BRANCH-APPLIED ELECTRONICS & INSTRUMENTATION ENGINEERING

Specialization: Electronics & Instrumentation Engineering/ Applied Electronics & Instrumentation Engg

Theory					Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Fiber Optics & LASER Instrumentation	4-0	4	100	50	-	-	-
Specialization Core-2 Industrial Process Control Instrumentation	4-0	4	100	50	-	-	-
Elective-I (Specialization related) 1 .Biomedical instrumentation & Signal Processing 2.Analytical Instrumentation 3. Microsystems Principle, Design and Application 4.Digital & Adaptive Control 5.Digital & IC Based Instrumentation	4-0	4	100	50	-	-	-
Elective-II (Departmental related) 1. Non-Linear Systems 2. Adaptive Signal Processing. 3. Virtual Instrumentation 4.Micro Controller & Embedded Systems	4-0	4	100	50	-	-	-
Elective-III (from any Department) 1.Data Encryption and Security 2.Industrial Automation & Robotics 3.Bio-mems & nanotechnology 4.Bio Informatics	4-0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the Department) Modeling & Simulation Laboratory					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

FIBER OPTICS AND LASER INSTRUMENTATION

MODULE – I (11 hours)

Optical Fibers and their Properties : Principles of light propagation through a fiber, Different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion, Optical fiber measurement, Optical sources, Optical detectors, LED-LD-PIN and APD.

Industrial Application of Optical Fibers: Fiber optic sensors, Fiber optic instrumentation system, Different types of modulators, Detectors, Application in instrumentation, Interferometric method of measurement of length, Moiré fringes, Measurement of pressure, temperature, current, voltage, liquid level and strain, Fiber optic gyroscope, Polarization maintaining fibers.

MODULE – II (11 hours)

Laser Fundamentals: Fundamental characteristics of Lasers, Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Q-switching and mode locking, Cavity dumping, Types of lasers: gas lasers, solid lasers, liquid lasers, semi conductor lasers.

Industrial Application of Lasers: Laser for measurement of distance, length velocity, acceleration, current, voltage and atmospheric effect, Material processing, Laser heating, welding, melting and trimming of materials, Removal and vaporization.

MODULE – III (12 hours)

Hologram and Medical Application : Holography, Basic principle, methods, Holographic interferometry and applications, Holography for non-destructive testing, Holographic components, Medical applications of lasers, Laser and tissue interaction, Laser instruments for surgery, Application of Laser for removal of tumours, brain surgery, plastic surgery, gynaecology and oncology.

Textbooks:

1. John and Harry, Industrial Lasers and their Applications, McGraw Hill, 1974.
2. Senior J.M., Optical Fiber Communication Principles and Practice, Prentice Hall, 1985.

Recommended Reading:

1. John F Read, **Industrial Applications of Lasers**, Academic Press, 1978
2. MonteRoss, **Laser Applications**, McGraw Hill, 1968
3. Keiser G., **Optical Fiber Communication**, McGraw Hill, 1991
4. Jasprit Singh, **Semiconductor Optoelectronics**, McGraw Hill, 1995
5. Ghatak A.K and Thiagarajar K, Optical Electronics Foundation Book, TMH, New Delhi, 1991.

INDUSTRIAL PROCESS CONTROL INSTRUMENTATION
(Will be uploaded soon)

BIOMEDICAL INSTRUMENTATION AND SIGNAL PROCESSING

MODULE – I (10 hours)

Introduction: Cell structure, basic cell function, origin of bio-potentials, electric activity of cells.

Biotransducers: Physiological parameters and suitable transducers for its measurements, operating principles and specifications for the transducers to measure parameters like blood flow, blood pressure, electrode sensor, temperature, displacement transducers.

MODULE – II (12 hours)

Cardiovascular system: Heart structure, cardiac cycle, **ECG** (electrocardiogram) theory (B.D.), **PCG** (phonocardiogram). **EEG, X-Ray, Sonography, CT-Scan**,The nature of biomedical signals.

Analog signal processing of Biosignals: Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits, Active filters, Rate Measurement. Averaging and Integrator Circuits, Transient Protection circuits.

MODULE – III (13 hours)

Time-frequency representations: Introduction, Short-time Fourier transform, spectrogram, wavelet signal decomposition.

Biomedical applications: Fourier, Laplace and z-transforms, autocorrelation, crosscorrelation, power spectral density.

Noise: Different sources of noise, Noise removal and signal compensation.

Software based medical signal detection and pattern recognition.

TextBooks:

1. R S Kandpur, ***Handbook of Biomedical Instrumentation***, 2nd Edn, TMH Publication, 2003
2. E. N. Bruce, ***Biomedical Signal Processing and Signal Modelling***, John Wiley, 2001.

References

1. Wills J. Tompkins, Biomedical Digital Signal Processing, PHI.
2. M. Akay, Time Frequency and Wavelets in Biomedical Signal Processing, IEEE Press, 1998.
3. Cromwell, Biomedical Instrumentation and Measurements, 2nd Edn, Pearson Education.

ANALYTICAL INSTRUMENTATION

Module – I (12 Hours)

Introduction Introduction to Chemical Analysis, Classical and Instrumental Methods, Classification of Instrumental Techniques, Important Considerations in Evaluating an Instrumental Method. Absorption Methods

(a) Spectrometric UV and VIS Methods: Laws of Photometry, Instrumentation.
(b) IR Spectrometry: Correlation of IR Spectra with Molecular Structure, Instrumentation.
(c) Atomic Absorption Spectrometry: Principle, Instrumentation.

Emission Methods Flame, AC/DC Arc, Spark, Plasma Excitation Sources, Instrumentation.

Module – II (14 Hours)

Spectro-Fluorescence and Phosphorescence Spectrometer Instrumentation, Raman Spectrometer. Mass Spectrometer Ionization Methods, Mass Analyzers, Mass Detectors, FTMS. Chromatography Classification, Gas Chromatography, Liquid Chromatography, Instrumentation.

Module – III (14 Hours)

X-ray and Nuclear Methods X-ray Absorption, Fluorescence and Diffractometric Techniques, Electron-Microscope and Microprobe, ESCA and Auger Techniques, Nuclear Radiation Detectors.

NMR Spectroscopy Principle, Chemical Shift, Spin-Spin Coupling, Instrumentation, Types of NMR. Elector-Analytical Methods Potentiometry, Voltammetry, Coulometry Techniques.

Textbooks:

1. *Galen W. Ewing, **Instrumental Methods of Chemical Analysis**, 5th Edition, McGraw-Hill.*
2. *Willard, Merritt, Dean and Settle, **Instrumental Methods of Analysis**, 7th Edition, CBS Publishers, New Delhi.*

MICROSYSTEMS – PRINCIPLES, DESIGN AND APPLICATION

MODULE – I (11 hours)

Introduction: MEMS, MEMS Processing, Micromachining, Wafer Bonding, LIGA, MEMS Examples, Scaling Laws

MEMS Materials: MEMS Materials, Silicon, Crystal Defects, Mechanical Properties of Materials, Beams and structures, Piezoelectric Materials, Piezoresistive Materials

MEMS Sensor: Resistive and Capacitive methods, Strain gauges, Piezoresistivity, MEMS Capacitive Sensors, MEMS Position sensor, MEMS Pressure sensor

MODULE – II (11 hours)

MEMS Sensor (Continued): MEMS Accelerometer, MEMS Gyroscope, MEMS Gas Sensors, Cantilever Sensors

MEMS Actuator: Electrostatic MEMS actuators, Comb drives, MEMS RF resonator, Scratch drive, Inchworm motor, Piezoelectric MEMS actuators, Thermal MEMS actuators, Magnetic MEMS actuators

MODULE – III (12 hours)

Optical MEMS: MEMS Infrared sensor, Digital Mirror Displays, Grating Light Valve Displays, Micro-optical elements

Micro-fluidics, Chemical MEMS: Microfluidics – Fluid flow, Electro-osmotic flow, Electrophoresis, Micropumps, Microvalves, Fabrication Process for microfuidic chip, Lab-on-a-Chip, μ-TAS, Inkjet Printer Head

Bio MEMS: DNA Analysis, Micro-array Gene Chip, Micro-surgery, Drug delivery

Text Books:

1. Stephen D. Senturia, ***Microsystem Design***, Kluwer Academic/Springer, 2nd edn. (2005), ISBN: 0792372468
2. R.S. Muller and A.P. Pisano, ***Micro Actuators***, IEEE Press, 2000.
3. P. Rai-Choudhury, ***Recent Advances in MEMS/MOEMS Technologies***, SPIE Press, 2000.
4. S.M. Sze, ***Semiconductor Sensors***, Wiley-Interscience Publishers, 1994.
5. T. Fukuda, and W. Menz, (Eds), ***Micro Mechanical Systems: Principles and Technology, Handbook of Sensors and Actuators***, Vol. 6, Elsevier, 1998.

DIGITAL AND ADAPTIVE CONTROL

MODULE – I (11 hours)

Review of Spectrum Analysis and Sampling Process. Reconstructing Original Signals from sampled signals: Sampling theorm, Ideal lowpass filter, frequency responce characteristics of the zero-order Hold, folding, aliasing. Pulse Transfermation: Pulse ternsfer function of closed loop systems, Pulse transfer function of Digital PID controllers.

MODULE – II (11 hours)

Transient and steady state response analysis of Digital control system: Deadbeat response, Digital control system with state feedback. State regular, State observer, combined state feedback control and state Estimation, Deedbeat control by state feedback and Dead beat observer. Optimal Digital Control System: Discrete Algebraic Riccati Equation.

MODULE – III (12 hours)

Adaptive Control: Introduction to adaptive control. Model Reference Adaptive Control (MARC) sysRelation between MRAC and STR. Introduction to sliding Mode Control (Variable Structure Control).

Textbooks:

1. K. Ogata, ***Discrete-Time Control System,*** 2nd edn., Pearson Education, Printed by Thomson Press (India).
2. M. Gopal, ***Digital Control and State Variable Methods,*** 3rd edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Eronini Umez-Eronini, ***System Dynamics and Control***, Thomson Books/Cole Publication.

DIGITAL & IC BASED INSTRUMENTATION

(Will be uploaded soon)

NONLINEAR SYSTEMS

MODULE – I (11 hours)

Introduction to Non Linear System: Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, linearization, slope, isoclines, singular point, limit cycle.

Phase Plane Analysis: Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol’s equation, stability from phase portrait, time response from trajectories, isoclines method, Pell's method of phase trajectory, Delta method of phase trajectory construction.

MODULE – II (11 hours)

Frequency Domain Analysis: Absolute stability, circle criterion, Popov criterion Describing function, DF of typical nonlinearities stability analysis using DF method, DIDF, pole zero shifting transformation.

Liapunov Stability: Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function Liapunov Stability: asymptotic stability, global asymptotic stability.

MODULE – III (12 hours)

Stability Criterion: Linear systems, linearization of nonlinear systems about equilibrium point. Liapunov's indirect method. Stability analysis of nonlinear system using Liapunov's theorem.

Nonlinear Control Design: Feedback linearization, Input Output linearization, sliding mode control.

Textbooks:

1. Hasan A. Khalil, ***Nonlinear Systems***, Printece Hall of India.
2. George J. Thaler Brown, ***Automatic Control System***, Jaico Publications.

Recommended Reading:

1. Samarjit Ghosh, ***Control Systems Theory and Application***, Pearson Education.
2. Nagrath and Gopal, ***Control System Engineering***, Wiley Eastern.
3. A. K. MandaI, ***Introduction to Control Engineering***, New Age International Publications.

ADAPTIVE SIGNAL PROCESSING

MODULE – I (11 hours)

Adaptive System

Definition and Characteristics, Areas of Application, Example of an Adaptive System, Adaptive Linear Combiner, The Performance Function, Gradient and Minimum Mean-Square Error, Alternative Expression of the Gradient, Decorrelation of Error and Input Components. [Read Widrow: Chapter 1 and 2]

Winer Filter

Linear Optimum Filtering, Principle of Orthogonality, Minimum Mean Square Error, Winer-Hopf Equation, Error Performance Surface. [Read Haykin: Chapter 2.1-2.5]

Linear Prediction

Forward Linear Prediction, Backward Linear Prediction, Properties of Prediction Error Filters. [Read Haykin: Chapter 3.1, 3.2, 3.4]

MODULE – II (11 hours)

Method of Steepest Descent

Basic Idea of Steepest-Descent Algorithm, Steepest-Descent Algorithm Applied to Winer Filter, Stability of Steepest-Descent Algorithm, Limitations of Steepest-Descent Algorithm. [Read Haykin: Chapter 4.1 – 4.3, 4.6]

Least-Mean Square Adaptive Filter

Overview, LMS Adaptation Algorithm, Application, Comparison of LMS With Steepest-Descent Algorithm. [Read Haykin: Chapter 5.1 – 5.3, 5.5]

Normalized Least-Mean Square Adaptive Filter

Normalized LMS Filter as the Solution to Constrained Optimization Problem, Stability of the NLMS. [Read Haykin: Chapter 6.1, 6.2]

MODULE – III (11 hours)

Frequency-Domain and Subband Adaptive Filters

Block Adaptive Filters [Read Haykin: Chapter 7.1]

RLS Adaptive Filters

Statement of Linear Least-Square Estimation Problem, Matrix Inversion Lemma, The Exponentially Weighted RLS Algorithm. [Read Haykin: Chapter 8.1, **9.1 – 9.3]**

Kalman Filter

Recursive Minimum Mean-Square Estimation For Scalar Random Variable, Kalman Filtering Problem, Initial Conditions, Summary of Kalman Filter. [Read Haykin: Chapter 10.1, 10.2, 10.6, 10.7]

Text Books

1. Bernard Widrow and Samuel D. Stearns, Adaptive Signal Processing, Pearson Education
2. Simon Haykin, Adaptive Filter Theory (Fourth Edition), Pearson Education.

VIRTUAL INSTRUMENTATION

MODULE – I (11 hours)

Introduction to Virtual Instrumentation: Computers in instrumentation, What is Virtual instrumentation (VI), History of VI, LabVIEW and VI, Conventional and graphical programming, Distributed systems.

Basics of LabVIEW: Components of LabVIEW, Owned and free labels, Tools and other palettes, Arranging objects, pop-up menu, Colour coding, Code debugging, Context sensitive help, Creating sub-Vis.

FOR and WHILE Loops: The FOR loop, The WHILE loop, Additional loop problem, Loop behaviour and interloop communication, Local variables, Global variables, Shift registers, Feedback, Autoindexing, Loop timong, Timed loop.

Other Structures: Sequence structures, Case structures, Formula node, Event structure.

Arrays and Clusters: Arrays, Clusters, inter-conversion of arrays and clusters.

MODULE – II (11 hours)

Graphs and Charts: Waveform chart, Resetting plots, Waveform graph, Use of cursors, X-Y graph.

State Machines: What is a state machine? A simple state machine, Event structures, The full state machine, Notes and comments.

File Input/Output: File formats, File I/O functions, Path functions, Sample VIs to demonstrate file WRITE and READ, Generatinf file names automatically.

String Handling: String functions, LabVIEW string formats, Examples, Some more functions, Parsing of strings.

Basics of Data Acquisition: Classification of signals, Read-world signals, Analog interfacing, Connecting the signal to the board, Guidelines, Practical versus ideal interfacing, Bridge signal sources.

MODULE – III (12 hours)

Data Acquisition with LabVIEW DAQmx and DAQ Vis: Measurement and automation explorer, The waveform data type, Working in DAQmx, Working in NI-DAQ (Legacy DAQ), Use of simple VIs, Intermediate VIs.

Interfacing with Assistants: DAQ assistant, Analysis assistant, Instrument assistant.

Interfacing Instruments: GPIB and RS232: RS232C versus GPIB, Handshaking, GPIB interfacing, RS232C/RS485 interfacing, Standard commands for programmable instruments, VISA, Instrument interfacing and LabVIEW.

Advanced Topics in LabVIEW: Interprocess communication, Other related tools (Queue, Semaphore, Rendezvous and Occurrence), Wait for front panel activity, Data sockets, Progrmmatically printing front panels.

Distributed Systems: Basic, Programming in FPGA, Operating in a batch mode, Wave server versus data socket.

Textbooks:

1. Sanjay Gupta and Joseph John, ***Virtual Instrumentation Using LabVIEW***, 2nd Edn., Tata McGraw-Hill, 2010, **ISBN-10:** 0-07-07002**8-1**, **ISBN-13:** 978-0-07-070028-4.

Recommended Reading:

1. Jerome Jovitha, ***Virtual Instrumentation Using Labview***, PHI Learning,, 2010, **ISBN-10:** 8120340302, **ISBN-13:** 9788120340305, 978-8120340305.
2. Gary W. Johnson and Richard Jeninngs, ***LabVIEW Graphical Programming***, 4th Edn., McGrawHill, 2006.
3. J. Travis and J. Kring, ***LabVIEW for Everyone***, 3rd Edn., Prentice Hall, 2006.
4. Peter A. Blume, ***The LabVIEW Style Book***, Prentice Hall, 2007.

MICRO-CONTROLLER & EMBEDDED SYSTEM

(Will be uploaded soon)

DATA ENCRYPTION AND SECURITY

(Will be uploaded soon)

INDUSTRIAL AUTOMATION AND ROBOTICS

Module – I (12 Hours)

Basic Concepts

Definition and origin of robotics, Different types of robotics, Various generations of robots, Degrees of freedom, Asimov's laws of robotics, Dynamic stabilization of robots.

Power Sources and Sensors

Hydraulic, pneumatic and electric drives, Determination of HP of motor and gearing ratio, Variable speed arrangements, Path determination, Micro machines in robotics, Machine vision, Ranging, Laser, Acoustic, Magnetic, Fiber optic and tactile sensors.

Module – II (12 Hours)

Manipulators, Actuators and Grippers

Construction of manipulators, Manipulator dynamics and force control, Electronic and pneumatic manipulator control circuits, End effectors, Various types of grippers, Design considerations.

Module – III (14 Hours)

Kinematics and Path Planning

Solution of inverse kinematics problem, Multiple solution jacobian work envelop, Hill climbing techniques, Robot programming languages.

Case Studies

Multiple robots, Machine interface, Robots in manufacturing and non-manufacturing applications, Robot cell design, Selection of robot.

Textbooks:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

Recommended Reading:

1. S.R. Deb, Robotics technology and flexible Automation, John Wiley, USA 1992.
2. C.R. Asfahl, Robots and Manufacturing Automation, John Wiley, USA 1992.
3. R.D. Klafter, T.A. Chimielewski, and M. Negin, Robotic Engineering – An Integrated Approach, Prentice Hall of India, New Delhi, 1994.

BIO-MEMS & NANOTECHNOLOGY
(Will be uploaded soon)

BIO INFORMATICS
(Will be uploaded soon)

MODELING & SIMULATION LABORATORY

(Will be uploaded soon)