MOSFET-protection circuits for power IGBT and power MOSFETs.

**UNIT-II:**

**AC-DC SINGLE-PHASE CONVERTERS:** 1-phase fully-controlled bridge rectifiers feeding R load, RL, RLE loads (continuous and discontinuous current conduction mode of operation)– 1-phase semi-controlled bridge rectifiers feeding R, RL and RLE loads (continuous and discontinuous current conduction mode of operation)– Harmonic Analysis.

**UNIT-III:**

**AC-DC THREE-PHASE CONVERTERS:** 3-phase Full converter feeding R, RL and RLE loads (continuous current conduction mode only)– 3-phase semi-converter feeding R, RL and RLE loads (continuous current conduction mode only)–Harmonic analysis -Dual converter.

**UNIT-IV:**

**DC-DC CONVERTERS:** Analysis of Buck, boost, buck-boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) – Output voltage equations using volt-sec balance in CCM & DCM- output voltage ripple & inductor current ripple for CCM only – Principle operation of forward and fly back converters in CCM.



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**UNIT-V:**

**DC-AC CONVERTERS AND AC-AC CONVERTERS:** 1- phase half-bridge and full bridge inverters with R and RL loads – Unipolar and bipolar switching-Quasi-square wave pulse width modulation-3- phase square wave inverters – 120° conduction and 180° conduction modes of operation – Sinusoidal pulse width modulation –single-phase Current Source Inverter (CSI)- single-phase AC-AC voltage regulator with R and RL load.

**TEXT BOOKS:**

1. Power Electronics: converters, applications & design -by Nedmohan, Tore M. Undeland, Robbins by Wiley India Pvt. Ltd.
2. Power Electronics- by Daniel W.Hart, Mc Graw Hill publications
3. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India

**REFERENCE BOOKS:**

1. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009
2. Elements of Power Electronics–Philip T.Krein. Oxford publishers.
3. Power Electronics – by P.S.Bhimbra, Khanna Publishers.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Explain the characteristics of various power semiconductor devices and understand the gate driver circuits.
- Explain the operation of single-phase full wave converters and perform harmonic analysis.
- Explain the operation of three phase full-wave converters and perform harmonic analysis.
- Analyze the operation of different types of DC-DC converters.
- Explain the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>MEMS AND ITS APPLICATIONS</b> Open Elective (OE1)					

**OBJECTIVES:**

The main objectives of this course are given below:

- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To study the various materials and their properties used for micromachining techniques.
- To analyze the fundamentals of micromachining and micro fabrication techniques.
- To impart knowledge of the basic concept of electromechanical effects, thermal effects Micro fluidics and Integrated fluidic systems.
- To study the fundamentals of pressure sensors and accelerometer sensors through design and modeling.

**UNIT I:**

**OVERVIEW OF MEMS AND MICROSYSTEMS:** MEMS and Microsystems, Typical MEMS and Microsystem products, Evolution of Microfabrication, Microsystem and Microelectronics, The Multidisciplinary nature of microsystem design and manufacture, Microsystem and Miniaturization. Application of Microsystems in the automotive industry, Application of Microsystems in other industries: Health care industry, Aerospace industry, Industrial products, Consumer products, Telecommunications. Markets for Microsystems.

**UNIT II:**

**WORKING PRINCIPLES OF MICROSYSTEMS:** Introduction, Microsensors: Acoustic Wave Sensors, Biomedical sensors and Biosensors, Chemical sensors, Pressure sensors, Thermal sensors. Micro actuation: Actuation using thermal forces, shaped memory alloys, Piezoelectric crystals, Electrostatic forces. MEMS with Micro actuators: Microgrippers, Micromotors, Microvalves, Micropumps, Micro accelerators, Microfluidics.

**UNIT III:**

**SCALING LAWS IN MINIATURIZATION:** Introduction to scaling, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Materials for MEMS and Microsystems: Introduction, Substrates and wafers, Active substrate materials, Silicon as a substrate material. Silicon compounds, Silicon piezo resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Packing materials.



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**UNIT IV:**

**MICRO SYSTEM FABRICATION PROCESS:** Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition by Epitaxy, Etching. Overview of Micro manufacturing and Applications: Bulk Micro manufacturing- any one example of application, Surface Micromachining- any one example of application. LIGA Process- any one example of application.

**UNIT V:**

**APPLICATIONS OF MEMS-SWITCHING:** Introduction, Switch parameters, Basics of switching, Mechanical switches, Electronic switches for RF and microwave applications, Mechanical RF switches, PIN diode RF switches.

**TEXT BOOKS:**

1. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, Tata McGraw Hill, (2002).
2. Gabriel M. Rebeiz, “RF MEMS Theory, Design and Technology”, Wiley India Pvt Ltd.

**REFERENCE BOOKS:**

1. Stephen D. Senturia, “Microsystem Design”, Springer International Edition, (2010).
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press, (2002).
3. Chang Liu, “Foundations of MEMS”, Second Edition, Pearson Publication.

**E-R ESOURCES:**

1. <https://nptel.ac.in/courses/117105082/4>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-design-and-fabrication-of-microelectromechanical-devices-spring-2007/lecture-notes/>
3. <https://www.edx.org/course/micro-nanofabrication-mems-epflx-memx-0>

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Understand the basic overview of MEMS and Microsystems with broad category of MEMS & Micro system applications.
- Understanding the working principles of Microsystems
- Understand the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
- Understand the Micro system Fabrication Process and Analyze the different Micro manufacturing process and Applications.
- Study and Analyze the different types of RF switches, Various Switching Mechanism and their applications.



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>ARTIFICIAL NEURAL NETWORKS (OPEN ELECTIVE-1)</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- To provide an introduction to the field of artificial neural networks and machine learning.
- To teach students how to solve practical problems via implementation of these techniques via simulation.
- To promote further independent learning on the topics of artificial neural networks and machine learning.

**UNIT-I:**

**INTRODUCTION:** History of Neural Networks, Structure and Functions of Biological and Artificial Neuron, Neural Network Architectures, Characteristics of ANN, Basic Learning Laws and Methods.

**UNIT-II:**

**SUPERVISED LEARNING:** Single Layer Neural Network and architecture, McCulloch-Pitts Neuron Model, Learning Rules, Perceptron Model, Perceptron Convergence Theorem, Delta learning rule, ADALINE, Multi-Layer Neural Network and architecture, MADALINE, Back Propagation learning, Back Propagation Algorithm.

**UNIT-III:**

**UNSUPERVISED LEARNING-1:** Outstar Learning, Kohonen Self Organization Networks, Hamming Network And MAXNET, Learning Vector Quantization, Mexican hat.

**UNIT-IV:**

**UNSUPERVISED LEARNING-2:** Counter Propagation Network -Full Counter Propagation network, Forward Only Counter Propagation Network, Adaptive Resonance Theory (ART) -Architecture, Algorithms.

**UNIT V:**

**ASSOCIATIVE MEMORY NETWORKS:** Introduction, Auto Associative Memory, Hetero Associative Memory, Bidirectional Associative Memory (BAM) -Theory and Architecture, BAM Training Algorithm, Hopfield Network: Introduction, Architecture of Hopfield Network.

**TEXT BOOKS:**

1. B. Yegnanarayana” Artificial neural networks” PHI, New Delhi.
2. S.N. Sivanandam, S.N. Deepa, “Introduction to Neural Networks using MATLAB 6.0“, TATA McGraw- Hill publications.
3. J.M. Zurada,” Introduction to Artificial neural systems” –Jaico publishing.



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**REFERENCE BOOKS:**

1. S.Rajasekaran and G.A.Vijayalakshmi "Neural Networks. Fuzzy Logic and genetic Algorithms".
2. James A Freeman and Davis Skapura "Neural Networks Algorithm, applications and programming Techniques", Pearson Education, 2002.
3. Simon Hakins "Neural Networks " Pearson Education.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Survey of attractive applications of Artificial Neural Networks.
- practically approach for using Artificial Neural Networks in various technical, organizational and economic applications

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		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>DATA ACQUISITION SYSTEM</b>					

**OBJECTIVES:**

**The main objectives of this course are:**

- Understand and learn single and multichannel Data Acquisition System.
- Acquire basic skills on capturing experimental data.
- Understand and learn digital to analog and analog to digital conversion techniques.
- Understand and learn on-linear data converter techniques and applications.
- Understand and learn monolithic data converters and error budget of Data Acquisition System.

**UNIT-I**

**INTRODUCTION:** Objective of a Data Acquisition System, single channel Data Acquisition System, Multi-channel Data Acquisition System, Components Used in Data Acquisition System – Converter Characteristics-Resolution-Non-linearity, settling time, Monotonicity.

**UNIT-II**

**ANALOG TO DIGITAL CONVERTERS (ADCS):** Classification of A/D converters, Parallel feedback – Successive approximation – Ramp comparison – Dual slope integration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.

**NON-LINEAR DATA CONVERTERS (NDC):** Basic NDC configurations – Some common NDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM – High speed hybrid NADC – PLS based NADC – Switched capacitor NDACS.

**ADC APPLICATIONS:** Data Acquisition systems – Digital signal processing systems – PCM voice communication systems – Test and measurement instruments – Electronic weighing machines.

**UNIT-III**

**DIGITAL TO ANALOG CONVERTERS (DACs):** Principles and design of – Parallel R–2R, weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.

**DATA CONVERTER APPLICATIONS:** DAC applications – Digitally programmable V/I source – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analog multipliers/ dividers – Analog delay lines.

**UNIT-IV**

**Monolithic data converters:** typical study of monolithic DACs and ADCS. Interfacing of DACs and ADCS to a microprocessor,



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**UNIT-V**

**Error budget of DACS and ADCS:** Error sources, error reduction and noise reduction techniques in Data Acquisition System. Error budget analysis Of Data Acquisition System, case study of a DAC and an ADC.

**TEXT BOOKS:**

1. Electronic data converters fundamentals and applications – Dinesh K. Anvekar, B.S. Sonde –Tata McGraw Hill.
2. D/A and A/D converters a user's handbook of -E.R. Hnateck, Wiley
3. Data converters by G.B.Clayton.

**REFERENCES:**

1. Electronic Analog/ Digital conversions – Hermann Schmid – Tata McGraw Hill.
2. Electronic instrumentation by HS Kalsi- TMH 2<sup>nd</sup> Edition, 2004.

**OUTCOMES:**

**At the end of this course the student will be able to:**

- Differentiate between single and multichannel Data Acquisition System.
- Describe the functional blocks of data acquisition system.
- Operation of different DACs, ADCs and non-linear ADCs.
- Understands of data convertor and monolithic data convertors and their applications.
- Gets aware of error budget analysis of Data Acquisition System.

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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>DIGITAL SIGNAL PROCESSING LAB</b>					

(Note: Students have to perform at least FOUR experiments from each part.)

List of the Experiments

**PART-A**

1. Generation of DT signals.
2. Verify the Linear Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
3. Verify the Circular Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
4. Find the sum of DT sinusoidal signals.
5. Computation of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT)
  - a) Using MATLAB
  - b) Using Code Composer Studio(CCS)
6. Transfer Function Stability Analysis: using pole-zero plot, bode plot and Nyquist plot.

**PART-B**

Following Experiments are to be done using a TI DSP Starter Kit.

7. Generation of a sinusoidal signal.
8. Linear and circular convolution of DT sequences.
9. Compute N-point DFT of a given DT sequence.
10. Design and implementation of FIR filters.
11. Design and implementation of IIR filters.

**PART-C**

Following Experiments are to be done using Cypress FM4 Starter Kit.

12. Verification of sampling theorem.
13. Implementation of FFT algorithm.
14. Implementation of FIR filters.
15. Implementation of IIR filters.

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		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>
<b>INDUSTRIAL INSTRUMENTATION LAB</b>					

**List of Experiments:**

1. Calibration of Pneumatic pressure to Current (P to I) and Current to Pneumatic Pressure (I to P) Converters
2. Measurement of RPM using Opto-coupler and comparing it with troboscope
3. Measurement of precision Angular Velocity and RPM of a rotating Disk
4. Measurement of Velocity, Acceleration and Vibration using Piezo- electric transducer
5. Measurement of Humidity
6. Measurement of intensity of Light
7. Measurement of Sound Level.
8. Measurement of Viscosity of Edible Oil using Redwood Viscometer
9. Measurement of Viscosity of Crude Oil using Saybolt Viscometer
10. Measurement of Density
11. MEMS based Accelerometer
12. Design of signal conditioner for MEMS based Accelerometer
13. MEMS based Gyroscope
14. Design of signal conditioner for MEMS based Gyroscope

Note: Experiments based on Industrial Bus Protocols



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		<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>INTELLECTUAL PROPERTY RIGHTS (IPR) &amp; PATENTS</b>					

**Course Objectives:**

- To know the importance of Intellectual property rights, which plays a vital role in advanced Technical and Scientific disciplines
- Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latest developments

**UNIT-I**

Introduction to Intellectual Property Rights (IPR): Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

**UNIT- II**

Copyrights and Neighboring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

**UNIT-III**

Patents: Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Compulsory Licensing — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations

**UNIT- IV**

Trademarks: Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing Off Action.

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**UNIT-V**

Trade Secrets & Cyber Law and Cyber Crime: Introduction to Trade Secrets – General Principles - Laws Relating to Trade Secrets –

Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements – Breach of Contract – Law of Unfair Competition – Trade Secret Litigation – Applying State Law.

Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions – E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers.

**Text Books:**

- 1) Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
- 2) Deborah E. Bouchoux: Intellectual Property, Cengage Learning, New Delhi.

**References:**

- 1) Prabhuddha Ganguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
- 2) Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
- 3) Kompal Bansal & Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
- 4) Cyber Law - Texts & Cases, South-Western's Special Topics Collections.
- 5) R. Radha Krishnan, S. Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
- 6) M. Ashok Kumar and Mohd Iqbal Ali: Intellectual Property Rights, Serials Pub.

**Course Outcomes:**

- IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents
- Student get an insight on Copyrights, Patents and Software patents which are instrumental for further advancements