Applied Electronics & Instrumentation Engineering Department

SYLLABUS FOR M.TECH. PROGRAMME

Release date: June, 2019

PART-I: COURSE STUCTURE

Release date: June, 2019

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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

1st Year 1st Semester Syllabus:

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) Medical 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**

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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

1st Year 2nd Semester Syllabus:

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**

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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	
Prog. Specific Elective	AEIE6131/ AEIE6132/ AEIE6133 AEIE6134	**Elective-V** (1) Micro-Electromechanical System Design (2) VLSI Technology (3) Robotics Engineering (4) Remote Sensing	3	0	0	3	3
Open Elective* (Any one subject from the course list)	AEIE6121/ AEIE6122/ CSEN6121/ CSEN6122/ MATH6121	**Elective-VI** (1) Biosignal and Biomedical Image Processing (2) Intelligent Control (3) Business Analytics (4) Advanced Artificial Intelligence (5) Optimization Techniques	3	0	0	3	3
Major Project	AEIE6195	Dissertation Phase I	0	0	20	20	10
		Total	**6**	**0**	**20**	**26**	**16**

2nd Year 2nd Semester Syllabus:

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

*The detail syllabus of Open Elective subjects are available from Open Electives Link

Heritage Institute of Technology
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PART-II: DETAILED SYLLABUS

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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 – [9L]

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-[9L]

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- [9L]

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.

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.
2. Perform DFT, FFT and IDFT of a given discrete signal and learn STFT and DWT of discrete signal.
3. Design digital FIR and IIR filters according to the given specification.
4. Realize a digital filter structure from it's transfer function.
5. Understand theory of multirate DSP and adaptive filtering techniques, solve numerical problems.
6. Understand theory of prediction, solution of normal equations and methods of spectral estimation.

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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 **[10L]-**

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 **[9L]**

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**-[9L]**

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**-[8L]**

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. Interpret the vision of IoT from a global context.
2. Understand the key features, design challenges and related to IoT systems.
3. Learn the architecture of NodeMCU and develop IoT systems using it.
4. Demonstrate working knowledge of Micro Python.
5. Design an IoT system with functional requirements for hardware components including processor, networking components and sensors.
6. Develop an IoT system with 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 – [6L]

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.

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-[6L]

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 and its solution approches.
2. Analyze research related information.
3. Learn how to write report and research proposal following research ethics.
4. Judge importance of intellectual property and patent rights and learn the process of obtaining them.

Heritage Institute of Technology
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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 - [9L]
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. Analysis of two stage CMOS amplifier, IC-power amplifier

Module III-[9L]
Digital Integrated Circuits Analysis: Performance analysis of CMOS inverter, CMOS logic Circuits; Pass-transistor Circuits; Dynamic Logic Circuits.

Module IV-[8L]
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) 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.

Heritage Institute of Technology
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Subject Name: MEDICAL INSTRUMENTATION					
Paper Code: AEIE5132					
Contact hrs per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

Module I – [8L]

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 - [8L]

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-[8L]

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. Design signal processing hardware circuits.
5. Learn various therapeutic devices.
6. 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 - [9L]
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-[8L]
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 will be able to

1. Analyse the characteristics of resistive, inductive and capacitive sensors.
2. Learn various process variable measuring instruments.
3. Learn to read and draw the P&I diagrams.
4. Apply the knowledge of various control methodologies in industrial automation.
5. Learn industrial signal transmitter and safety in handling industrial instruments.
6. Explain the 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 – [8L]

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, Filters- active and Passive, Oscillator, Multivibrator. Logic Systems-Synchronous and Asynchronous Sequential System Design.

Module IV - [8L]

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, 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. Design a machatronic system.
2. Identification of key elements of mechatronics system and its representation in terms of block diagram
3. Gain knowledge of different types of Sensors required for developing mechatronics systems.
4. Know the functions of different types of Actuators and identify their application areas.
5. Understand the concept of signal conditioning and use of interfacing systems such as comparetor, filters, amplifiers, etc.
6. Learn the concept of computer interfacing, networking, embedded systems, ADC, DAC and data logging 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 - [8L]

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-[8L]

Adaptive Control and Self Tuning: Gain scheduling, Model reference adaptive control, Self-tuning regulators, Cascade control, and 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. Learn various digital control algorithms for dusigning digital controllers.
4. Develope algorithms for applications based various digital controllers
5. Learn analyze different discrete control systems using various time and frequency domain tools.
6. 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 - [11L]

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 – [9L]

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. Learn the fundamentals of LASER.
5. Explain the techniques of measurement of distance, length, velocity, acceleration, current, voltage using laser. Formulate the structure of generalized measurement system.
6. Acquire knowledge on basic principle of holography and its uses in different fields such as nondestructive testing, medical field etc.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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. Generate different types of sequences and perform operations on them using MATLAB.
2. Write MATLAB programs to determine time domain properties of the discrete time signals.
3. Perform DFT, FFT and IDFT of discrete signals in MATLAB.
4. Design FIR and IIR digital filters and implement decimator, interpolator and filter banks of discrete signals using MATLAB.
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.
    c) 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 Node MCU 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 IIoT cloud service using low power microcontrollers and Raspberry Pi.
3. Interface a sensor with Node MCU for IoT applications.
4. Implement Android Things app using Java ME/Kotlin
5. Perform programming with MicroPython.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Audit Course Syllabus

Course Name : DISASTER MANAGEMENT					
Course Code: CSEN5116					
Contact Hours Per Week	L	T	P	Total	Credit Points
	2	0	0	2	0

Module I (6L)

Introduction on Disaster:

- Introduction on Disaster - Disaster: Definition; Types of Disaster
- Natural Disaster: such as Flood, Cyclone, Earthquakes, Land slides 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 Economic Damage; Loss of Human and Animal Life; Destruction of Ecosystem; Outbreaks of Disease and Epidemics; War and Conflict
- Natural Disaster-prone areas in INDIA - Areas prone to; Earthquake; Floods and Droughts; Landslides and Avalanches; Cyclonic And Coastal Hazards such as Tsunami;
- Lessons Learnt from Recent Disasters

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

Module -II (6L)

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

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; Data From Meteorological and other agencies; Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe

Module -III (6L)

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

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

Module -IV (6L)

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

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

References:

1. R. Nishith, A.K. Singh, *Disaster Management in India: Perspectives, issues and strategies*, New Royal book Company.

2. P. Sahni et.al. (Eds.), *Disaster Mitigation: Experiences and Reflections*, Prentice Hall of India, New Delhi.
3. S. L. Goel, *Disaster Administration and Management Text and Case Studies*, Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Outcomes:

After the completion of this course, students should 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.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Course Name : CONSTITUTION OF INDIA					
Course Code: INCO5117					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

Module I (8L)

- History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working)
- Philosophy of the Indian Constitution: Preamble, Salient Features

Module II (4L)

- Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Module III (4L)

- Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Module IV (8L)

- Local Administration: District's Administration head: Role and Importance; Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation; Pachayati raj: Introduction, PRI: ZilaPachayat; Elected officials and their roles; CEO ZilaPachayat: Position and role; Block level: Organizational Hierarchy (Different departments); Village level: Role of Elected and Appointed officials, Importance of grass root democracy
- Election Commission: Election Commission: Role and Functioning; Chief Election Commissioner and Election Commissioners; State Election Commission: Role and Functioning; Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1. *The Constitution of India*, 1950 (Bare Act), Government Publication.

2. Dr. S. N. Busi, *Dr. B. R. Ambedkar framing of Indian Constitution*, 1st Edition, 2015.
3. M. P. Jain, *Indian Constitution Law*, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, *Introduction to the Constitution of India*, Lexis Nexis, 2015.

Course Outcomes:

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

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Course Name : PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS					
Course Code: PDLS5118					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.

Module I (6L)

Neetisatakam-Holistic development of personality:

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

Module II (6L)

Approach to day to day work and duties:

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,

Module III (6L)

Statements of basic knowledge:

- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18

Module IV (6L)

Personality of Role model:

- Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

References

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication 2. Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes:

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

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Course Name : STRESS MANAGEMENT BY YOGA					
Course Code: YOGA5119					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Module I (6L)

- Definitions of Eight parts of yog. (Ashtanga)

Module II (6L)

Yam and Niyam:
Do`s and Don't's in life.

- Ahinsa, satya, astheya, bramhacharya and aparigraha
- Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Module III (6L)

Asan and Pranayam:

- Various yog poses and their benefits for mind & body

Module IV (6L)

- Regularization of breathing techniques and its effects-Types of pranayam

References:

1. 'Yogic Asanas for Group Tarining-Part-I" Janardan Swami Yogabhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Course Outcomes:

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

1. Develop healthy mind in a healthy body thus improving social health.
2. Improve efficiency.

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Course Name : SANSKRIT FOR TECHNICAL KNOWLEDGE					
Course Code: SANS5120					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**0**	**0**	**2**	**0**

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
2. Learning of Sanskrit to improve brain functioning.
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects.
4. Enhancing the memory power.
5. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Module I (6L)

- Alphabets in Sanskrit,
- Past/Present/Future Tense,

Module II (6L)

- Simple Sentences
- Order

Module III (6L)

- Introduction of roots
- Technical information about Sanskrit Literature

Module IV (6L)

- Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

References:

1. “Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Outcomes:

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

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

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 – [9L] ***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 - [10L] ***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 - [9L] ***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 - [8L] ***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- 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. Design embedded systems required in industry applications.
5. Write programs for embedded systems using Python.
6. Learn techniques to develop applications using SPI/I2C bus.

Heritage Institute of Technology
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	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 – [8L]
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 - [10L]
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 - [10L]
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. Address the importance of optimization and solve the the optimization problem.
3. Understand the architecture of process control system like DCS and SCADA.
4. Apply their knowledge of adaptive control for effective process control.
5. Design process control system applying different linear, nonlinear and soft-computing techniques.
6. Explain the control mechanism of different industrial processes.

Heritage Institute of Technology
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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 – [10L]

Overview of Micro-Sensors Engineering Science for Design and Fabrication:
Principle of transduction**;** classification of micro-sensors; Chemical, thermal, pressure, acoustic, optical, electrical, mechanical and 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 - [11L]

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, 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.

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]

Micro-manufacturing techniques & Introduction to Smart Sensors:
Overview of micro-manufacturing techniques: Bulk Micro-machining, Surface Micro-machining, LIGA. 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. Gain the concept of transduction principle in micro-sensors.
2. Understand the atomic structure of matter, dopinig process, ionization process and diffusion in semiconductor.
3. Learn the process microfabrication technology.
4. Identify the pattern generation and transfer process like masking, photolithography, etc.
5. Learn different types of materials used in microsensor fabrication.
6. Understand various types of micro-manufacturing techniques and concept of smart sensors.

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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 – [9L]
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

Module II - [9L]

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.

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-[8L]
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.

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:

1. Describe DC Drive operations and implementations
2. Compare between performance of Voltage source and current source inverters

3. Differentiate among multi-level inverters.
4. Analyze speed and position control methods of DC motors
5. Explain control of induction motors
6. Explain control mechanisms and models of HVDC and HVAC Transmission lines

Heritage Institute of Technology
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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 and applications.

Module IV - [8L]

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.

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. Learn 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. Explain the UV-VIS, IR and FTIR spectrophotometers
4. Learn atomic spectrophotometric analysis.
5. Learn Raman and X-Ray-based spectrophotometric analysis.
6. Apply the chromatographic techniques for various analytical applications.

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, Hadamard, Haar and Wavelet transforms.

Module II - [10L]

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. Morphological operations- Dilation and Erosion, Opening and Closing, Boundary extraction.

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 - [8L]

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, 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. Learn segmentation of a given image by line, edge and boundary detection and thresholding and region based techniques.
6. Gain concept of analyzing an imege by features extraction and object recognition techniques.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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 – [10L]

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 - [10L]

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 of a signal.
2. Describe and apply various Hypotheses testing techniques.
3. Stochastic and deterministic analysis of ECG, EEG, and EMG signals.
4. Learn regression and correlation models and different random process such as –ARMV Process, AR Process, MA Process, Harmonic Process, etc.
5. Apply matched filter; Wiener and Kalman filter on bio-signals and develop probabilistic models, Hidden Markov models and multivariate autoregressive model (MVAR), etc.
6. Learn practical usage of ECG and EEG signal processing techniques.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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 – [9L]

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.

Module II - [9L]

Development of sensor communication protocols, Protocols: Modbus, relay, Zigbee, 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.

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 IIoT architecture and application in various fields.
2. Distinguish building blocks of Internet of Things and characteristics.
3. Outline the concept of NB-IoT and LoRa.
4. Realize the importance of security and privacy issues in IIoT.
5. Interprete the concept of IIoT and M2M.
6. Point out the applications of IIoT in various industries.

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: 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 and I2C bus registers in an AVR 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.
5. Perform interfacing with GPIO of Raspberry Pi.

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. Perform tuning of different conventional controllers.
3. Control different processes by designing controllers in simulation and real time environment.
4. Design different adaptive schemes for effective control.
5. Apply dual control scheme for crane position and angle 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 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. Learn how to write a technical document.
3. Demonstrate the ability to deliver technical seminar.
4. Interact effectively with audience to share knowledge and views.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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
	3	0	0	3	3

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: [10L]

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; Overview of Finite Element Method.

Module III: [11L]

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; Heat Conduction Mechanics- Fourier Law of Heat Conduction, Heat conduction Equations with Cooling Law, Solid-Fluid Interaction, Boundary Conditions.

Module IV: [10L]

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 Facture Analysis, Mechanical Design Using Finite Element Method: Finite element Formulation, Simulation of Micro-fabrication Process; Design of Silicon Die for a Micro-pressure Sensor.

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. Learn the significance of mechanical characteristics varies that with design.
2. Design MEMS-based diaphragm type devices analytically.
3. Fabricate the whole MEMS system with the help of simulation software.
4. Develop micro-fluidic system for biomedical applications.
5. Gain knowledge to design with finite element method based simulation process.
6. Develop skill on engineering mechanics for micro-system design.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Course Name: VLSI TECHNOLOGY					
Course Code : AEIE6132					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Module I- [11L]
Digital VLSI Circuits & Physical Layout:

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.
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 II- [9L]
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 III-[8L]
Hardware Description Language:
Introduction to HDL and VHDL/Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed Mode combinational and sequential circuits with various examples, FSM Example: Mealy Machine and Moore Machine.

Module IV- [8L]
Analog VLSI Circuits:
Basic building blocks of Analog VLSI Chips, Analog VLSI Design Steps, MOS switch, MOS Diode, MOS Resistor, CMOS Current Source/Sink, Active Load, Voltage Dividers, CMOS Current Mirror, CMOS Cascode Current Sink and Current Mirror, CMOS Voltage Reference / Bandgap Reference.
CMOS Differential Amplifiers with passive and active load, Differential Gain, Common Mode Gain, CMRR, Ideal OPAMP, 2 Stage CMOS OPAMP, Switched Capacitor Filter and Integrator.

References

1. Neil Weste and Kamran Eshraghian, *Principles of CMOS VLSI Design, A Systems Perspective*, Addison Wesley, 2nd Edition, 2000.
2. Phillip E. Allen and Douglas R. Holberg, *CMOS Analog Circuit Design*, 2nd Ed., Oxford.
3. Sung-Mo Kang and Yusuf Leblebici, *CMOS Digital Integrated Circuits, Analysis and Design*, Tata McGraw Hill, 3rd Edition, 2006.

4. Neil Weste, David Harris and Ayan Banerjee, *CMOS VLSI Design, A Circuits and Systems Perspective*, 3rd Ed., Pearson, 2011.
5. M. Rabaey, *Digital Integrated Circuit- Design Perspective*, Prentice-Hall.
6. Angsuman Sarkar, Swapnadip De and Chandan Kumar Sarkar, *VLSI Design and EDA Tools*, Scitech Publications (India) Pvt. Ltd., 2011.
7. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw Hill.
8. 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.
5. Explain the fundamental principles of analog VLSI circuits.
6. Design models of moderately sized analog VLSI circuits for specified analog computing.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

Subject Name: ROBOTICS ENGINEERING					
Paper Code: AEIE6133					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Module I [8L]

Introduction to robotics, applications, elements of robots:
Introduction – progressive advancement in robots, laws of robotics, robot anatomy- links, joints, degree of freedom, manipulator and end effectors.
Industrial applications- material handling, processing, assembly, inspection; robot safety, non-industrial applications.

Module II [10L]

Direct and inverse kinematic model of robots:
Direct kinematic- description and structure of components, direct kinematic modeling of the manipulator, Denavit-Hartenberg (D-H) notation, kinematic relationship between adjacent links and manipulator transformation matrix, kinematic model examples.
Inverse kinematic- inverse kinematic technique, solvability of inverse kinematic model, inverse kinematic model examples.

Module III [9L]

Static and dynamic analysis of robot manipulators:
Manipulator differential motion and statistics- linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, mapping of velocity vector and velocity propagation along links.
Dynamic modeling- Lagrangian mechanics, dynamic model of two degree of freedom manipulator.

Module IV [9L]

Robotic sensors and control of manipulators:
Robotic sensors- kinds of sensors used in robotics, industrial applications of vision – controlled robotic systems.
Control of manipulators- linear control schemes, characteristics of second order linear systems, partitioned PD control scheme, PID control, hybrid control, applications.

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 robot anatomy by identifying its different components.
2. Know the potential area of application of robot.
3. Formulate direct and inverse kinematics model of robots for different degree of freedom robot manipulators.
4. Perform static and dynamic model analysis of robot manipulator.
5. Understand the applications of vision-controlled robotic systems and find the proper sensors used in robotics.
6. Choose and apply proper control strategy for second order linear systems model.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	SUBJECT NAME: REMOTE SENSING				
	Paper Code: AEIE6134				
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

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 - [10L]

Image Acquisition and Photogrammetry:

Arial Photography, Flight lines, Flight planning; Thermal Infrared Remote Sensing; 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); Photogrammetry- Scale and height measurement, Stereoscopic measurement of object height or Terrain Elevation, Area measurement.

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.

Module IV-[8L]

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 algorithms; Supervised classification- Bayesian classification strategy, Introduction to Neural Networks and Support Vector Machines (SVM), Decision rules: dissimilarity functions; Post-classification processing- smoothing and accuracy assessment, 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. Understand and describe the key theoretical components involved in the remote sensing data collection process such as, energy sources, energy-terrain-atmosphere interactions, platforms and sensor resolution characteristics spanning multispectral and hyperspectral.
2. Gain knowledge of thermal remote sensing, active microwave remote sensing such as RADAR, LIDAR and synthetic aperture RADAR.
3. Perform photogrammetric calculations such as scale factor, height, area, etc. from vertical aerial photographs.
4. Learn essential image processing techniques such as image enhancement, restoration and filtering of noise, etc.
5. Carry-out basic arithmetic operations and correction procedures such as geometric, radiometric and atmospheric corrections on image.
6. Acquire knowledge of machine learning techniques of remote sensing data analysis.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	SUBJECT NAME: DISSERTATION PHASE I				
	Paper Code: AEIE6195				
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	20	20	10

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 Phase I shall consist of the following division(s) whichever applicable:

1. Introduction
2. Aims and objective of the work
3. Extensive literature survey and evaluation of unsolved issue
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 related to thesis

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. Demonstrate ability to identify and formulate real world engineering problems relevant to society needs; study its feasibility and methodology for implementation.
2. Apply knowledge of circuit design, sensor selection, signal processing, artificial intelligence, intelligent control system, embedded system and programming, etc., to implement the project work with proper time frame.
3. Implement hardware model along with its relevant software programming, conduct experiments, analyze and interpret data and explain them.
4. Prepare project report properly and demonstrate presentation confidently.
5. Develop regularity, engage in enduring learning and deal existing project ethically.
6. Build up interpersonal communication skill and demonstrate sound technical knowledge of their project work.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

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

	SUBJECT NAME: DISSERTATION PHASE II				
	Paper Code: AEIE6295				
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	28	28	14

The Dissertation Phase II is an extension of Dissertation Phase I. It shall be assessed internally by a panel of examiners (similar to the one formed in dissertation Phase 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. Demonstrate ability to identify and formulate real world engineering problems relevant to society needs; study its feasibility and methodology for implementation.
2. Apply knowledge of circuit design, sensor selection, signal processing, artificial intelligence, intelligent control system, embedded system and programming, etc., to implement the project work with proper time frame.
3. Implement hardware model along with its relevant software programming, conduct experiments, analyze and interpret data and explain them.
4. Prepare project report properly and demonstrate presentation confidently.
5. Develop regularity, engage in enduring learning and deal existing project ethically.
6. Develop interpersonal communication skill and demonstrate sound technical knowledge of their project work.

Heritage Institute of Technology
Department of Applied Electronics & Instrumentation Engineering

	SUBJECT NAME: COMPREHENSIVE VIVA VOCE				
	Paper Code: AEIE6297				
Contact hrs per week:	L	T	P	Total	Credit points
	0	0	0	0	2

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. Answer questions from all the courses studied.
2. Attain Oral Presentation skills by answering questions in precise and concise manner.
3. Appear interview elegantly and confidently.
4. Develop habits of learning.