Department of Applied Electronics & Instrumentation Engineering

M.TECH in AEIE

COURSE STRUCTURE AND SYLLABUS

Release Date: July, 2018

PART-I: COURSE STUCTURE

Release Date: July, 2018

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

1st Year 1st Semester Course Structure:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Core 1	AEIE5101	Advanced Digital Signals and Systems	3	0	0	3	3
Core 2	AEIE5102	Programming Language for Embedded IoT Systems	3	0	0	3	3
	AEIE5103	Research Methodology and IPR	2	0	0	2	2
Prog. Specific Elective	AEIE5131/ AEIE5132/ AEIE5133	Elective-I (1) Micro-Electronic Devices and Circuits (2) Advanced Biomedical Instrumentation (3) Instrumentation and Industrial Automation	3	0	0	3	3
Prog. Specific Elective	AEIE5141/ AEIE5142/ AEIE5143	Elective-II (1) Mechatronics (2) Advanced Digital Control System (3)Advanced Optical Instrumentation	3	0	0	3	3
LAB	AEIE5151	Digital Signal Processing LAB	0	0	4	4	2
	AEIE5152	Programming Language LAB	0	0	4	4	2
Aud 1 Any one subject from the course list	DIMA5116	Disaster Management	2	0	0	2	0
	INCO5117	Constitution of India					
	PDLS5118	Personality Development through Life Enlightenment Skills.					
	YOGA5119	Stress Management by Yoga					
	SANS5120	Sanskrit for Technical Knowledge					
		Total	**16**	**0**	**8**	**24**	**18**

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1st Year 2nd Semester Course Structure:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Core 3	AEIE5201	Embedded Systems	3	0	0	3	3
Core 4	AEIE5202	Process Control System Design	3	0	0	3	3
Prog. Specific Elective	AEIE5231/ AEIE5232/ AEIE5233/	**Elective-III** (1) Micro Sensor Science and Technology (2) Advanced Power Electronics (3) Instrumental Methods of Analysis	3	0	0	3	3
Prog. Specific Elective	AEIE5241/ AEIE5242/ AEIE5243/	**Elective-IV** (1) Digital Image Processing (2) Statistical and Bio-signal Processing (3) Industrial Internet of Things	3	0	0	3	3
LAB	AEIE5251	Embedded Systems LAB	0	0	4	4	2
	AEIE5252	Process Control System Design LAB	0	0	4	4	2
	AEIE5293	Term Paper and Seminar	0	0	4	4	2
Aud 2		Audit course 2: **Any one subject from Elective III or Elective IV**	2	0	0	2	0
		Total	**16**	**0**	**8**	**26**	**18**

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Department of Applied Electronics & Instrumentation Engineering

2nd Year 1st Semester Course Structure:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Prog. Specific Elective	AEIE6131/ AEIE6132/ AEIE6133	**Elective-V** (1) Micro-Electromechanical System Design (2) VLSI Technology (3) Robotics Engineering	3	0	0	3	3
Open Elective	AEIE6121/ AEIE6122/ AEIE6123	**Elective-VI** (1) Remote Sensing (2) Artificial Intelligence (3) Intelligent Control	3	0	0	3	3
Major Project	AEIE6195	Dissertation Phase-1	0	0	20	20	10
		Total	**6**	**0**	**20**	**26**	**16**

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2nd Year 2nd Semester Course Structure:

Course Type	Course Code	Course Name	Contact Hrs Per Week				Credit Points
			L	T	P	Total	
Major Project	AEIE6295	Dissertation Phase- II	-	-	28	28	14
	AEIE6297	Comprehensive Viva-Voce	-	-	-	-	2
Total			**-**	**-**	**28**	**28**	**16**

Total course credit = 68

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PART-II: DETAILED SYLLABUS

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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

Subject Name: ADVANCED DIGITAL SIGNALS AND SYSTEMS					
Paper Code: AEIE5101					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [10L]

Discrete-Time Signals, Systems and Transforms:
Overview of DSP, Characterization of discrete time signals and systems, Sampling and, aliasing, Quantization error; Convolution and correlation, DFT and IDFT, FFT Algorithms, Introduction to - time frequency analysis, Short Time Fourier Transform, Continuous Wavelet Transform (CWT), and Discrete Wavelet Transform (DWT), Application of Wavelet Transform.

Module II - [9L]

Digital Filter Design Techniques and Structures:
Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR direct form-I and II, cascaded, parallel and lattice structures realization.

Module III-[10L]

Multirate Signal Processing and Adaptive Filtering:
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.
Adaptive Filters- Principles of adaptive filtering, LMS and RLS algorithms, Applications in noise and echo cancellation.

Module IV- [10L]

Linear Prediction, Optimum Linear Filters and Power Spectral Estimation:

Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.
Estimation of Spectra from finite-duration observations of signals, Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

References:

1. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 4th ed., Prentice Hall, 2007.
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, 2002.
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. S. Haykin, *Adaptive Filter Theory*, 4th Edition, Prentice Hall, 2001.
7. D. G. Manolakis, V. K. Ingle and S. M. Kogon, *Statistical and Adaptive Signal Processing*, McGraw Hill, 2000
8. A.V. Oppenheim, R.W. Schaffer and John R. Buck, *Discrete Time Signal Processing*, 3rd Edition, Prentice-Hall Signal Processing Series, 2009.
9. A. Nagoor Kani, *Signals and Systems,* McGraw Hill Education (India) Privet Limited, New Delhi, 2013.

Course Outcome:

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

1. Characterize and analyze the properties of discrete time signals and systems and compute signal transforms.
2. Design digital FIR and IIR filters according to the given specification.
3. Understand theory of multirate DSP and adaptive filtering techniques, solve numerical problems.
4. Understand theory of prediction and solution of normal equations.

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Subject Name: PROGRAMMING LANGUAGE FOR EMBEDDED IOT SYSTEMS					
Paper Code: AEIE 5102					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**0**	**3**

***Module I* – [Introduction to IoT]**

IoT-An Architectural Overview, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Everything as a Service (XaaS), M2M and IoT Analytics,

***Module II* - [Languages for IoT]**

Introduction to Python 2.7 - I/O statements, condition statements, loops, functions, classes, Python packages (i.e. serial, os, JSON, urllib, httplib), publishing messages to the cloud using PubNub, MQTT broker with python client, Introduction Android Things on Raspberry Pi 3 using Java/Kotlin,

***Module III*-[Introduction to Cloud]**

Introduction to Cloud Computing, Platform for Internet of Things and Analytics using ThingSpeak and PubNub, Real time sensor (i.e. LM35, DHT 11, MQx gas sensors) data acquisition using NodeMCU and ESP8266 for Arduino, Introduction to Python for microcontrollers

***Module IV*-[Cloud services for IoT]**

Development environments for cloud services; AWS IoT, Google App-cloud platform in for industrial IoT, Introduction to Android Studio for Android Things App development
Understanding the relationship between IoT and BigData, IoT Data analytics on cloud.

References:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st Edition, Academic Press, 2014.
2. Gaston C. Hillar, *Internet of Things with Python*, 1st Ed. Packet Publishing, 2016.
3. Peter Waher, *Learning Internet of Things*, PACKT publishing, BIRMINGHAM – MUMBAI
4. Bernd Scholz-Reiter, Florian Michahelles, *Architecting the Internet of Things*, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
5. Daniel Minoli, *Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications*, ISBN: 978-1-118-47347-4, Willy Publications.
6. Vijay Madisetti and ArshdeepBahga, *Internet of Things (A Hands-on-Approach)*, 1st Edition, VPT, 2014.

Course Outcome:

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

1. Understand the key features, design challenges and related to IoT systems
2. Learn the architecture of NodeMCU and develop IoT systems using it.
3. Demonstrate working knowledge of Micro Python.
4. Complete design of an IoT system with functional requirements for hardware and software components including processor, networking components and sensors, along with applications of cloud

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Subject Name: RESEARCH METHODOLOGY AND IPR					
Paper Code: AEIE5103					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**2**

Module I – [7L]

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Module II - [6L]

Effective literature studies approaches, analysis Plagiarism, Research ethics.
Effective technical writing, how to write report, Paper developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Module III-[7L]

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Module IV- [6L]

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. C. R. Kothari, *Research Methodology- Methods and Techniques*, 2nd ed., New Age International Publishers, 2004.
2. Stuart Melville and Wayne Goddard, *Research methodology: an introduction for science & engineering students.*
3. Wayne Goddard and Stuart Melville, *Research Methodology: An Introduction.*
4. Ranjit Kumar, 2nd Edition, *Research Methodology: A Step by Step Guide for beginners.*
5. Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd ,2007.

6. Mayall, *Industrial Design*, McGraw Hill, 1992.
7. Niebel, *Product Design*, McGraw Hill, 1974.
8. Asimov , *Introduction to Design*, Prentice Hall, 1962.
9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*, 2016.
10. T. Ramappa, *Intellectual Property Rights Under WTO*, S. Chand, 2008.

Course Outcome:

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

1. Understand research problem formulation.
2. Analyze research related information.
3. Follow research ethics.
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

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	SUBJECT NAME: MICRO-ELECTRONIC DEVICES AND CIRCUITS				
	Paper Code: AEIE5131				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

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 - [10L]
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 impedance and frequency response.
Analysis of two stage CMOS amplifier, IC-power amplifier, Switched capacitor filters

Module III-[10L]
Digital Integrated Circuits Analysis: Performance analysis of CMOS inverter, CMOS logic Circuits; Pass-transistor Circuits; Dynamic Logic Circuits.

Module IV-[9L]
Design of Analog Integrated Circuits: ADC, DAC, Trans-conductance and Trans-resistance amplifier.
Design of Digital Integrated Circuits: Flip-flops and multivibrator circuits; Dynamic MOS Storage Circuit; (Fussable) Programmable logic array: (Fussable) Logic gate array.

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.
5. C. G. Fonstad, *Microelectronic Devices and Circuits*, Electronic Edition, 2006.

Course Outcome:

After the completion of the course, the students will be able to:
1. Explain the production and fabrication process of microelectronic devices and integrated circuits.
2. Select MOS transistor as per datasheet parameters to design analog and digital building blocks.
3. Analyze the DC and AC performance of single-stage analog amplifiers.

4. Analyze analog electronic circuits of moderate complexity.
5. Explain the operation and features of common MOS logic inverter stages.
6. Design devices and circuits to meet stated operating specifications.

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Subject Name: ADVANCED BIOMEDICAL INSTRUMENTATION					
Paper Code: AEIE5132					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

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: Half-cell potential, Electrode-Electrolyte interface, Off-set potentials, Polarization- polarizable and non-polarizable electrodes, Ag/AgCl electrodes, motion artifact, Types and selection: Electrodes-surface, needle and micro electrodes and their electrical models.

Module III-[12L]

Biomedical signal processing:
Signal conditioners- OP-AMP,CMRR, filters, 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.

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.

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	Subject Name: INSTRUMENTATION AND INDUSTRIAL AUTOMATION				
	Paper Code: AEIE5133				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Module I – [9L]
Static and dynamic characteristics of sensors, Resistive, Inductive and Capacitive sensors and signal conditioning circuits.
Temperature, pressure, flow and level measurement techniques.

Module II - [10L]
pH and conductivity sensors. Piezoelectric and ultrasonic sensors and its applications in process. Measurement of viscosity, humidity and thermal conductivity.
Process Control: P-I-D Control, Controller Tuning, Special Control Structures: Feedforward and Ratio Control, Predictive Control, Cascade Control, Advanced Control Schemes. Process and Instrumentation Diagrams.

Module III - [11L]
Introduction to transmitters, two wire and four wire transmitters, Smart and intelligent Transmitters. Design of transmitters.
Introduction to safety, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures – NEMA types, Electrical and Intrinsic safety; Zener Barrier.

Module IV-[9L]
Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems.
PLC, DCS, SCADA

References:

1. B. G. Liptak, *Instrumentation Engineers Handbook (Measurement)*, Chilton Book Co.; 1994
2. John P. Bentley, *Principles of Measurement Systems*, Third edition, Addison Wesley Longman Ltd., UK, 2000.
3. E.O. Doebelin, *Measurement Systems - Application and Design*, Fourth edition, McGraw-Hill International Edition, New York, 1992.
4. U. A. Bakshi, A.V.Bakshi; *Instrumentation Engineering*; Technical Publications; 2009.
5. Harold E. Soisson; Instrumentation in Industry; John Wiley & Sons Canada, Limited, 1975.
6. B.E. Noltingk, *Instrumentation Reference Book*, 2nd Edition, Butterworth Heinemann, 1995.
7. L.D. Goettsche, *Maintenance of Instruments and Systems – Practical guides for measurements and control*, ISA, 1995.

Course Outcome:

Upon completing this course the student would learn thoroughly about

1. Basic measurement techniques, sensing and transducting of various physical quantities
2. Control methodology used in industry and automation
3. Industrial signal transmitter and safety in handling industrial instruments.
4. Process automation and architecture.

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Subject Name: MECHATRONICS					
Paper Code: AEIE5141					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [10L]

Overview of Mechatronic and Physical System Modeling :
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.
Introduction to System Modeling; Mechanical System, Electrical System, Fluid Systems, Thermal System, Translational and Rotational Mechanical System with spring, damper and mass.

Module II - [12L]

Transducers and Sensors and Actuators:
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.
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 III - [8L]

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. Logic System Design, Synchronous and Asynchronous Sequential System

Module IV - [9L]

Computers and Logic Systems, Software and Data Acquisition:
System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Architecture, Control with Embedded Computers and Programmable Logic Controllers.
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.

Course Outcome:

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

1. Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.
2. Apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems.
3. Understand the different types of actuation units to activate real time systems.

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Subject Name: ADVANCED DIGITAL CONTROL SYSTEM					
Paper Code: AEIE5142					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

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, the zero and first order holds, linear difference equations and discrete transfer functions, block diagrams, and block diagram reduction.
Stability analysis techniques- Jury's stability test, bi-linear transformation, 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. Understand Transformation technique from continuous to discrete domain.
2. Realize the fundamental principles for design of Digital Control system and will gain industrial application based knowledge for their implementations.

3. Developing algorithms for applications based various digital controllers and analysis of discrete control systems using various time and frequency domain tools.
4. Aware of advanced understanding of adaptive and self tuning principles and applications.

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Subject Name: ADVANCED OPTICAL INSTRUMENTATION					
Paper Code: AEIE5143					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [8L]

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 - [8L]

LED:

Structure, characterization,hetero-junction, power and efficiency calculations

Optical detectors:

PIN photodiode, avalanche photodiode, phototransistor,LDR, Photovoltaic cell.

Module III - [12L]

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.

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 – [11L]

Optical Fiber, Hologram and Medical applications:
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.
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. SterlingJr, *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.

Course Outcome:

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

1. Learn the techniques of communications using optical fiber.
2. Characterize structures and performance of LEDs and lasers.
3. Learn the structures and performance of photo detectors (like photo diode, PIN diode, APD etc).
4. Explain the techniques of measurement of distance, length, velocity, acceleration, current, voltage using laser. Formulate the structure of generalized measurement system.
5. Acquire knowledge on basic principle of holography and its uses in different fields such as nondestructive testing, medical field etc.

Heritage Institute of Technology
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Subject Name: DIGITAL SIGNAL PROCESSING LAB					
Paper Code: AEIE5151					
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. Discrete Fourier Transform, Fast Fourier Transform, Spectral Analysis with FFT, Time varying spectra, Spectrogram of Chirp Signal, Wavelet transform.
4. Design of FIR filters and their realizations.
5. Design of IIR filters and their realizations.
6. Design of decimator, interpolator and filter banks.
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, The fast Fourier transform (FFT), adaptive filtering.

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. Rulph Chassaing, *Digital Signal Processing and Applications with the C6713 and C6416 DSK*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2005.

Course Outcomes:

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

1. Determine time domain properties of the discrete time signals.
2. Apply various transforms in time and frequency.
3. Design different digital filters in software.
4. Perform decimation and interpolation.
5. Get an exposure on DSP processor and code composure studio for implementation of real time digital signal processing.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: PROGRAMMING LANGUAGE FOR EMBEDDED IOT SYSTEMS LAB					
Paper Code: AEIE 5152					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**4**	**4**	**2**

1. Introduction to NodeMCU and Arduino IDE for ESP8266
2. Experiments with GPIO devices:

a) Input: Push button, toggle switch, Temp sensor LM35

b) Output: Blink LED, Relay control, Rotate LEDs.

3. Programming Arduino UNO to connect with ESP8266-01
4. Experiments with WiFi on Thingspeak cloud

a) Send LM35 temperature data (publish)

b) Receive temperature data

d) Read data from cloud with Python client and print it on the console

5. Real time data publish of temperature and humidity data from DHT11 to Thingspeak cloud.
6. Configure Raspberry Pi 3 as IoT server using Python
7. Introduction to Android Studio for Android Things IoT service on Raspberry Pi 3
8. GPIO operations for Android Things using Java ME/Kotlin.
9. Programming NodeMCU with micro Python

Course Outcome:

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

1. Design and conduct experiments with input and output devices using a Node MCU.
2. Perform programming with cloud service using low power microcontrollers.
3. Interface a sensor with Node MCU for IoT applications.
4. Implement Android Things app using Java ME/Kotlin

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: DISASTER MANAGEMENT					
Paper Code: DIMA5116					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**0**

Course Objectives: -Students will be able to:
1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Syllabus

	Units	**CONTENTS**	**Hours**
Module -I	1	**Introduction on Disaster** Disaster: Definition Types of Disaster • Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc. • Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. • Differences, Nature and Magnitude • Factors Contributing to Disaster Impact and Severity • Repercussions of various types of Disasters o Economic Damage o Loss of Human and Animal Life o Destruction of Ecosystem o Outbreaks of Disease and Epidemics o War and Conflict Natural Disaster-prone areas in INDIA • Areas prone to o Earthquake o Floods and Droughts, o Landslides and Avalanches;	3

		○ Cyclonic And Coastal Hazards such as Tsunami; Trends of major Disasters and their Impact on India • Lessons Learnt from Recent Disasters	
	2	**Introduction to Disaster Management** What is Disaster Management Different Phases of Disasters Disaster Management Cycles Disaster Management Components • Hazard Analysis • Vulnerability Analysis • Prevention and Mitigation • Preparedness • Prediction and Warning • Response • Recovery Disaster Management Act, 2005 National Disaster Management Structure Organizations involved in Disaster Management	3
Module -II	1	**Overview on Hazard Analysis and Vulnerability Analysis** **Disaster Preparedness** • Disaster Risk Assessment, People's Participation in Risk Assessment • Disaster Risk Reduction • Preparedness Plans • Community preparedness: Emergency Exercises/ Trainings/Mock Drills	3
	2	**Disaster Prediction and Warning** • Activities ○ Tracking of disaster ○ Warning mechanisms ○ Organizational response ○ Public education ○ Communication ○ Evacuation planning • Current tools and models used for Prediction and Early Warnings of Disaster ○ Application of Remote Sensing	3

		○ Data From Meteorological and other agencies ○ Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe	
Module -III	1	**Disaster Response** • Crisis Management: The Four Emotional Stages of Disaster ○ Heroic Phase ○ Honeymoon Phase ○ Disillusionment Phase ○ Reconstruction Phase • Need for Coordinated Disaster Response ○ Search, Rescue, Evacuation, Medical Response and Logistic Management ○ Psychological Response and Management (Trauma, Stress, Rumor and Panic) • Role of Government, International and NGO Bodies	3
	2	**Post-disaster Situation Awareness** • Need for Situation Awareness in Post Disaster scenario • Challenges in communication of situational data from affected areas • Need for community-driven disaster management for reliable situation awareness • Crowd-sourcing of situational data: Issues and challenges **Post-disaster Damage and Need Assessment** • Current Trends and Practices – RAPID Damage and Need Assessment • SPHERE standards in Disaster Response • ICT based techniques for Post-disaster damage and need assessment	3
Module -IV	1	**Rehabilitation, Reconstructions and Recovery** • Reconstruction and Rehabilitation as a Means of Development. • Post Disaster effects and Remedial Measures • Creation of Long-term Job Opportunities and • Livelihood Options • Disaster Resistant House Construction • Sanitation and Hygiene • Education and Awareness • Dealing with Victims' Psychology • Long-term Counter Disaster Planning	3
	2	**Disaster Mitigation** • Meaning, Concept and Strategies of Disaster Mitigation • Emerging Trends in Mitigation • Structural Mitigation and Non-Structural Mitigation • Programs of Disaster Mitigation In India	3

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.
2. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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

Subject Name: EMBEDDED SYSTEMS					
Paper Code : AEIE 5201					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Module I – [8L]

Introduction to an Embedded System:
Embedded systems overview, design challenge, processor technology, IC technology, Design Technology, Trade-offs. Processors - Application Specific Instruction-Set Processors (ASIPs) Micro Controllers and Digital Signal Processors, Special Purpose Processors, I/O devices.

Module II - [12L]

Introduction to AVR microcontroller:
Introduction to AVR (ATmega 328p-pu) microcontroller, pin layout, architecture, program memory, Data Direction register (DDRx), Port Registers (PORTx), PWM registers (8-bit), ADC registers, basics of communication, overview and interfacing I/O devices with I^2C Bus, UART and Serial Peripheral Interchange (SPI) bus, introduction to AVR Studio and avrdude with GNU gcctoochain.

Module III - [8L]

Embedded Systems Software:
Introduction to Linux based operating systems and Linux commands (i.e. GNU bash), introduction to Embedded Linux (i.e. Arch and Debian) Real-time operatingsystems, introduction to Python 2.7 on Raspberry Pi

Module IV - [11L]

Programming Embedded Systems with AVR (Arduino API), ARM CPUs and case studies:
Introduction to ARMv8-A based embedded development board (i.e. Raspberry Pi rev.3), programming a Raspberry Pi rev.3 using Python 2.7, introduction to Arduino UNO rev.3, case study- speed control of a DC motor using an Arduino UNO rev.3, user defined LED

blink using Raspberry Pi GPIOs, communication between an Arduino UNO rev.3 with Raspberry Pi 3 over USB serial.

References:

1. Elliot Williams,*AVR Programming: Learning to Write Software for Hardware*, Maker Media, Incorporated, 2014
2. Silberschatz Galvin Gagne, *Operating System Concepts*, WILEY, 2014
3. Raj kamal, *Embedded Systems: Architecture, programming and design*, TMH, 2002.
4. David E. Simon , *An Embedded Software Primer* , Pearson Ed., 2005.
5. Arnold S Burger, *Embedded system design*, CMP.
6. KVKK Prasad, *Embedded / Real Time Systems*, Dreamtech Press, 2005.
7. Kraig Mitzner, *Complete PCB Design using ORCAD Capture and Layout*, Elsevier.
8. Woon-Seng Gan and Sen M. Kuo, *Embedded Signal Processing with the Micro Signal Architecture*, John Wiley & Sons, Inc., Hoboken, New Jersey 2007.
9. Dhananjay Gadre, *Programming and Customizing the AVR Microcontroller*, McGraw Hill Education, 2014.

Course Outcome:

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

1. Gain the knowledge in the area of embedded development of AVR microcontroller.
2. Justify the selection criteria for ARM based single board computers for needs in industrial environment.
3. Demonstrate working knowledge of programming Linux based systems used in industry applications.
4. Get ideas to develop embedded systems required in industry applications.
5. Get ideas to program embedded systems using Python.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	Subject Name: PROCESS CONTROL SYSTEM DESIGN				
	Paper Code: AEIE5202				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Module I – [9L]
Introduction to process control, control objectives and benefits.

Process modeling and identification: mathematical modelling principles, types of models, modelling and analysis for process control, empirical (linear) dynamic models, model structure considerations, model identification.

Process dynamics: characteristics of a few processes such as heat exchangers, boilers and condensers, model analysis and control, system order reductions.

Module II - [11L]
Optimization of process operation: introduction to real-time optimization, optimization and its benefits, hierarchy of optimization, issues to be addressed in optimization, degrees of freedom selection for optimization, procedure for solving optimization problems, problems in optimization, model building, and the objective function.

Designing process control systems – different approaches: supervisory, direct digital, distributed control system: architecture, communication data links, control information and display unit; redundancy, reliability, data transfer protocols, standard interfaces. SCADA architecture.

Module III - [11L]
Controller design: complex and nonlinear systems.

Adaptive control: introduction, deterministic self-tuning regulator: indirect and direct self-tuning regulator, model reference adaptive system: design of MRAS using MIT rule, gain scheduling control, application of adaptive controller in process.

Intelligent control: introduction, benefits and application scope of fuzzy logic, neural network and genetic algorithm in process control, fuzzy sets and crisp sets, design of fuzzy controller, industrial applications.

Module IV-[8L]
Variation of algorithm designs, comparisons. Case studies of specific control schemes such as temperature of oven/ furnace, thickness and flatness of rolled metal sheets, boiler drum level control, refinery crude oil distillation, resin plant - design details of the algorithm developed and the complete scheme.

References:

1. Thomas E. Marlin, *Process Control: Designing Processes and Control Systems for Dynamic Performance*, 2nd Edition, McGraw-Hill.

2. B. Roffel and B. H. L. Betlem, Advanced Practical Process Control, Springer-Veriag Berlin Heidelberg 2004.
3. J. R. Leigh, *Applied Digital Control*, Prentice Hall.
4. Deshpande & Ash, *Elements of Computer Process Control*, ISA.
5. C. L. Smith, *Digital Computer Process Control*, Intext Education Publishers, 1972.
6. Astrom, *Adaptive Control*, Pearson, 2nd Ed.
7. B. Sohlberg, *Supervision and Control for Industrial Processes*, Springer-Verlay, 1998.
8. M. Murari & E. Zafirion, *Robust Process Control*, Prentice Hall, 1989 –.

Course Outcome:

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

1. Explain the importance of process modeling, identification and analyze process dynamics.
2. Understand the process optimization and architecture of process control system like DCS and SCADA.
3. Design process control system applying different linear, nonlinear and soft-computing techniques.
4. Explain the control mechanism of different industrial processes.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: MICRO SENSOR SCIENCE AND TECHNOLOGY					
Paper Code: AEIE5231					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [12L]

Overview of Micro-Sensors Engineering Science for Design and Fabrication:
Principle of transduction**;** classification of micro-sensors; Chemical, thermal, pressure, acoustic, optical, electrical, mechanical, biological sensors, their calibration and determination of characteristics. 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 II - [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 III - [8L]

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

Module IV - [7L]

Testing and Packaging & Introduction to Smart Sensors:
Partitioning, Layout, Technology constraints, scaling, compatibility study; Scaling laws in Miniaturization. Examples of selected micro 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.

Course Outcomes:

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

1. Application of concepts on IC fabrication in sensor and understand the role of various semiconductor material in fabrication steps.
2. Analysis of sensor structural stability and their performance index based on their diaphragms geometrical mechanics, ability to choose various material types for various micro-fabrication processes.
3. Understand various types of sensor signal conditioning circuitry in real time applied systems.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	SUBJECT NAME: ADVANCED POWER ELECTRONICS				
	Paper Code: AEIE5232				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Module I – [10L]
Classification of Electric Drives, Requirements of Electric Drives, Some Applications -

Three-phase converters, effect of load and source impedances; multi-pulse converters, transformer utilization; Multi-pulse converters using delta/ zigzag/ Polygon transformers.

DC-DC converters-Cuk converter, ZETA converter

Module II - [10L]
Review of Three-phase voltage source inverters & Current source inverters, voltage and frequency control, transient voltage suppressing techniques

Harmonic reduction techniques, PWM inverters, Space Vector Modulation.

Multi-level inverters, advantages, configurations: Diode clamped, flying capacitor and cascade multi-level inverters. Introduction to Matrix converters.

Module III-[10L]
Speed-torque characteristics DC shunt, PMDC and series motors, Dynamic model, Speed and position control methods.

d-q model of induction motor, constant flux speed control structure, vector control model, vector control structure.

Module IV-[9L]
Evolution of HVDC Transmission, Comparison of HVAC and HVDC systems, Type of HVDC Transmission systems, Components of HVDC transmission systems, HVDC control Modes, Schemes and relative comparisons, Reactive power measurements, Converter protection, HVDC system application in wind power generation.

References:

1. N. Mohan, T. M. Underland and W.P. Robbins, *Power Electronics – Converters, Applications and Design*, 3rd Ed., Wiley, India, 2008.
2. S. N Singh, *Electric Power Generation, Transmission and Distribution*, PHI, New Delhi 2nd edition, 2008.
3. B. N. Sarkar, *Fundamentals of Industrial Drives*, PHI, 2011.
4. Teresa Orłowska-Kowalska, Frede Blaabjerg, José Rodríguez, *Advanced and Intelligent Control in Power Electronics and Drives*, Springer International Publishing, 2014

Course Outcome:
After the completion of the course, the students will be able to know:
1. DC Drive operations and implementations

2. The types, control mechanisms of three phase inverters
3. Speed and position control methods of DC motors
4. Control mechanisms and models of HVDC and HVAC Transmission lines.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: INSTRUMENTAL METHODS OF ANALYSIS					
Paper Code: AEIE5233					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [10L]

Basics of Analysis and Techniques: Qualitative and quantitative analysis, Sample Handling System (SHS), Steam and Water Analysis System (SWAS).
Electro-Analytical methods: REDOX reactions, Half-cells, Electrode potentials, Calculation of Cell potentials, Electrochemical cells.
Pollution Monitoring Analyzers: O_2, CO_x, NOx, SOx measuring analyzers, Particulate Analyzer.

Module II - [8L]

Radiation spectrometry: Electromagnetic Radiation and Electromagnetic Spectrum.
Absorption Spectroscopy: transmittance and absorbance, Beer-Lambert law
Ultraviolet-Visible absorption spectrometry, Infrared spectrometry, quantitative determination of different analytes effects of instrumental noise on analysis.

Module III - [10L]

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

Module IV - [11L]

Gas Chromatography: fundamental of chromatographic separation, chromatography column, instrumentation, Gas-Solid chromatography, application.
Liquid Chromatography: LC, HPLC, instrumentation. Applications in food, pharmaceutical, petrochemical, etc. industries.
Effluent Treatment Plant (ETP): Stages, Processes, BOD, Measurement of BOD .

References:

1. Skoog, Holler and Crouch, *Instrumental Analysis*, Cengage Learning, India, 2007.

2. R.D. Braun, *Introduction of Instrumental Analysis*, Pharma book syndicate, Hyderabad, 2006.
3. R. S. Khandpur, *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. D. Patranabis, *Principles of Industrial Instrumentation*, Tata McGraw Hill, New Delhi.

Course Outcomes:

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

1. Describe the basic techniques and instruments adopted for quantitative and qualitative analysis of samples.
2. Identify different components of spectrometers and acquire knowledge about their functioning.
3. State the fundamental properties of different types of chromatography and able explain their working principle and application.
4. Basic parameters and instruments used in Effluent treatment plant.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	SUBJECT NAME: DIGITAL IMAGE PROCESSING				
	Paper Code: AEIE5241				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Module I – [10L]

Introduction to Digital Image Processing & Image Transforms:
Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations; Color image fundamentals - Colour models, Conversion of colour models, Pseudo colour image processing, Full colour processing; Image Transforms- Need for image transforms, DFT, DCT, Walsh, Hadamard, Haar, KLT and Wavelet transforms.

Module II - [12L]

Image Enhancement and Restoration and Morphological Image Processing:
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. Dilation and Erosion, Opening and Closing, Boundary extraction, Region filling, Convex hull, Thinning, Thickening, Skeletons, Pruning.

Module III - [8L]

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 IV - [9L]

Image Segmentation, Representation, Description and Recognition:
Discontinuity based segmentation- Line detection, edge detection, thresholding techniques, Region based segmentation, boundary descriptors; Image Recognition - Patterns and pattern classes, Feature extraction, feature selection techniques, introduction to classification- supervised and unsupervised learning, Template matching, Bayes classifier, Introduction to - ANN and SVM classifiers, Cluster analysis- k-means method.

References:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, 3rd Edition, Prentice Hall, 2008..
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, NewYork, 2002.
5. Milman Sonka,Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, Brooks/Cole, Vikas Publishing House, II ed., 1999.

Course Outcomes:

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

1. Learn how images are formed, sampled, quantized and represented digitally and processed by discrete, linear, time-invariant systems.
2. Apply transformation algorithms such as DFT, DCT, Walsh, Hadamard, Haar, KLT and Wavelet transform to any given image.
3. Perform image enhancement, restoration and morphological operations on images.
4. Compress a given image by applying lossy and loss less image coding techniques.
5. Analyze a given image by segmentation, features extraction and using object recognition techniques.

Subject Name: STATISTICAL AND BIO-SIGNAL PROCESSING					
Paper Code: AEIE5242					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [12L]

Introduction:
Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, Analysis of variance. Hypotheses testing: The null and alternative hypothesis, Types of tests: t-test, f-test etc..
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.

Module II - [8L]

Regression and correlation:
Simple linear regression model, regression equation. Multiple regression and correlation model. Filtering Random Process, Special Types of Random Process- ARMV Process, AR Process, MA Process, Harmonic Process, prediction and probability of occurrence.

Module III - [11L]

Univariate signal:
Filters, Matched filters; Wiener filters Probabilistic models; Hidden Markov model; Kalman filter.
Multivariate signals:
Multivariate autoregressive model (MVAR); Formulation of MVAR model4; Formulation of MVAR model.

Module IV - [8L]

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.
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, NewDelhi,2005
6. Semmlow, *Biosignal and Biomedical Image Processing*, Marcel Dekker, 2004.
7. Bruce, *Biomedical Signal Processing*, Prentice Hall, 1993.

Course Outcomes:

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

1. Compute statistical measures such as central tendency, dispersion, variance, standard deviation, etc. of a given discrete ECG, EEG, EMG signal
2. Learn regression and correlation models and different random process such as –ARMV Process, AR Process, MA Process, Harmonic Process, etc.
3. Apply matched filter; Wiener and Kalman filter on bio-signals and develop probabilistic models, Hidden Markov models and multivariate autoregressive model (MVAR), etc.
4. Learn practical usage of ECG and EEG signal processing techniques.

Heritage Institute of Technology
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Subject Name: INDUSTRIAL INTERNET OF THINGS					
Paper Code: AEIE5243					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [11L]

IoT & Web Technology: The Internet of Things Today, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization. Recent trends in home automation: IOT-locks, Energy optimization in home. Development of sensor electronics — IoT vs legacy, and open source vs traditional PCB design style. Introduction to different Mobile app. platform for IoT.

Module II - [10L]

Development of sensor communication protocols, Protocols: Modbus, relay, Zigbee, nRF, Zwave, X10, Bluetooth, ANT, etc. Zigbee and Zwave — advantage of low power mesh networking. Long distance Zigbee. Introduction to different Zigbee chips. Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Wireless protocols such as Piconet and packet structure for BLE and Zigbee. Different kind of calibration Techniques: manual, automation, infield, primary and secondary calibration — and their implication in IoT.

Module III - [9L]

PCB vs FPGA vs ASIC design, Prototyping electronics vs Production electronics, QA certificate for IoT- CE/CSA/UL/IEC/RoHS/IP65, Basic Open source platforms: Arduino, Raspberry Pi, Beaglebone. M2M to IoT – A Basic Perspective– Introduction, An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module IV - [9L]

Available M2M cloud platform, Axeda Xively, Omega NovoTech, Ayla Libellium, CISCO M2M platform, AT &T M2M platform, Google M2M platform, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, IoT for Retailing Industry, IoT For Oil and Gas Industry.

References:

1. Vijay Madisetti and ArshdeepBahga, *Internet of Things (A Hands-on-Approach)*, 1st Edition, VPT, 2014.
2. Francis daCosta, *Rethinking the Internet of Things: A Scalable Approach to Connecting Everything*, 1st Edition, Apress Publications, 2013.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things: Key Applications and Protocols*, Wiley-Blackwell.
4. Cuno Pfister, *Getting Started with the Internet of Things*, O_Reilly Media, 2011.

Course Outcomes:

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

1. Determine the IoT architecture and application in various fields.
2. Understand building blocks of Internet of Things and characteristics.
3. Understand the concept of IoT and M2M.
4. Understand the security and privacy issues in IoT.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: EMBEDDED SYSTEMS LAB					
Paper Code : AEIE 5251					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**4**	**4**	**2**

1. Introduction to Atmel Studio 7.0 and Arduino IDE basics
2. Experiments with GPIO devices in Atmega 328p-pu (AVR):
   a) Input: Push Button using external and internal pull up.
   b) Output: Light LEDs, Flash LEDs (Delay Loop), Simple Delays Using Timer0, Rotate LEDs.
3. Programming with Timers to control servo position in an Atmega 328p-pu (AVR).
4. Experiments with Atmega 328p-pu (AVR) ADC:
   a) LDR based intensity measurement
5. Interfacing MPU 6050 accelerometer using Arduino UNO
6. Speed control of DC motor using PWM in Arduino UNO.
7. Programming Raspberry Pi 3 GPIOs using Python 2.7.
8. Programming UART application in Arduino UNO
9. Interfacing Arduino UNO with Raspberry Pi 3 over USB serial

Course Outcome:

After the completion of the course students will be able to:
1. Design and conduct experiments with input and output devices using an AVR microcontroller.
2. Perform programming with PORT, ADC registerin anAVR microcontroller.
3. Interface a sensor with and AVR microcontroller and monitor its input by displaying the measured value in a PC.
4. Implement USB communication between a Raspberry Pi and Arduino.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: PROCESS CONTROL SYSTEM DESIGN LAB					
Paper Code : AEIE 5252					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**4**	**4**	**2**

1. Study of boiler drum and burner management system using Boiler SIM software.
2. P, PI, PID controller tuning for different simulation processes.
3. Real time DC motor speed control and furnace temperature control using PI/PD/PID controller.
4. Study the system modeling techniques using Model identification Toolbox.
5. Design of adaptive controller – model reference adaptive controller (MRAC), self-tuning regulator (STR).
6. Dual control scheme for crane position and swing angle control of a digital pendulum.

Course Outcome:

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

1. Understand the activity and importance of boiler drum in an industry.
2. Simulate, tune and control different processes.
3. Understand principle of modeling and control.
4. Design adaptive schemes for effective control.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: TERM PAPER AND SEMINAR					
Paper Code: AEIE5293					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**4**	**4**	**2**

The students are required to search/gather the material/information on a specific a topic comprehend it and present/discuss in the class. The paper topic should be relevant 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 students should submit a report consist of a preliminary outline of paper, a list of the references that they have reviewed to date, a short statement of the findings of the paper and analysis of how this information fits, or does not fit, into the paper. 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.

Course Outcomes:

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

1. Understand of contemporary/emerging technology for various processes and systems.
2. Share knowledge effectively in oral and written form and formulate documents.