

Applied Electronics & Instrumentation Engineering



M.TECH. PROGRAMME

Curriculum & Syllabus , M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)

1st. Year- 1st. Semester Syllabus:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Regular	MATH5101	Advanced Mathematical Methods	4	0	0	4	4
	AEIE5101	Micro-Electronic Devices and Circuits	4	0	0	4	4
	AEIE5102	Digital Signals and Systems	4	0	0	4	4
	AEIE5103	Advanced Industrial Instrumentation	4	0	0	4	4
Elective-I (Any one)	AEIE5131/ AEIE5132/ AEIE5133	Mechatronics Measurement and System Design Optical Instrumentation	4	0	0	4	4
LAB	AEIE5111	Process Instrumentation LAB	0	0	4	4	2
	AEIE5112	Digital Signal Processing LAB	0	0	4	4	2
Sessional	AEIE5121	Seminar-I	0	0	3	3	1
Total of Semester						31	25

1st. Year- 2nd. Semester Syllabus:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Regular	AEIE5201	Process Control System Design	4	0	0	4	4
	AEIE5202	Micro Sensor Science and Technology	4	0	0	4	4
	AEIE5203	Instrumental Methods of Analysis	4	0	0	4	4
	AEIE5204	Embedded Systems	4	0	0	4	4
Elective-II (Anyone)	AEIE5231/ AEIE5232/ AEIE5233	Digital Image Processing Industrial Automation Technology Statistical and Bio-signal Processing	4	0	0	4	4
LAB	AEIE5211	Embedded Systems LAB	0	0	4	4	2
	AEIE5212	Virtual Instrumentation LAB	0	0	4	4	2
Sessional	AEIE5221	Seminar-II	0	0	3	3	1
Total of Semester						31	25

M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)
Course Structure

2nd. Year- 1st. Semester Syllabus:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Elective-III (Any One)	AEIE6131/	Micro-Electromechanical System Design	4	0	0	4	4
	AEIE6132/	VLSI Technology					
	AEIE6133	Robotics Engineering					
Elective-IV (Any One)	AEIE6141/	Applied Soft Computing	4	0	0	4	4
	AEIE6142/	Wireless Sensor Networks					
	AEIE6143	Remote Sensing					
Elective-V (Any One)	AEIE6151/	Medical Instrumentation	4	0	0	4	4
	AEIE6152/	Advanced Digital Control					
	AEIE6153	Nonlinear Control					
Sessional	AEIE6121	Dissertation Part-I	0	0	16	16	8
Total of Semester						28	20

2nd. Year- 2nd. Semester Syllabus:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Sessional	AEIE6221	Post-Submission Defense of Dissertation	-	-	-	-	4
	AEIE6222	Dissertation (Completion)	-	-	24	24	12
	AEIE6223	Comprehensive Viva-Voce	-	-	-	-	4
Total of Semester						24	20

Total course credit = 90

Detailed Syllabus
M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)
1st. Year- 1st. Semester

Subject Name: ADVANCED MATHEMATICAL METHODS					
Paper Code: MATH5101					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]

Linear Algebra I:

Definition of Field, Vector Spaces, Subspaces, Linear Dependence, Basis and Dimension, Inner Product Space, Concept of Norm, Gram-Schmidt Orthogonalization Process, QR Decomposition.

Module II - [10L]

Linear Algebra II:

Eigen Values and Eigen Vectors, Singular Value Decomposition, Concept of Positive Semidefinite Matrices, Linear Transformations, Kernels and Images, Rank-Nullity Theorem, Matrix Representation of Linear Transformations, Change of Basis.

Module III-[10L]

Classical Optimization:

Classification of Optimization Problems, Single Variable Optimization, Multivariate Optimization Without Constraints: Semidefinite Case, Saddle Point, Multivariate Optimization with Equality Constraints: Method of Constrained Variation and Lagrange Multipliers, Multivariate Optimization with Inequality Constraints: Kuhn- Tucker Conditions.

Module IV-[10L]

Optimization Algorithms:

Simplex Method, Big-M Method, Concept of Duality in LPP, Interior-Point Methods, Basic Descent Methods.

References:

1. Linear Algebra : Kenneth M. Hoffman, Ray Kunze (Prentice-Hall)
2. Linear Algebra : Seymour Lipschutz, Marc Lipson (SCHAUM’S Outlines, Mc Graw Hill)
3. Matrices and Linear Transformations : Charles G. Cullen (Dover)

4. Engineering Optimization : Singiresu S. Rao (New Age International Publishers)
5. Introductory Operations Research : H.S.Kasana, K.D.Kumar (Springer-Verlag)
6. Linear and Nonlinear Programming: D.G. Luenberger , Yinyu Ye (Springer)
7. Introduction to Linear Algebra : Gilbert Strang (Wellesley-Cambridge Press)
8. Linear Algebra and its Applications: Gilbert Strang (Thomson Brooks/Cole Cengage Learning)
9. Matrix Computations : Gene H. Golub, Charles F. Van Loan (JHU Press)

SUBJECT NAME: MICRO-ELECTRONIC DEVICES AND CIRCUITS					
Paper Code: AEIE5101					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]

Introduction to Microelectronics: IC Production Process- Basic Steps involved in Production, Layout and Fabrication.

Analog Building Blocks: Active resistors, Current mirrors/amplifiers, Current sources and sinks, Voltage and Current references.

Digital Building Blocks: NMOS inverter and CMOS inverter.

Module II - [8L]

Analysis of Analog Integrated Circuits:

DC analysis and small signal (ac) analysis of 741 Op-amp: Input stage, intermediate (second) stage and output stage – Gain, input-output resistance and frequency response.

Module III-[6L]

Analysis of two stage CMOS amplifier

Design (Synthesis) of analog Integrated Circuit.

Module IV-[16L]

Digital Integrated Circuits Analysis: Performance analysis of CMOS inverter, CMOS logic Circuits; Pass-transistor Circuits; Dynamic Logic Circuits.

Design: Flip-flops and multivibrator circuits; Dynamic MOS Storage Circuit; (Fussable) Programmable logic array: (Fussable) Logic gate array; Introduction to VHDL & FPGA.

References:

1. Sedra Smith, Microelectronic Circuits. 5th Edition, McGraw Hill.
2. R. L. Geiger, P. E. Allen & N. R. Strader – Design techniques for Analog & Digital Circuits, McGraw Hill, Singapore, 1990.

3. D. A. Hodges & H. G. Jackson – Analysis and Design of Digital Integrated Circuits, McGraw Hill, New York, 1983.
4. S. M. Sze – VLSI Technology, Second Edition, TMH, New Delhi, 2004.

Subject Name: DIGITAL SIGNALS AND SYSTEMS					
Paper Code: AEIE5102					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [8L]

Discrete-Time Signals and Systems:

Generation of discrete and digital signals, Sampling of continuous time signals and aliasing, Classification of discrete time signals, Mathematical operations on discrete time signals, Discrete time system description, Response of LTI discrete time system, Linear and circular convolution.

Module II - [6L]

Spectrum Analysis:

Introduction to Fourier series and Fourier transform of discrete-time signals (DTFT), Discrete Fourier transform (DFT) - properties and limitations, Fast Fourier Transform (FFT) algorithm.

Module III-[10L]

Design of Digital Filters:

Design methods of FIR and IIR filters, Structures for realization of FIR and IIR filters, Finite word length effect in digital filters.

Module IV- [4L]

Wavelet Theory:

Introduction to time frequency analysis, Short Time Fourier Transform, continuous time Wavelet Transform, Discrete wavelet transform, construction of wavelets, Multiresolution analysis, Application of wavelet transforms.

Module V - [6L]

Multirate Digital Signal Processing:

Introduction to change of sampling rate – Decimation and Interpolation- Direct digital domain approach - Decimation by integer factor - Interpolation by an integer factor - Single and multistage realization - Poly phase realization – Applications of Multirate signal Processing - Subband coding and filter banks.

Module VI - [6L]

Discrete Time Random Process:

Random variables- Definitions, Ensemble averages, Jointly distributed random variables, Gaussian random variables, Joint moments, Linear mean square estimation; Random process- Definitions, Ensemble averages, Gaussian processes, Stationary processes, Autocovariance and Autocorrelation Matrices, Ergodicity, White noise, Power spectrum, Spectral Factorization, Response of linear systems to random input.

References:

1. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 3rd ed., Pearson Education Inc., New Delhi, India.
2. Sanjit K. Mitra, *Digital Signal Processing- A computer based Approach*, McGraw-Hill.
3. Monson H. Hayes, *Statistical Digital Signal Processing & Modeling*, John Wiley & Sons
4. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, 1992.
5. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, *Digital Signal Processing*, TMH, 2nd Edition, 2010.
6. A.V. Oppenheim, R.W. Schaffer and John R. Buck, *Discrete Time Signal Processing*, 3rd Edition, Prentice-Hall Signal Processing Series, 2009.
7. A. Nagoor Kani, *Signals and Systems*, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

Subject Name: ADVANCED INDUSTRIAL INSTRUMENTATION					
Paper Code: AEIE5103					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]

Review of Industrial Instrumentation:

Measurement of Pressure; Temperature; Flow; Level: Classification and modern methods; signal processing circuits.

Module II - [10L]

Measurements and analysis in Thermal Power Plant:

Fuel, Air and steam flows, Drum level, Steam temperature and pressure, Dissolved oxygen, Coal/Oil, Water quality analyzers, Pollution monitoring equipments: O₂, CO and CO₂, SO_x and NO_x.

Module III - [12L]

Measurements and analysis in chemical Plant:

Temperature measurements in Distillation column, heat exchanger, Level measurements of liquid –Liquid; Liquid-gas phases etc. Flow and pressure measurement in Pyrolysis, Catalytic cracking, Calibration and Maintenance of process instruments.

Module IV-[8L]

Special Purpose Instrumentation:

Electrical and Intrinsic safety; Zener Barrier; Flame, Fire and smoke detectors, Hydrocarbon (HC) detector; Flame Scanner.

References:

1. Liptak B. G.; Instrumentation Engineers Handbook (Measurement) ; Chilton Book Co.; 1994
2. D. A. Reay; Industrial Energy Conservation; Pergamon Press; 1997.
3. Ness S.A.; Air monitoring for Toxic explosions Air Integrated approach, Von Nostrand.
4. Hodge B. K.; Analysis and Design of Energy Systems; Prentice Hall; (1988).
5. U. A. Bakshi, A.V.Bakshi; Instrumentation Engineering; Technical Publications; 2009.
6. Harold E. Soisson; Instrumentation in Industry; John Wiley & Sons Canada, Limited, 1975.

Subject Name: MECHATRONICS					
Paper Code: AEIE5131					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [4L]

Overview of Mechatronics:

Introduction to Mechatronics, Mechatronic Design Approach, Elements of Mechatronics— Control Interface/Computing Hardware; Mechatronics-based Product Realization, Revolution of Mechatronics as a Contemporary Design Paradigm.

Module II - [7L]

Physical System Modeling:

Introduction to System Modeling; Mechanical System, Electrical System, Fluid Systems, Thermal System, Translational and Rotational Mechanical System with spring, damper and mass.

Module III - [6L]

Transducers and Sensors:

Introduction and Background, Difference Between Transducer and Sensor, Transducer Types, Transduction Principle, Photoelectric Transducers, Thermistor, Thermocouple, Inductive

Transducers, Capacitive Transducer, Pyroelectric Transducers, Piezoelectric Transducer, Hall-effect Transducer, Ionization Transducer.

Module IV - [6L]

Actuators:

Introduction to Actuator types and Application Areas, Electromechanical Actuator, DC motor, AC motor, Fluid Power Actuators, Piezoelectric Actuators, Magnetostrictive Actuator, Memory-metal Actuator, Ion-exchange Polymer-metal Actuator, Micro Actuator.

Module V - [5L]

Signal Conditioning Theory, Circuits and Systems:

Introduction to signal conditioning, Voltage divider, Rectification, Diode Voltage Stabilizer, Clipping and Clamping Circuit, Amplifier, Instrument Amplifier, Bridge Circuit, Comparator, Oscillator, Multivibrator.

Module VI - [5L]

Computers and Logic Systems:

System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Logic System Design, Synchronous and Asynchronous Sequential System, Architecture, Control with Embedded Computers and Programmable Logic Controllers.

Module VII - [7L]

Software and Data Acquisition:

Introduction to Data Acquisition, Measurement Techniques: Sensors and Transducers, A/D and D/A Converters, Signal Conditioning, Computer-Based Instrumentation Systems, Software Design and Development, Data Recording and Logging.

References:

1. Robert H. Bishop, *The Mechatronics Handbook*, CRC Press 2006
2. W. Bolton, *Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering*, Pearson Education, 2003.
3. N. P. Mahalik, *Mechatronics, Principles, Concept and Applications*, McGraw Hill, 2003.
4. R. Isermann, *Mechatronic Systems Fundamental*, Springer, 2005.
5. Denny K. Miu, *Mechatronics*, Springer-Verlag, New York, 1993.

	Subject Name: MEASUREMENT AND SYSTEM DESIGN				
	Paper Code: AEIE5132				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [4L]

Qualitative and Quantitative aspect of measurement; Input-Output configuration of Measuring Instruments and Instrument Systems; Methods of Correction for Interfering and Modifying Inputs; Standards & Calibration.

Module II - [8L]

Generalized Mathematical Model of Measurement System; Response of Instruments to Periodic and Transient Inputs, Dead-Time Elements, Characteristics of Random Signals, Requirements on Instrument Transfer Function to ensure accurate measurement, Experimental determination of measurement-system parameters, Loading effect under Dynamic conditions.

Module III-[6L]

Statistical Analysis: Band Diagrams, Specification Analysis, multi-parameter techniques. Computer-Aided Calibration and Measurement; Multiple Regression.

Module IV-[22L]

Manipulation of Data: Noise Problems, Shielding and Grounding, Filtering by Statistical Averaging, Dynamic Compensation, Function Generation and Linearization, Signal and System Analyzers, Microprocessor Applications;

Transmission of Data: Transmission of Analog Voltage and Current signals and Digital Data, FM/FM Radio Telemetry;

Recording of Data: DSO, Spectrum Analyzer;

Engineered Data Acquisition and Processing Systems: Versatile, modular system emphasizing analog signal processing, Sensor-based, computerized data systems.

References:

1. Measurement Systems – Application & Design, E. O. Doebelin, 6th Ed, McGraw Hill.
2. Instrumentation Design Studies, E. O. Doebelin, CRC Press, 2010.
3. Principles of Industrial Instrumentation (2e) , D. Patranabis, TMH, 1996.
4. Principles of Engineering Instrumentation – D. C. Ramsay, Wiley, NY, 1996.
5. Transducers in Electronic and Mechanical Design – H. L. Trithy, Mercal Dekker, 1986.
6. Transducers for Automation – M. Hordeski, Van Nostrand, 1987.
7. Industrial Instrumentation – Principles of Design – TR. Padmanavhan, Springer, International Ed.

	Subject Name: OPTICAL INSTRUMENTATION				
	Paper Code: AEIE5133				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [9L]

Optical Fibers and their Performances:

Principle of light propagation through fiber-different types of fibers and their properties-fiber characteristics-Absorption losses-scattering losses-dispersions-connectors and splicer-fiber termination-optical sources-optical detectors.

Module II - [9L]

Industrial applications of optical fiber:

Fiber optic sensors-fiber optic Instrumentation system-Different types of modulators-Inferometric method of measurement of length-Moire fringes-Measurement of pressure, temperature, current, voltage, liquid level and strain.

Module III - [9L]

LASER fundamentals:

Fundamental characteristics of lasers-Three level and four level lasers-Properties of lasers-laser modes-Resonator configuration-Q switching and mode locking- cavity damping-Types of lasers-gas lasers, liquid laser, solid lasers, semi-conductor lasers.

Module IV - [9L]

Industrial applications of LASER:

Laser for measurement of distance, length, velocity, acceleration, current,voltage and atmospheric effect- Material processing -Laser Heating, Welding, Melting and trimming of material-Removal and vaporization.

Module V - [4L]

Hologram and Medical applications:

Holography-Basic Principle-Methods-Holographic Inferometry and application, holography for non-destructive testing-holographic components-Medical applications of laser and tissues interactive.

References:

1. J.M. Senior, Optical Fiber Communication – Principles and Practice, Prentice Hall of India, 1985.

2. J. Wilson and J. F. B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2001.
3. Donald J. Sterling Jr, Technicians Guide to Fiber Optics, 3rd Edition, Vikas Publishing House, 2000.
4. M. Arumugam, Optical Fiber Communication and Sensors, Anuradha Agencies, 2002.
5. John F. Read, Industrial Applications of Lasers, Academic Press, 1978.
6. Monte Ross, 'Laser Applications', McGraw Hill, 1968
7. G. Keiser, Optical Fiber Communication, McGraw Hill, 1995.
8. Mr. Gupta, Fiber Optics Communication, Prentice Hall of India, 2004.

Subject Name: PROCESS INSTRUMENTATION LAB					
Paper Code: AEIE5111					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	4	4	2

1. Study of boiler using Boiler SIM software (MS Window version).
2. Testing & Calibration of Instruments through Automatic test equipments.
3. Characteristics study of various sensors using Microprocessor based Data Acquisition and Control system.
4. Tuning of different simulation process in MATLAB environment.
5. DC motor and Furnace control using PID controller.
6. Dual control scheme for crane position and swing angle control of a Digital pendulum.
7. Studies of Process telemetering and remote control.

Subject Name: DIGITAL SIGNAL PROCESSING LAB					
Paper Code: AEIE5112					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	4	4	2

- 1 Generations of different types of sequences and operations on them.
- 2 Simulation of some simple discrete-time systems and investigation of their time domain properties.
- 3 Spectral Analysis-
Discrete Fourier Transform, Fast Fourier Transform, Spectral Analysis with FFT, Time varying spectra, Spectrogram of Chirp Signal, Wavelet transform.

- 4 Design of IIR filters and their realizations.
- 5 Design of FIR filters and their realizations.
- 6 Analysis of Finite Word-Length effects.
- 7 Real Time signal Processing by TI C6713 and Code Composer studio –
Introduction to Code Composer Studio as an integrated development environment, Creating projects, writing and compiling programs for the C6713 DSK, Real-time FIR and IIR filtering, Real-time FIR and IIR filtering, The fast Fourier transform (FFT), adaptive filtering, code optimization.

References:

1. Vinay Ingle and John Proakis, Digital Signal Processing Using MATLAB, 2nd edition, CL-Engineering, 2006
2. Thad B. Welch, et al., Real-Time Digital Signal Processing from MATLAB® to C with the TMS320C6x DSPs, Second Edition. 2nd Edition, CRC Press, 2011, ISBN-13 978-1439883037.
3. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, John Wiley & Sons, Inc., Hoboken, New Jersey, 2005.

Subject Name: SEMINAR I					
Paper Code: AEIE5121					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	1

The seminar should be on any topic having relevance with Instrumentation engineering and related areas of technology. The topic should be decided by the student and concerned teacher. Seminar work shall be in the form of presentation to be delivered by the student regularly throughout the semester. The candidate will deliver a final talk on the topic at the end of the semester and assessment will be made by a group of internal examiners.

Detailed Syllabus
M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)
1st. Year- 2nd. Semester

Subject Name: PROCESS CONTROL SYSTEM DESIGN					
Paper Code: AEIE5201					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]

Mathematical Modeling of Processes: The System equations approach, Analytical Approximations, effect of parameter variation; Open loop step response method, frequency response, method, the parameter estimation technique-linear regression, least square regression technique.

Process Dynamics: characteristics of a few processes such as heat exchangers, boilers and condensers, Model analysis and control; System order reductions.

Module II - [16L]

Designing process control systems – different approaches: Supervisory, direct digital, Fuzzy logic, Distributed Computer, Adaptive and self-tuning.

Supervisory control using procedural model and/or economic model, process optimization, various aspects of direct digital control -- Hierarchical, multilayer, multilevel etc. Comparison of design strategies and performances.

Control system design with distributed computer networks, local controller, communication data links, control information and display unit; redundancy, reliability, data transfer protocols, standard interfaces, real time languages.

Module III - [10L]

Fuzzy logic process control – main advantages, the approach, the controller design and applications to systems.

Adaptive control – the system identification technique, the model reference technique, self-adaptation, the predictive approach; Design of the self-tuning control systems: Based on (i) Transient response (ii) frequency response (iii) parametric models.

Module IV - [4L]

Variation of algorithm designs, comparisons. Case studies of specific control schemes such as temperature of oven and /or flatness of rolled metal sheets- design details of the algorithm developed and the complete scheme.

References:

1. Applied Digital Control – J. R. Leigh, Prentice Hall.
2. Elements of Computer Process Control – Deshpande & Ash, ISA.
3. Digital Computer Process Control – C. L. Smith, Intext Education Publishers, 1972.
4. Advanced Practical Process Control – B. Roffel and B. H. L. Betlem.
5. Digital Computer Process Control - C. L. Smith, Intext Education Publishers, 1972.
6. Adaptive Control– Astrom, Pearson, 2nd Ed.
7. Supervision and Control for Industrial Processes – B. Sohlberg, Springer-Verlay, 1998.
8. Robust Process Control – Prentice Hall, 1989 – M. Murari& E. Zafirion.

	Subject Name: MICRO SENSOR SCIENCE AND TECHNOLOGY				
	Paper Code: AEIE5202				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [6L]

Overview of Micro-Sensors:

Principle of transduction; classification of micro-sensors; Chemical, thermal, pressure, acoustic, optical, electrical, mechanical, biological sensors, their calibration and determination of characteristics.

Module II - [7L]

Engineering Science for Micro-sensor design and Fabrication:

Atomic structure of matter, Ions and ionization; Molecular theory of matter and intermolecular forces; Doping techniques of semiconductor; The diffusion process; Plasma Physics; ElectroChemistry: electrolysis, electrodynamics.

Module III - [12L]

Micro-Fabrication Process:

IC technology used in micro sensor system; Crystal growth and wafer making, different techniques of deposition; physical vapor deposition - evaporation, thermal oxidation, sputtering, epitaxy, ion implantation and diffusion, LASER ablation; Chemical vapor deposition- LPCVD, APCVD, PECVD, spin coating, electrochemical deposition,

Pattern generation and transfer- masking, photolithography: Photoresists and application, light sources, photo resist development and removal; different types of etching: chemical and plasma; Overview of micro-manufacturing techniques: Bulk Micro-machining, Surface Micro-machining, LIGA.

Module IV - [8L]

Materials for Micro-Sensors:

Substrates and Wafers; Silicon as substrate material; Silicon Compounds: Silicon dioxide, Silicon Carbide, Silicon Nitride and Polycrystalline silicon, Silicon Piezo-resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Langaur-Blodgett (LB) films, Packaging materials.

Module V - [4L]

Testing and Packaging:

Partitioning, Layout, Technology constraints, scaling, compatibility study; Scaling laws in Miniaturization. Examples of selected micro sensors.

Module VI - [3L]

Smart Sensors:

Introduction; Nature of semiconductor sensor output, information coding, integrated sensor principles, sensor networking, present trends.

References:

1. J. W Gardner, V. K. Varadan, *Microsensors, MEMS And Smart Devices*, Wiley, 2001.
2. Stephen Beedy, *MEMS Mechanical Sensors*, Artech House, 2004
3. N. P. Mahalik, *MEMS*, McGraw Hill, 2007
4. Jon Wilson, *Sensor Technology Handbook*, Elseiver, 2005.
5. Leondes, Cornelius T. (Ed.), *Mems/Nems Handbook Techniques and Applications*, Springer, 2006
6. Mohamed Gad-el-Hak, *The MEMS Handbook*, CRC Press; 2nd edition, 2005.
7. B. G. Streetman and Sanjay Banerjee, *Solid State Electronic Devices*, Prentice Hall; 6th edition, 2005.

	Subject Name: INSTRUMENTAL METHODS OF ANALYSIS				
	Paper Code: AEIE5203				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [6L]

Classification of analytical instruments,

Basic Analysis Technique: Sample Handling System (SHS), Steam and Water Analysis System (SWAS).

Electro-Analytical methods: Electrochemical cells, Electrode potentials, Calculation of Cell potentials.

Module II - [6L]

Pollution Monitoring Analyzers: O₂, CO, CO₂, NO_x, SO_x measuring analyzers, Particulate Analyzer.

Module III - [6L]

Electromagnetic Radiation and Electromagnetic Spectrum.

Absorption Spectroscopy: transmittance and absorbance, Beer-Lambert law, principle of Infra-Red, Ultraviolet-Visible absorption spectrometry, effects of instrumental noise on analysis, quantitative determination of different analytes, applications in analytical chemistry, biochemistry, etc.

Flame scanner.

Module IV - [9L]

Atomic spectroscopy: Introduction to spectrometric methods,

Atomic absorption and Atomic fluorescence spectrometry,

Mass spectrometry: types, principle, instrumentation, identifying elements present in a sample (Organic and inorganic),

X-Ray Spectrometry: fundamental principle, X-Ray absorption spectrometry, X-Ray fluorescence spectrometry, X-Ray monochromator, detectors, applications.

Module V - [6L]

Gas Chromatography: fundamental of chromatographic separation, qualitative and quantitative analysis, chromatography column, instrumentation, Gas-Solid chromatography, application.

Liquid Chromatography: scope of HPLC, LC instrumentation. Applications in food, pharmaceutical, petrochemical, etc. industries.

Module VI - [7L]

Liquid Analyzer: Operating principle (chemistry) of liquid analyzer,

Silica, Hydrazine, TOC, Phenol, BOD and Effluent Treatment Plant (ETP) analyzer.

References:

1. Skoog, Holler and Crouch - Instrumental Analysis, Cengage Learning, India, 2007.
2. Braun R.D – Introduction of Instrumental Analysis, Pharma book syndicate, Hyderabad, 2006.
3. Khandpur R. S. – Handbook of Analytical Instruments, Tata McGraw Hill, New Delhi, 2010.
4. Willard, Merritt, Dean and Settle – Instrumental methods of Analysis, CBS publishers, New Delhi.
5. Patranabis D.- Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi

Subject Name: EMBEDDED SYSTEMS					
Paper Code: AEIE5204					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [4L]*Introduction:*

Embedded systems overview, design challenge, processor technology, IC technology, Design Technology, Trade-offs.

Module II - [12L]*Hardware and Communication Interface:*

Processors - Application Specific Instruction-Set Processors (ASIPs) – Micro Controllers and Digital Signal Processors, Special Purpose Processors, I/O devices, interfacing and control - Analog I/O, Digital I/O, Bus I/O, Serial and Network I/O, Memory, Power and Display Device, Communication interfaces- RS232 / UART, RS422 / RS485, USB, Infrared, IEEE 1394 Firewire, Ethernet, IEEE 802.11, Blue tooth.

Module III - [12L]*Embedded Systems Software:*

Introduction to Operating Systems, Device Drivers Timers, Memory Management, Priority inversion problem, Embedded operating systems- Embedded Linux, Real-time operating systems, RT Linux, Handheld operating systems, Debian.

Module IV - [12L]*Embedded Systems Application Design, Programming and case studies:*

System Specification and Modeling, High level language descriptions in embedded system, Java based embedded system design - Simulation and Emulation of embedded systems- ARM processor

based embedded boards, Raspberry- Pi, Arduino; Typical applications in Signal processing, instrumentation, control and actuation systems, etc.

References:

1. Embedded System Design: A Unified Hardware/Software Introduction – Frank Vahid, Tony D. Givargis, John Wiley, 2002.
2. Embedded Microcomputer Systems – Jonathan W. Valvano, Brooks / Cole, Thompson Learning.
3. Embedded Systems: Architecture, programming and design- Raj kamal, TMH, 2002.
4. An Embedded Software Primer – David E. Simon, Pearson Ed., 2005.
5. Embedded system design by Arnold S Burger, CMP.
6. Embedded / Real Time Systems – KVKK Prasad, Dreamtech Press, 2005.
7. Complete PCB Design using ORCAD Capture and Layout- Kraig Mitzner, Elsevier.
8. Embedded Signal Processing with the Micro Signal Architecture, Woon-Seng Gan and Sen M. Kuo, John Wiley & Sons, Inc., Hoboken, New Jersey 2007.
9. PIC Microcontroller and Embedded Systems- Mohammad Ali Mazidi, Rolind Mckinley and Danny Causey, Pearson Education.
10. Advanced PIC microcontroller projects in C- Dogan Ibrahim, Elsevier 2008.

Subject Name: DIGITAL IMAGE PROCESSING					
Paper Code: AEIE5231					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [5L]

Introduction:

Elements of digital image processing systems, Elements of visual perception, digital Image sensing, sampling and quantization, digital image representation, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals -RGB,HSI models.

Module II - [5L]

Image Transforms:

2D transforms - DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD and Wavelet Transform.

Module III - [10L]

Image Enhancement and Restoration:

Basic gray level transformations, histogram processing, Smoothing and sharpening spatial filters, Image enhancement in frequency domain, Smoothing and sharpening frequency domain filters, Image restoration, Types of noises, noise reduction by spatial and frequency domain filtering, Homomorphic filtering. Image Restoration - degradation model, Unconstrained and Constrained restoration, Inverse filtering - removal of blur caused by uniform linear motion, Wiener filtering.

Module IV - [5L]

Morphological Image Processing:

Dilation and Erosion, Opening and Closing, Boundary extraction, Region filling, Convex hull, Thinning, Thickening, Skeletons, Pruning.

Module V - [4L]

Image Compression:

Need for data compression, Coding redundancy, Interpixel redundancy, Psycho visual redundancy, Image compression models, Error free compression, Huffman coding, Run Length coding, Shift coding, Arithmetic coding, Vector Quantization, Block truncation coding, Lossless predictive coding, Lossy predictive coding, Transform coding, Wavelet coding.

Module VI - [5L]

Image Segmentation:

Point Detection, Line Detection, Edge Detection, Edge linking and boundary detection. Image segmentation by region growing, region splitting and merging, edge linking.

Module VII - [6L]

Image Representation, Description and Recognition:

Image Recognition - Patterns and pattern classes, Feature extraction, Matching by minimum distance classifier, Matching by correlation, Cluster analysis, Overview of supervised classifiers like ANN and SVM in Image Processing.

References:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson Education, Inc., Second Edition, 2004.
2. Anil K. Jain, *Fundamentals of Digital Image Processing*, Prentice Hall of India, 2002.
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, *Digital Image Processing using MATLAB*, Pearson Education, Inc., 2004.
4. William K. Pratt, *Digital Image Processing*, John Wiley, New York, 2002.
5. Milman Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, Brooks/Cole, Vikas Publishing House, II ed., 1999.

Subject Name: INDUSTRIAL AUTOMATION TECHNOLOGY					
Paper Code: AEIE5232					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [6L]

Introduction:

Types of industrial processes and their associated control & operational requirements; Necessity and importance of automation in industry; Evolution of industrial automation – conventional and computer control of processes, control systems – elements and architecture.

Module II - [6L]

SCADA:

Elements, Features and Functions; Topology, Architecture and Communication Methods; Industry Specific (Power Transmission & Distribution / Manufacturing / Water & Sewage etc..) Applications.

Module III - [16L]

Programmable Logic Controllers:

Evolution, Function and Architecture; Modules – Types, Wiring and Interfacing; CPU and Memory; PLC Programming.

Distributed Control Systems:

Evolution, Function and Architecture; Elements and Features; System Integration with PLC and 3rd party devices.

General Considerations:

Hierarchical Communication Model – Levels & Network Requirements; Network Access Protocols, Arbitration Methods, Transmission Media and Topology; FieldBus Technology (Profibus, Foundation Fieldbus, etc.); Multi-level Redundancy – Concepts & Implementation.

Module IV - [6L]

Human Machine Interface:

Operator & Engineering Interface – Features, Functions and Requirements.

Module V - [6L]

Trends & Practices:

Computer Integrated Manufacturing/Processing, Management Information Systems; Safety Instrumented Systems (SIS) – Risk analysis and reduction methods, SIF & SIL considerations, IEC 61508 requirements; Wireless Communication – Remote Networks, LAN, HART.

References:

- 1.B. G. Liptak, Instrument Engineers Handbook – Process Control, Chilton Book Co/ Butterworth-Heinemann.
- 2.B. G. Liptak, Instrument Engineers Handbook – Process Software & Digital Networks, CRC Press.
- 3.M. P. Lukas, Distributed Control Systems, Van Nostrand Reinhold Co.
- 4.W. Bolton, Programmable Logic Controllers, Elsevier.
- 5.Webb & Reis, Programmable Logic Controllers, PHI.
- 6.S. K. Singh, Computer Aided Process Control, PHI.
- 7.P. Bhatkar, Distributed Computer Control for Industrial Automation, Dekkar Publication.
- 8.Stuart A. Boyer, SCADA-Supervisory Control & Data Acquisition, ISA Publication.
- 9.Gruhn and Cheddie, Safety Shutdown Systems, ISA Publication.
10. Sunit Sen, Field Bus and Networking in Process Automation, CRC Press.

Subject Name: STATISTICAL AND BIO-SIGNAL PROCESSING					
Paper Code: AEIE5233					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]*Introduction:*

Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, Analysis of variance. Biomedical signals – ECG, EEG, EMG etc., Stochastic and deterministic signals, concepts of stationary and periodicity. Discrete signals, the sampling theorem, Aliasing, Quantization error. Duality of time and frequency domain. Hypotheses testing: The null and alternative hypothesis, Types of tests.

Module II - [8L]*Regression and correlation:*

Simple linear regression model, regression equation. Multiple regression and correlation model. The Autocorrelation and Auto-covariance Matrix Power Spectrum, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process.

Module III - [10L]*Univariate signal:*

Filters, Matched filters; Wiener filters Probabilistic models; Hidden Markov model; Kalman filter.

Module IV - [4L]

Multivariate signals:

Multivariate autoregressive model (MVAR); Formulation of MVAR model; Formulation of MVAR model.

Module V - [4L]

Case study-I: Application to biomedical signals:

Analysis of continuous EEG signals, Single channel analysis; Multiple channel analysis: Mapping; Elimination of artifacts; sleep EEG analysis.

Module VI - [4L]

Case study-II: Application to biomedical signals:

Analysis of continuous ECG signals: Measurements, Processing of ECG, Artifact removal, Statistical methods and models for ECG; Heart rate variability: Time-domain methods of HRV analysis; Frequency-domain methods of HRV analysis.

References:

1. Stanton A. Glantz, Primer of Biostatistics, McGraw Hill, 2nd Ed.
2. A.K. Sharma, Text Book of Biostatistics, DPH Mathematics series, 2005
3. Monson H. Hayes, Statistical Digital Signal Processing & Modeling, John Wiley & Sons.
4. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, Statistical and Adaptive Signal Processing, ARTECH HOUSE, INC., Norwood, 2005.
5. D.C. Reddy, Biomedical Signal Processing: Principles and techniques. TMH, New Delhi, 2005
6. Semmlow, Biosignal and Biomedical Image Processing, Marcel Dekker, 2004.
7. Bruce, Biomedical Signal Processing, Prentice Hall, 1993.

	Subject Name: EMBEDDED SYSTEMS LAB				
	Paper Code: AEIE5211				
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	4	4	2

1. Introduction to MPLAB® IDE Basics
2. Experiments with GPIO devices:
 - a) Input: Push Button, Push Button Interrupt, Interrupt-on-Change, Using Weak Pull-Ups.
 - b) Output: Light LEDs, Flash LEDs (Delay Loop), Simple Delays Using Timer0, Rotate LEDs.
3. Programming with Timers, Interrupts, Serial port.
4. Experiments with Comparator Peripherals
 - a) Simple Compare

- b) Using the Comparator Voltage Reference
- c) Higher Resolution Sensor Readings Using a Single Comparator
- 5. Generation of PWM.
- 6. Real time monitoring of voltage and displaying with LCD or seven segment display.
- 7. Interfacing of real time clock.
- 8. Program to transmit and receive a message from Microcontroller to PC serially using RS232.
- 9. Program to get analog input from Temperature sensor and display the temperature value on PC Monitor.
- 10. FIR Filter implementation in ARM/PIC Platform Design FIR filter, Implementation of FIR filter on hardware Testing and Parameter adjustment.

Subject Name: VIRTUAL INSTRUMENTATION LAB					
Paper Code: AEIE5212					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	4	4	2

1. Introduction to LabVIEW tool kit.
2. Simulation and Analysis of various signals using LabVIEW.
3. Real time data acquisition and signal conditioning (amplification, filtration etc.) from various sensors/Transducers using LabVIEW.
4. Time response analysis of a model using LabVIEW.
5. Frequency response analysis of a model using LabVIEW.
6. Root locus and Bode plots based analysis of a given system using LabVIEW.
7. Bio-signal processing using LabVIEW.
8. Study of pressure control using LabVIEW.

Subject Name: SEMINAR-II					
Paper Code: AEIE5221					
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	3	3	1

The main objective of this course work is to encourage self-learning in the field of student's own interest among the emerging areas of technology. The student is expected to do an extensive literature survey in his subjects of interest and present seminar on a research problem, available methods in literature, future trends, etc. to a group of experts.

Detailed Syllabus
M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)
2nd Year- 1st. Semester

Subject Name: MICRO-ELECTROMECHANICAL SYSTEM DESIGN					
Paper Code: AEIE6131					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I: [5L]

Overview of Microsystems Design:

Glimpses of Microsystems; Typical MEMS and Micro-system products, Evaluation of Micro-fabrication, Micro systems and Micro-electronics; The multidisciplinary nature of micro system design and manufacturing; Applications of Microsystems in Automotive, health care, aerospace, telecommunication industries.

Module II: [12L]

Engineering Mechanics for Micro-system Design:

Static bending of thin plates: Bending of circular plates with edge fixed, Bending of rectangular plates with all edge fixed, Bending of square plates with all edge fixed; Mechanical Vibration: General Formulation, resonant Vibration, Micro-accelerometers, Design Theory of accelerometers, Damping coefficient, Resonant Micro-sensors; Thermo Mechanics: Thermal effects on mechanical strength of materials, creep deformation, thermal stresses; Fracture Mechanics: Stress Intensity Factors, Fracture Toughness, Interfacial Fracture Mechanics; Thin Film Mechanics; Overview of Finite Element Method.

Module III: [11 L]

Microfluidic System Design:

Introduction to Fluid Mechanics: Viscosity of fluids, Streamlines and Stream Tubes, Control Volumes and control surfaces, Flows patterns; Basic Equations in Continuum Fluid Dynamics: Continuity, momentum equations and equations of motion; Laminar Fluid Flow in Circular Conduits: Computational Fluid dynamics; Incompressible Fluid Flow in Microconduits: Surface Tension, Capillary Effect, Micro-pumping; Fluid flow in submicrometer and nanoscale: The Rarefied gas, Kudsens and Mach Number, Modelling of Micro-gas Flow; Heat Conduction Mechanics- Fourier Law of Heat Conduction, Heat conduction Equations with Cooling Law, Solid-Fluid Interaction, Boundary Conditions.

Module IV: [12L]

Microsystems Design:

Design Considerations: Constraints of Design, Material Selection, manufacturing process selection, Signal Transduction Selection, Electromechanical System, Packaging; Process Design: Photo-Lithography, Thin film Fabrications, Geometry Shaping, Mechanical Design: Thermo-mechanical loading, Thermomechanical Stress Analysis, Dynamic Analysis, Interfacial Fracture Analysis, Mechanical Design Using Finite Element Method: Finite element Formulation, Simulation of Micro-fabrication Process; Design of Silicon Die for a Micro-pressure Sensor; Design of Microfluidic Network Systems: Fluid Resistance in Micro channels, Mathematical Modeling of Capillary electrophoresis network systems.

References:

1. G.T.A. Kovacs, *Micromachined Transducers Sourcebook*, WCB McGraw-Hill, 1998.
2. J.W. Gardner, *Microsensors: principles and applications*, John Wiley & Sons, 1994.
3. M. Madou, *Principles of Microfabrication*, CRC Press, 1998.
4. Kubby, *A Guide to Hands-on MEMS Design and Prototyping*, Cambridge, 2011
5. *MEMS and Nanotechnology*, Volume 6: Proceedings of the 2012 Annual Conference on Experimental and Applied Mechanics: 42 (Conference Proceedings of the Society for Experimental Mechanics Series), Gordon A. Shaw (Author, Editor), Barton C. Prorok (Author, Editor), LaVern A. Starman, Kindle Edition, 2012.

Course Outcomes:

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

1. Design MEMS-based diaphragm type devices analytically.
2. Fabricate the whole MEMS system with the help of simulation software.
3. Develop micro-fluidic system for biomedical applications.
4. Develop skill on engineering mechanics for micro-system design.

	Subject Name: VLSI TECHNOLOGY				
	Paper Code: AEIE6132				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I: [12L]

Digital VLSI Circuits:

MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics (VTC), Inverter Delay & Noise, NAND and NOR gates, Complex Logic Circuits, Logical Effort, Pass Transistor Logic & Transmission Gate, CMOS Sequential Circuits, CMOS D-Latch and D-Flip-Flop, Pseudo NMOS Logic, Dynamic gate, Domino and NORA Logic.

Module II: [8L]

Physical Layout of VLSI Circuits:

CMOS Cross Section, Layout and Mask layers, Inverter Layout, Lambda Rule vs. Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm, Layout Legging.

Module III: [12L]

VLSI Design Methodology:

Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node, VLSI Design Cycle, Y-Chart, Full Custom Design, Std Cell based Semi Custom Design, Gate Array Design, PLD, FPGA: CLB, LUT, MUX.

Module IV: [8L]

Hardware Description Language:

Introduction to HDL, VHDL/Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed Mode with various examples of combinational and sequential circuits, FSM Example: Mealy Machine and Moore Machine.

References:

1. Neil Weste, *Principles of CMOS VLSI Design, A Systems Perspective*, Kamran Eshraghian, Addison Wesley, 2nd Edition, 2000
2. Sung-Mo Kang, *CMOS Digital Integrated Circuits, Analysis and Design*, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006
3. Neil Weste, David Harris, *CMOS VLSI Design, A Circuits and Systems Perspective* Pearson, 3rd Edition, 2011
4. Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, *VLSI Design and EDA TOOLS*, SCITECH PUBLICATIONS (India) Pvt. Ltd., 2011
5. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw Hill
J. Bhasker, *A VHDL Primer*, Prentice-Hall, 2013.

Course Outcome:

After the completion of the course student will be able to

1. Analyze CMOS digital electronics circuits including logic components and their interconnection.
2. Develop models of moderately sized CMOS circuits that realize specified digital functions.
3. Apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects.
4. Learn VLSI design methodologies - the various steps and tools, the implementation choices, and good architecture practices.

Subject Name: ROBOTICS ENGINEERING					
Paper Code: AEIE6133					
Contact hrs per week:	L	T	P	Total	Credit
	4	0	0	4	4

Module I [9L]

Introduction to Robotics, Elements of robots – links, joints, actuators, and sensors:

Introduction – brief history, types, classification and usage, Science and Technology of robots.

Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms.

Types of transmissions, Purpose of sensors, internal and external sensors, common sensors, encoders, tachometers and strain gauge based force-torque sensors, proximity & distance measuring sensors, vision sensors.

Module II [7L]

Kinematics of serial and parallel robots:

Direct and inverse kinematics problems, Examples of kinematics of Common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination.

Degrees-of freedom of parallel mechanisms and manipulators, Direct Kinematics problem, Mobility of Parallel manipulators, Inverse kinematics of parallel manipulators and mechanisms.

Module III [10L]

Static and Dynamic analysis of robot manipulators:

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Joint and Cartesian space trajectory planning and generation.

Module IV [14L]

Motion planning and control of robots:

Classical control concepts using the example of control of a single link, Independent joint, PID control, Control of a multi-link manipulator, nonlinear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control. Modeling and Analysis of Wheeled Mobile robots: Introduction, Kinematics of contact, Kinematics of a single wheel, Kinematic modeling of a three-wheeled mobile robot, equations of motion of a three-wheeled mobile robot, algorithm for solving the equations of motion.

References:

1. A. Ghosal, *Robotics: Fundamental Concepts and Analysis*, Oxford University Press, 2nd reprint, 2008.
2. K. Fu, R. Gonzalez and C.S. G. Lee, *Robotics: Control, Sensing, Vision and Intelligence*, McGraw- Hill, 1987.
3. R.D. Klafter, T. A. Chimielewski and M. Negin, *Robotic Engineering – An integrated approach*, Prentice Hall of India, New Delhi, 1994.
4. Nagrath and Mittal, *Robotics and Control*, Tata McGraw- Hill, 2003.
5. Spong and Vidhyasagar, *Robot Dynamics and Control*, John Wiley and sons, 2008.

Course Outcomes:

After the completion of the course students will be able to

1. Explain the roles of links, joints & Identify sensors and actuators required in robotic control.
2. Solve direct and inverse kinematics problem of serial and parallel manipulators.
3. Illustrate the degrees of freedom of manipulators.
4. Solve basic robotic dynamics, path planning and control problems.
5. Model robot links and joints and integrate sensor technology and other external devices into the robot system to design multilink flexible robot.

	Subject Name: APPLIED SOFT COMPUTING				
	Paper Code: AEIE6141				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [3L]

Introduction to Soft Computing:

Introduction, Benefits and application scope of Fuzzy Logic, Neural Network and Stochastic algorithms. Introduction to different hybrid systems:-Fuzzy-conventional, Neuro-Fuzzy, Neuro-Genetic, Genetic-Fuzzy Systems.

Module II - [10L]

Fuzzy Logic -I:

Basic concepts of Fuzzy Logic- Probability and possibility theorem, Fuzzy sets and crisp sets, properties of Fuzzy sets, Fuzzy relations, Compositional rule of inference, Fuzzy implications.

Module III-[10L]

Fuzzy Logic-II:

Membership functions, Choice of scaling factors- normalization and de-normalization, Fuzzification procedure, Inference engine- Mamdani and TSK FIS, Choice of defuzzification procedures, Design of Fuzzy controllers, Industrial applications.

Module IV-[6L]

Neural Network-I:

Biological Neural Network, Evolution of Neural Network, Basic models of ANN, Activation functions, McCulloch-Pitts Neural Network model, Single layer and Multi-layer feed forward Neural Network, Hebb Network, Numerical problems.

Module V-[6L]

Neural Network-II:

Supervised learning network- BPNN, Radial Basis Function Network. Unsupervised learning network- Kohonen Self-Organizing Feature Map.

Module VI-[5L]

Stochastic Algorithm:

Biological background, Basics of Stochastic algorithms and its applications.

References:

1. J. S. R. Jang, C. T. Sun and E. Mizutani, *Neuro-Fuzzy and Soft Computing*, PHI, 2004, Pearson Education 2004.
2. Dirankov, Hellendoorn and Reinfrank, *An Introduction to Fuzzy Control*, Narosa Publishing House.
3. Davis E. Goldberg, *Genetic Algorithms: Search, Optimization and Machine Learning*, Addison Wesley, N.Y., 1989.
4. S. Rajasekaran and G. A. Vijaylakshmi Pai, *Neural Networks Fuzzy Logic, and Genetic Algorithms*, Prentice Hall of India.
5. J. Yen and R. Langari, *Fuzzy Logic, Intelligence, Control and Information*, Pearson Education.
6. S. Haykin, *Neural Networks*, Prentice Hall of India.

Course Outcomes:

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

1. Classify the soft-computing into the different computing methods based on their application, knowledge-base, mode of operation, construction, etc.
2. Explain the functions and properties of different fuzzy sets and compare with crisp set, explain different fuzzy relations and implications.
3. Design and analyze the different components of fuzzy controller appropriately to obtain the best possible fuzzy controller that can be applied to any process control systems.
4. Identify different component of biological and artificial neural network, and acquire knowledge of different ANN terminologies to apply in solving simple ANN problems.
5. Analyze and design algorithms for different supervised and unsupervised learning networks.
6. Illustrate biological background and give idea about basics of stochastic algorithm.

	Paper Name: WIRELESS SENSOR NETWORKS				
	Paper Code: AEIE 6142				
Contact hrs. per Week :	L	T	P	Total	Credit points
	4	0	0	4	4

Module I - [8L]

Introduction & Architecture:

Brief historical survey of sensor networks, WSN types and Architecture : Single-node architecture - hardware components, design constraints, energy consumption of sensor nodes, operating systems and execution environments, types of sources and sinks – single hop vs. multi hop networks, multiple sources and sinks – mobility, optimization goals and figures of merit, gateway concepts, design principles for WSNs, service interfaces for WSNs. Introduction to frequency and bandwidth selection, Introduction to MANETs (Mobile Ad-hoc Networks), Comparative study of WSNs with MANETs, WSN standards.

Module II – [12L]

Communication Protocols:

Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs : low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols, Traffic-adaptive medium access protocol (TRAMA), WSN Standards : IEEE 802.15.4, Zigbee; Address and name management, assignment of MAC addresses; Routing challenges and design issues in Wireless Sensor Networks, Flooding and Gossiping, Data centric routing (SPIN), Directed Diffusion, Energy efficient routing, Gradient-based routing, Hierarchical routing (LEACH), Location based routing, Real time routing; Data aggregation - data aggregation operations, aggregate queries & techniques.

Module III – [8L]

Topology and Synchronization:

Topology control, flat network topologies, hierarchical networks by clustering, time synchronization, properties, protocols based on sender-receiver and receiver-receiver synchronization, LTS, TPSN, RBS, HRTS, localization and positioning, properties and approaches, single-hop localization, positioning in multi-hop environment, range based localization algorithms – location services, sensor tasking and control.

Module IV – [12L]

Network Platforms:

Operating Systems for Wireless Sensor Networks : Introduction & Design Issues - TinyOS – Mate – MagnetOS; Introduction to Tiny OS – NesC : Interfaces and Modules, Configurations and Wiring, Generic Components, Programming in Tiny OS using NesC; Network Simulation / Emulation using NS2, TOSSIM, Brief Introduction to other Operating Systems: MantisOS, Contiki, SenOS.

Applications: Industrial & Building Automation, Bio-Medical Applications, Highway Monitoring, Military Application, Civil and Environmental Engineering Applications, Nanoscopic Sensor Applications.

References:

1. Holger Karl & Andreas Willig, *Protocols and Architectures for Wireless Sensor Network*, John Wiley, 2005.
2. Kazem Sohraby, Daniel Minoli, & Taieb Znati, *Wireless Sensor Networks- Technology, Protocols, and Applications*, John Wiley, 2007.
3. Feng Zhao & Leonidas J. Guibas, *Wireless Sensor Networks- An Information Processing Approach*, Elsevier, 2007.
4. Anna Hac, *Wireless Sensor Network Designs*, John Wiley, 2003.

Course Outcomes:

After completing the course the students will be able to

1. Familiar with common wireless sensor node architecture.
2. Acquire knowledge of MAC protocols developed for WSN.
3. Carry out simple analysis and planning of WSN.
4. Apply routing protocols on the developed WSN.
5. Work on some WSN standards, platforms and tools.

Subject Name: REMOTE SENSING					
Paper Code: AEIE6143					
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [8L]***Remote Sensing Foundations:***

Introduction to Remote Sensing: Definitions, Milestones in the History of Remote Sensing, Overview of the Remote Sensing Process, Key Concepts of Remote Sensing, Components of Ideal and Real Remote Sensing Systems, Advantages and Limitations of Remote Sensing, Remote Sensing data collection- Active and Passive Remote Sensing systems, Sensor Resolution- Spectral Resolution, Spatial Resolution, Temporal Resolution and Radiometric Resolution. Electromagnetic Radiation (EMR) Models- Wave model and Particle model, Interaction of EMR with the Earth surface- Reflection, Transmission, Spectral Signature; Energy-Matter Interactions with the Terrain- Scattering, Absorption, Refraction and Reflectance, Radiance and Irradiance.

Module II - [12L]***Image Acquisition and Photogrammetry:***

Aerial Photography- Vertical and Oblique Aerial Photography; Aerial Cameras- Focal plane and Focal length, f/stop ratio, Shutter Speed; Types of Aerial Cameras, Flight lines of Vertical Aerial Photography, Flight planning; Thermal Infrared Remote Sensing- Thermal Properties of Terrain, Thermal Infrared Data Collection and its Geometric Correction; Active Microwave Imagery System- Components, wavelength, Frequency and Pulse Length, Azimuth and Range Direction, Depression Angle, Incident angle and Polarization, Slant-Range versus Ground-Range RADAR image geometry- Computation of Range and Azimuth Resolution, Radar Equation, Synthetic Aperture Radar System; Light Detection and Ranging (LIDAR)- LIDAR Imaging, Types of Imaging LIDAR, Accuracy of LIDAR Measurements; Photogrammetry- Scale and Height measurement on single Vertical Aerial Photograph- Over Level Terrain and Variable Terrain, Stereoscopic Measurement of Object Height or Terrain Elevation, Area Measurement of well known Geometric Shapes and Irregularly Shaped Polygons.

Module III-[10L]

Essential Image Processing for Remote Sensing:

Introduction to Monochromatic and Colour Image, Image Rectification and Restoration –Radiometric correction, Geometric correction and Noise removal; Image Enhancement- Contrast Manipulation, Spatial Feature Manipulation, Multi-Image Manipulation; Histogram modification, Image Filtering- Concepts of convolution for image filtering, Low-pass filters (smoothing), Gaussian filter, The k-nearest mean filter, Median filter, Mode (majority) filter, High-pass filters (edge enhancement), Gradient filters, Laplacian filters, Edge-sharpening filters, Local contrast enhancement; Arithmetic operations - Image addition, subtraction (differencing), multiplication, Image division (ratio), Index derivation and supervised enhancement, Vegetation indices, Iron oxide ratio index, TM clay (hydrated) mineral ratio index, Standardization and logarithmic residual, Simulated reflectance, Analysis of solar radiation balance and simulated irradiance, Simulated spectral reflectance image.

Module IV-[10L]

Remote Sensing Data Classification and Analysis:

Machine Learning Techniques of Remote Sensing data analysis- challenges, General concept of Machine Learning- Unsupervised classification, Supervised classification; Paradigms in Remote Sensing-Feature Extraction and Selection, Classification, Clustering; Unsupervised classification (iterative clustering)- Iterative clustering algorithms, Feature space iterative clustering, Seed selection, Cluster splitting along PC1; Supervised classification- Bayesian classification strategy, Neural Networks, Support Vector Machines (SVM), Decision rules: dissimilarity functions, Box classifier, Euclidean distance: simplified maximum likelihood, Maximum likelihood; Post-classification processing- smoothing and accuracy assessment, Class smoothing process, Classification accuracy assessment.

References:

1. John R. Jensen, *Remote Sensing of the Environment: An Earth Resource Perspective*, Prentice Hall press, Second edition, 2007.
2. James B. Campbell and Randolph H. Wynne, *Introduction to Remote Sensing*, The Guilford Press, New York, Fifth edition 2011.
3. Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, *Remote Sensing and Image Interpretation*, Wiley, 2004.
4. George Dr. Joseph, *Fundamentals of Remote Sensing*, Universities Press; Second edition, 2005.
5. Basudeb Bhatta, *Remote Sensing and GIS*, Oxford, Second edition, 2011.
6. Jian Guo Liu and Philippa J. Mason, *Essential Image Processing and GIS for Remote Sensing*, Wiley-Blackwell, UK, 2009.
7. Robert A. Schowengerdt, *Remote Sensing: Models and Methods for Image Processing*, Academic Press, Elsevier Inc., Third edition, 2007.

Course Outcomes:

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

1. Explain how remotely sensed images are acquired from satellites and aircraft.
2. Interpret the cause of different spectral responses and the significance of spectral signatures in optical, thermal infrared and microwave remote sensing.
3. Develop skills to address an environmental monitoring problem by selecting an appropriate remotely sensed data set and applying the relevant image analysis and interpretation techniques.
4. Perform basic remote sensing image interpretation including spectral ratios, histogram stretching, filtering, supervised and unsupervised classification algorithms.

	Subject Name: MEDICAL INSTRUMENTATION				
	Paper Code: AEIE6151				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [08L]

Transduction Principles:

Resistive Transducers; Strain gauge type blood pressure transducers, Thermo resistive transducer, Capacitive Transducer, Piezoelectric Transducer; Flow transducers, measurement errors; definitions: accuracy, precision, sensitivity, resolution, threshold.

Module II - [12L]

Bio-potentials and electrodes:

Origin of Bio-potentials- structure , types and electrical activity of Cells, Resting and action potentials of cells , Different models, Electrodes-surface, needle and micro electrodes and their electrical models; half cell potential, Electrode-Electrolyte interface, Off-set potentials , Polarization- polarizable and non-polarizable electrodes, Ag/AgCl electrodes, motion artifact.

Module III-[12L]

Biomedical signal processing:

Signal conditioners- OP-AMP -CMRR, ECG, EMG, EEG –Lead systems and typical waveforms. Image processing techniques- X-Ray Imaging, IR imaging, Ultrasonic imaging, CAT, MRI, Biotelemetry and patient monitoring.

Module IV-[08L]

Electrical safety:

Model of Electrical Danger, Physiological Effects of Current, Ground Shock Hazards, Schemes of Accident Prevention. Assisting and therapeutic instruments- Pacemakers, defibrillators, Hearing aids, Diathermy.

References:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, *Biomedical Instrumentation and Measurements*, Second edition, Prentice-Hall India, 1997.
2. R.S. Khandpur, *Handbook of Biomedical Instrumentation*, 2 Edition, Tata McGraw Hill New Delhi, 1987.
3. John G. Webster, *Medical Instrumentation application and design*, Third edition, Wiley, 1997.
4. S. K. Venkata Ram, *Biomedical Electronics and Instrumentation*, Galgotia Publication Pvt. Ltd., New Delhi.
5. Geddes L.A and Baker L.E, *Principles of Applied Biomedical Instrumentation*, Third edition, Wiley-Interscience, 1989.

Course Outcomes:

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

1. Explain the fundamental principles and applications of different transducers used for body parameter measurements.
2. Understand the physiology of biomedical systems and different methods in the design of biomedical instruments.
3. Learn the different methods of medical imaging systems, concepts related to the operations and analysis of biomedical instruments.
4. Aware of the importance of electrical safety and apply it in the design of different assisting therapeutic and diagnostic medical devices.

	Subject Name: ADVANCED DIGITAL CONTROL				
	Paper Code: AEIE6152				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [10L]

Review of Z- transform, inverse Z-transform, Mapping from s-plane to Z-plane, Initial value theorem, final value theorem etc. Discrete-time Systems: Sampled signals, Sampling frequency consideration and selection of optimum sampling period, quantization effects, the zero and first order holds, linear difference equations and discrete transfer functions, block diagrams, stability analysis techniques- Jury's stability test, bi-linear transformation, Computer Oriented Mathematical Models: Mathematical representation of sampling process, Pulse transfer function and data holds, Development of pulse transfer function of various block configurations.

Module II - [10L]

Digital Control Designs using Classical Methods: digital PID controller, Deadbeat controllers, Dahlin controller, ringing and pole-placement. Predictive controller design, Internal-Model control.

Module III-[10L]

Tools for designing: root locus method, frequency response based designs, introduction to direct design methods, State variable model , canonical forms , characteristic equation, solution to discrete state equation,, controllability and observability of discrete state space models.

Module IV-[10L]

Adaptive Control and Self Tuning: Gain scheduling, Model reference adaptive control, Self-tuning regulators, Cascade control, Feedforward control – Introduction and design fundamentals, and applications.

References:

1. K. Ogata, *Discrete Time Control Systems*, Prentice Hall, 2/e, 1995.
2. B. C. Kuo, *Digital Control Systems*, Oxford University Press, 2/e, Indian Edition, 2007.
3. M. Gopal, *Digital Control and State Variable Methods*, Tata Mcgraw Hill, 2/e, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, *Digital Control of Dynamic Systems*, Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000.
5. K. J. Astroms and B. Wittenmark, *Computer Controlled Systems - Theory and Design*, Prentice Hall, 3/e, 1997.

Course Outcomes:

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

1. Students will understand Transformation technique from continuous to discrete domain.
2. Will realize the fundamental principles for design of Digital Control system and will gain knowledge of implementing for industrial applications.
3. Will be capable of developing algorithms for applications based various digital controllers and analysis of discrete control systems using various time and frequency domain tools.
4. Learners will be aware of advanced understanding of adaptive and self tuning principles and applications.

	Subject Name: NONLINEAR CONTROL				
	Paper Code: AEIE6153				
Contact hrs per week:	L	T	P	Total	Credit points
	4	0	0	4	4

Module I – [5L]

Linear versus Nonlinear Control System:

Introduction to nonlinear control, Examples of nonlinear models and nonlinear phenomena: Pendulum equation, Mass-spring system, Negative-resistance oscillator, Common nonlinearities.

Module II - [8L]

Second Order Systems:

Qualitative behavior of linear systems, Phase plane method, Multiple equilibria, Qualitative behavior near equilibrium points, Limit Cycles, Numerical construction of phase portraits, Existence of periodic orbits, Bifurcation.

Module III-[10L]

Describing Function and Stability Analysis:

Describing function method- Calculation of Describing function for different non-linearities, Stability analysis using Describing function and Nyquist criterion- Concept of Limit Cycle.

Module IV-[10L]

Nonlinear Stability:

Lyapunov stability, Autonomous systems, Invariance principle, Linear systems and linearization, Comparison functions, Nonautonomous systems, Linear time-varying systems and linearization, Converse theorems, Boundedness and ultimate boundedness, Input-to-state stability.

Module V-[7L]

Feedback Linearization:

Feedback control, Control problems, Stabilization via linearization, Integral control, Integral control via linearization, Gain scheduling, Feedback linearization, Input-output linearization, Full-state linearization, State feedback control, Stabilization.

References:

1. H. Khalil, *Nonlinear Systems*, Third Edition, 2002.
2. S. Sastry, *Nonlinear Systems: Analysis, Stability, and Control*, Springer, 1999.
3. W. E. Dixon, A. Behal, D. M. Dawson, and S. Nagarkatti, *Nonlinear Control of Engineering Systems: A Lyapunov-Based Approach*, Birkhäuser Boston, 2003.
4. Jean-Jacques Slotine and Weiping Li, *Applied Nonlinear Control*, Pearson Education, 1990.
5. Miroslav Kritic, Ioannis Kanellakopoulos and Petar Kokotovic, *Nonlinear and Adaptive Control Design*, John Wiley and Sons, 1995.
6. S. H Zak, *Systems and Control*, Oxford University Press.

Course Outcomes:

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

1. Identify linear and nonlinear systems from mathematical model, and acquire knowledge of different nonlinear systems and their models.
2. Explain some of the basic ideas of nonlinear systems and look at the behavior of a nonlinear system near equilibrium points, the phenomenon of nonlinear oscillation, and bifurcation.
3. State Describing function method for stability analysis and get idea of limit cycle.
4. Analyze and determine the stability of nonlinear systems using Lyapunov Stability criterion.
5. Give idea about feedback control explain model uncertainties and linearization techniques.
6. Employ the most appropriate tools to solve the complexity of nonlinear feedback control challenges and come up with systematic design procedure to meet the control objectives and design specifications.

	Subject Name: DISSERTATION PART-1				
	Paper Code: AEIE6121				
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	16	16	8

Dissertation should be on any topic having relevance with Instrumentation, Electrical or inter-disciplinary field of engineering. The same should be decided by the student and concerned supervisor. Dissertation should consist of research work done by the student in the selected topic with comprehensive and significant review of recent developments in the same field.

Dissertation Part- I shall consist of the following division(s) whichever applicable:

1. Introduction
2. Goal of the work
3. Extensive literature survey
4. Data collection from experimental set-ups, websites, R&D organizations, industries, etc.
5. Study of the viability, applicability and scope of the dissertation
6. Detailed design (hardware or software as applicable)
7. Partial implementation with results
8. Future work

A candidate should prepare the following documents for examination:

1. A detailed report in the prescribed format based on the work related to dissertation.
2. Every candidate should present himself (for about 20-30 min.) for evaluation before the panel of examiners consisting of Head of Department, M. Tech. Coordinator, Supervisors and examiners from outside of the department.

Course Outcomes:

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

1. Improve in skills to apply knowledge of sensor selection, circuit design, signal processing, conduct experiments, analyze and interpret data.
2. Implement existing or new technology for a proposed project work by applying programming and computing skills using technical software like MATLAB, LAB VIEW, etc.
3. Identify, formulate an engineering problem and implement through a scientific manner.
4. Develop ethical and social responsibilities by finding and implementing the needs of society for betterment of life and engage themselves in life-long learning.
5. Represent and communicate technical project efficiently to the audience.

Detailed Syllabus
M. Tech. in Applied Electronics and Instrumentation Engineering (AEIE)
2nd Year- 2nd Semester

Subject Name: POST-SUBMISSION DEFENSE OF DISSERTATION					
Paper Code: AEIE6221					
Contact hrs	L	T	P	Total	Credit points
per week:	0	0	0	0	4

The student has to continue the thesis work done in third semester. At the end of fourth semester the student will appear in examination (viva-voce) before the panel of examiners to defense his/her work done in dissertation.

Course Outcomes:

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

1. Represent and communicate a project work very efficiently to the audience.
2. Interpret experimental data and explain observations competently.
3. Respond to all types of questions from audience based on their presentation topic.

Subject Name: DISSERTATION (COMPLETION)					
Paper Code: AEIE6222					
Contact hrs	L	T	P	Total	Credit points
per week:	0	0	24	24	12

The Dissertation (Completion) is an extension of Dissertation Part - I. It shall be assessed internally by a panel of examiners (similar to the one formed in dissertation part- I) before submission to the Institute. The candidate shall submit the dissertation in triplicate in the prescribed format to the Head of the department/ M. Tech coordinator, duly certified that the work has been satisfactorily completed.

Course Outcomes:

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

1. Manifest themselves in industrial and research ambiances by growing skills and confidence.
2. Solve, analyze and execute technical projects in specified time frame.
3. Develop ethical and social responsibilities by fulfilling the needs of society for betterment of life and engage themselves in life-long learning.
4. Develop confidence for self-learning attitude for lifelong learning.

Subject Name: COMPREHENSIVE VIVA VOCE					
Paper Code: AEIE6223					
Contact hrs	L	T	P	Total	Credit points
per week:	0	0	0	0	4

Every student should appear before a panel duly constituted by the members of internal faculties of the department in order to evaluate his/her knowledge in various subjects learned during the two years of study of the M. Tech AEIE course.

Course Outcomes:

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

1. Appear interview smartly and confidently.
2. Judge themselves about their domain knowledge.
3. Develop habits of learning.