CURRICULUM
FOR
ELECTRICAL & ELECTRONICS ENGINEERING

SEMESTER - VI (ELECTRICAL & ELECTRONICS ENGINEERING)

Module 1

Z-transform: z-transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z transforms.

Module 2

Discrete Fourier Transform: Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Module 3

Design Of Digital filters: Design of FIR Digital filters: Window method,
Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and
Elliptic Approximations; Low-pass, Band-pass, Band-stop and Highpass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multirate signal processing.

Module 4

Applications of Digital Signal Processing: Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

- S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
- A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.

- J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
- L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
- J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
- D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Course Outcomes:

- Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- Analyse discrete-time systems using z-transform.
- Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- Design digital filters for various applications.
- Apply digital signal processing for the analysis of real-life signals

PcC-EEE24	Digital Signal Processing Lab	L:0	T:0	P:2	CREDIT:1

Hands-on/Computer experiments related to the course contents of PCC-EEE23

PAPER CODE - PCC EEE 27

PCC-EEE27	Electronics Design Laboratory	L:1	T:0	P:4	CREDIT:3

Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Course Outcomes:

- Understand the practical issues related to practical implementation of applications using electronic circuits.
- Choose appropriate components, software and hardware platforms.
- Design a Printed Circuit Board, get it made and populate/solder it with components.

➔ Work as a team with other students to implement an application

Text/Reference Books:

➔ A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.

➔ P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.

➔ H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.

➔ W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.

➔ G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

PAPER CODE - PCC EEE 25

PCC-EEE25	Measurements and Instrumentation	L:3	T:0	P:0	CREDIT:3

Lectures/Demonstrations:

➔ Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.

➔ Errors in Measurements. Basic statistical analysis applied to measurements:
Mean, Standard Deviation, Six-sigma estimation, Cp, Cpk.

➔ Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.

➔ Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.

➔ Measurements of R, L and C.

➔ Digital Multimeter, True RMS meters, Clamp-on meters, Meggers

➔ Digital Storage Oscilloscope.

➔ Basic components of bio-medical instruments, bio-electric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non-invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response.

Course Outcomes:

- ➔ Design and validate DC and AC bridges. Analyze the dynamic response and the calibration of a few instruments.
- ➔ Learn about various measurement devices, their characteristics, their operation and their limitations.
- ➔ Understand statistical data analysis.
- ➔ Understand computerized data acquisition

PCC-EEE26	**Measurements and Instrumentation Lab**	**L:0**	**T:0**	**P:2**	**CREDIT:1**

List of Experiments:

- ➔ Measurement of a batch of resistors and estimating statistical parameters.
- ➔ Measurement of L using a bridge technique as well as LCR meter.
- ➔ Measurement of C using a bridge technique as well as LCR meter.
- ➔ Measurement of Low Resistance using Kelvin's double bridge.
- ➔ Measurement of High resistance and Insulation resistance using Megger.
- ➔ Usage of DSO for steady state periodic waveforms produced by a function generator. a. Selection of trigger source and trigger level, selection of time-scale and voltage scale. b. Bandwidth of measurement and sampling rate.
- ➔ Download one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
- ➔ Usage of DSO to capture transients like a step change in R-L-C circuit.
- ➔ Current Measurement using Shunt, CT, and Hall Sensor.

PROGRAM ELECTIVE

100903	**Information Theory and Coding**	**L:3**	**T:0**	**P:0**	**CREDIT:3**

Basics of information theory, entropy for discrete ensembles; Shannon's noiseless coding theorem; Encoding of discrete sources. Markov sources; Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels. Techniques of coding and decoding; Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes.

Text/Reference Books:

- ➔ N. Abramson, Information and Coding, McGraw Hill, 1963.

- M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.
- R.B. Ash, Information Theory, Prentice Hall, 1970.
- Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.

Course Outcomes:

- Understand the concept of information and entropy
- Understand Shannon's theorem for coding
- Calculation of channel capacity
- Apply coding techniques

100904	Speech and Audio Processing	L:3	T:0	P:0	CREDIT:3

Introduction- Speech production and modeling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid ; Requirements of speech codecs –quality, coding delays, robustness.

Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.

Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of nonstationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.

Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.

Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF.

Linear Prediction Coding- LPC model of speech production; Structures of LPCencoders and decoders; Voicing detection; Limitations of the LPC model.
Code Excited Linear Prediction- CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP.

Speech Coding Standards- An overview of ITU-T G.726, G.728 and G.729 standards **Text/Reference Books:**

- "Digital Speech" by A.M.Kondoz, Second Edition (Wiley Students" Edition), 2004.
- "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, Wiley Inter science, 2003.

Course Outcomes:

- Mathematically model the speech signal
- Analyze the quality and properties of speech signals.
- Modify and enhance the speech and audio signals

100905	Introduction to MEMS	L:3	T:0	P:0	CREDIT:3

Introduction and Historical Background, Scaling Effects. Micro/Nano Sensors,
Actuators and Systems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), and Etching.
Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding. Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.

Text/Reference Book:

- G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
- S. E. Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Micro engineering (Vol. 8). CRC press, (2005).
- S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
- M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
- G. Kovacs, Micro machined Transducers Sourcebook, McGraw-Hill, Boston, 1998.
- M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and Gyroscopes, Elsevier, New York, 2000.

Course Outcomes:

At the end of the course the students will be able to

- ➔ Appreciate the underlying working principles of MEMS and NEMS devices. ➔ Design and model MEM devices.

100908	Bio-Medical Electronics	L:3	T:0	P:0	CREDIT:3

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and biopotential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, Xray and nuclear imaging. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

Text/Reference Books:

- ➔ W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
- ➔ J.G. Webster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
- ➔ A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- ➔ Understand the application of the electronic systems in biological and medical applications.
- ➔ Understand the practical limitations on the electronic components while handling bio- substances.
- ➔ Understand and analyze the biological processes like other electronic processes.

100913	CMOS Design	L:3	T:0	P:0	CREDIT:3

Review of MOS transistor models, Non-ideal behavior of the MOS Transistor.
Transistor as a switch. Inverter characteristics, Integrated Circuit Layout: Design Rules, Parasitics. Delay: RC Delay model, linear delay model, logical path efforts.
Power, interconnect and Robustness in CMOS circuit layout.
Combinational Circuit

Design: CMOS logic families including static, dynamic and dual rail logic. Sequential Circuit Design: Static circuits. Design of latches and Flip-flops.

Text/Reference Books:

- N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
- C.Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.
- J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997.
- P. Douglas, VHDL: programming by example, McGraw Hill, 2013.
- L. Glaser and D. Dobberpuhl, The Design and Analysis of VLSI Circuits, Addison Wesley, 1985.

Course Outcomes:

At the end of the course the students will be able to

- Design different CMOS circuits using various logic families along with their circuit layout.
- Use tools for VLSI IC design.

100914	Power Electronics	L:3	T:0	P:0	CREDIT:3

Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBTTreatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations. Brief introduction to power devices viz.
TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power),
Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and
IGBTs (discrete and IC based).Concept of fast recovery and schottky diodes as freewheeling and feedback diode.

Controlled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor.

Choppers: Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control techniques for choppers – TRC and CLC, Detailed analysis of Type A choppers.
Step up chopper. Multiphase Chopper

Single-phase inverters: Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of inverters, Single phase current source inverter

Switching Power Supplies: Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.
Applications: Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS.

Separately excited DC motor drive. P M Stepper motor Drive.

Text /Reference Books:

- Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
- Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.
- P.C. Sen., "Modern Power Electronics", edition II, Chand& Co.
- V.R.Moorthi, "Power Electronics", Oxford University Press.
- Cyril W., Lander," Power Electronics", edition III, McGraw Hill.
- G K Dubey, S R Doradla,: Thyristorised Power Controllers", New Age International Publishers. SCR manual from GE, USA.

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Build and test circuits using power devices such as SCR
- Analyze and design controlled rectifier, DC to DC converters, DC to AC inverters,
- Learn how to analyze these inverters and some basic applications.
  - Design SMPS.

100919	Nano electronics	L:3	T:0	P:0	CREDIT:3

Introduction to nanotechnology, meso structures, Basics of Quantum Mechanics:
Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig- Penney Model. Brillouin Zones.

Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets,
Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.),

Resonant Tunneling Diode, Coulomb dots, Quantum blockade, Single electron transistors,Carbon nanotube electronics, Band Structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation

Text/ Reference Books:

- G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
- W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Materials And
- Novel Devices), Wiley-VCH, 2003.
- K.E. Drexler, Nanosystems, Wiley, 1992.
- J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
- C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand various aspects of nano-technology and the processes involved in making nano components and material.
- Leverage advantages of the nano-materials and appropriate use in solving practical problems.
- Understand various aspects of nano-technology and the processes involved in making nano components and material.
- Leverage advantages of the nano-materials and appropriate use in solving practical problems.

100921	**Scientific Computing**	**L:3**	**T:0**	**P:0**	**CREDIT:3**

Introduction: Sources of Approximations, Data Error and Computational, Truncation
Error and Rounding Error, Absolute Error and Relative Error, Sensitivity and

Conditioning, Backward Error Analysis, Stability and Accuracy

Computer Arithmetic: Floating Point Numbers, Normalization, Properties of Floating
Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow,
Exceptional Values, FloatingPoint Arithmetic, Cancellation

System of linear equations: Linear Systems, Solving Linear Systems, Gaussian elimination, Pivoting, Gauss-Jordan, Norms and Condition Numbers, Symmetric Positive Definite Systems and Indefinite System, Iterative Methods for Linear Systems

Linear least squares: Data Fitting, Linear Least Squares, Normal Equations Method,
Orthogonalization Methods, QR factorization, Gram-Schmidt Orthogonalization, Rank Deficiency, and Column Pivoting

Eigenvalues and singular values: Eigenvalues and Eigenvectors, Methods for Computing
All Eigenvalues, Jacobi Method, Methods for Computing Selected Eigenvalues, Singular Values Decomposition, Application of SVD

Nonlinear equations: Fixed Point Iteration, Newton's Method, Inverse Interpolation Method

Optimization: One-Dimensional Optimization, Multidimensional Unconstrained
Optimization, Nonlinear Least Squares Interpolation: Purpose for Interpolation, Choice of Interpolating, Function, Polynomial Interpolation, Piecewise Polynomial Interpolation Numerical

Integration And Differentiation: Quadrature Rule, Newton-Cotes Rule, Gaussian
Quadrature Rule, Finite Difference Approximation, Initial Value Problems for ODES,
Euler's Method, Taylor Series Method, Runge-Kutta Method, Extrapolation Methods,
Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method,
Eigenvalue Problems Partial Differential Equations, Time Dependent Problems, Time
Independent Problems, Solution for Sparse Linear Systems, Iterative Methods Fast
Fourier Transform, FFT Algorithm, Limitations, DFT, Fast polynomial Multiplication,

Wavelets, Random Numbers And Simulation, Stochastic Simulation, Random Number Generators, Quasi-Random Sequences.

Text/ Reference Books:

- ➔ Heath Michael T., "Scientific Computing: An Introductory Survey", McGraw-Hill, 2nd Ed., 2002
- ➔ Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery, "Numerical Recipes: The Art of Scientific Computing", Cambridge University Press, 3rd Ed., 2007
- ➔ Xin-she Yang (Ed.)., "Introduction To Computational Mathematics", World Scientific Publishing Co., 2nd Ed., 2008
- ➔ Kiryanov D. and Kiryanova E., "Computational Science", Infinity Science Press, 1st Ed., 2006
- ➔ Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, "Scientific Computing With MATLAB And Octave", Springer, 3rd Ed., 2010

Course Outcomes:

- ➔ Understand the significance of computing methods, their strengths and application areas.
- ➔ Perform the computations on various data using appropriate computation tools.

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