COURSES OF STUDY (Syllabus)
B. TECH. (INSTRUMENTATION)
(Effective from Academic Year 2012-13)

Department of Instrumentation Engineering,
SGGS Institute of Engineering and Technology,
Vishnupuri, Nanded-431606 (MS), India
(An autonomous institute established by Govt. of Maharashtra)

COURSES OF STUDY (Syllabus)
B.Tech. (Instrumentation)
(Effective from Academic Year 2012-13)

STRUCTURE

Course Code	Name of the Course	Total No of credits	Lectures/week	Tutorials/week	Practicals /week
	I Semester				
IN401	Instrumentation Component Design	4	3	-	2
IN402	Instrumentation Project Management	4	3	-	2
IN403	Distributed Control Systems	4	3	-	2
IN404	PC based Instrumentation	4	3	-	2
IN405	Elective-I	3	3	-	-
IN406	Seminar on Industrial Training	1	-	-	2
IN407	Project Work-I	1	-		2
	Sub. Total	**21**	**15**	**-**	**12**
	II Semester				
IN408	Modern Control Theory	4	3	-	2
IN409	Industrial Management	3	3	-	-
IN410	Embedded System Design	4	3	-	2
IN411	Elective-II	4	3	-	2
IN412	Project Work-II	8	-	-	12
	Sub. Total	**23**	**12**	**-**	**18**
	Total	**44**	**27**	**-**	**30**

Elective-I

IN405(I) Wireless Sensors Network
IN405(II) Instrumentation for Agriculture and Food Processing
IN405(III) Mechatronics
IN405(IV) Biomedical Signals and Processing
IN405(V) Opto-electronics Instrumentation
IN405(VI) Introduction to MEMS

Elective-II

IN411(I) Advanced Sensors
IN411(II) Virtual Instrumentation
IN411(III) Digital Image Processing
IN411(IV) Neural Network and Fuzzy Logic based Control System
IN411(V) Digital Control
IN411(VI) Process Modeling and Optimization

SEMESTER-I

IN401 INSTRUMENTATION COMPONENT DESIGN

(4 Credits, L-3, T-0, P-2)

1. Basic concepts of design, Design procedure, Basic concepts of instrument design, Functional requirements and specifications of instrumentation component. (02)
2. Design aspects and selection criteria for flow, temperature, pressure, and level transducers, Orientation table, General selection criteria for transducers, General transducer design considerations. (03)
3. Design of temperature instrumentation system using RTD, thermocouple, thermistor, Selection criteria, Self heating effects in resistive temperature transducers, Power-dissipation constant and it's calculations, Thermocouple with thermowell assembly, time-constant calculation, Protection-tubes, types, materials, Design considerations for thermowell, types, Manufacturing process of T/C, RTD, Thermistor, Testing of RTD as per the Standard. (04)
4. Design of Pressure Instrumentation using Diaphragm, Bourdon tubes and Bellows, Design of Diaphragm, Bourdon tubes and Bellows elements, Design criteria, fabrication methods, diaphragm seal. (04)
5. Design of flow instrumentation using orifice, rotameter, venturimeter, different flow coefficient like Cd Cc, and Cv and their calculation. Types of orifice designs, Types of pressure taps to measure Δp, Design of orifice used in tank outflow and pipe-flow measurements, Different design considerations in orifice, venturimeter and rotameter design. (04)
6. Design of LVDT, strain gauge and design of piezo-electric crystal, Analysis of piezo-electric crystal for its use in dynamic measurement, Time-constant of crystal assembly along with cable and amplifier, calculation of crystal capacitance. (04)
7. Design considerations for an instrument, Enclosure design guidelines, Grounding and shielding techniques, Protection against electromagnetic interference and electrostatic discharge, NEMA, ANSI standards with special reference to packaging, Packaging for various operational environments, Aesthetics design consideration in Instrument design, Heat dissipation, Forced air circulation and Humidity considerations, NEMA Enclosures. (04)
8. Electronic Design Guidelines: Noise in electronic circuits, Effects of noise and interference on measurement circuits, Component limits for intrinsic safe design, Electrical safety classification as per standards NEC, NFPA, ISA. Input filters and clamping, suppressors, intrinsically safe electronic systems, The Zener Barrier, Energy Storage calculations. (04)
9. Signal Conditioning Circuit Designs e.g. amplifiers etc., Transmitter design, Installation, calibration, maintenance and troubleshooting, specifications and reference data e.g. pressure, level Transmitter, Methods of reducing effects of noise and interference. (03)
10. Design considerations for controllers, Pneumatic controllers using flapper-nozzle mechanism, Electronics controller using op-amps, considerations in design of data presentation elements, recorders, and monitors. (04)

11. Design of control valve, Control valve application & selection, Inherent and Installed characteristics of control valve, Selection of characteristics to suit the process, for gas, vapor and liquid, Valve plug design, Body design, Control valve sizing, Cavitations, Effects and remedies of cavitations, flashing condition, Control valve noise, Testing, control valve capacity test procedure as per standard, control valve linearizer, valve auxiliary parts, flow characteristics of valve control effects of load changes, high pressure & high temperature service, installed rangeability & viscosity correction for control valve., valve sizing by ANSI/ISA-S-75.01. Valve Actuators and petitioners. (04)
12. Control Panel Design: Design considerations, Type of control panel designs, Ergonomics in design of control, control room layout, cabling, wiring details. (02)

Reference Books:

1. Considine D. M., "Process Instrumentation, and Control Handbook" McGraw Hill International
2. Liptak B. G., "Instrument Engineers Handbook, Process Measurement Volume I and Process Control Volume II" Chilton Book Company, 2001
3. Johnson C. D., "Process Control Instrumentation Technology" 7th Edition, Pearson Education, New Delhi, 2003.
4. Bentley J. P., "Principles of Measurement Systems" 3rd Edition, Pearson Education, New Delhi, 2000.
5. Nakra Chowdhari, "Instrumentation", Prentice Hall of India, New Delhi
6. Doeblin E. O. and D. Mannik "Measurement Systems" Fifth Edition, Application and Design, McGraw Hill International Edition, 2006.
7. Warren Boxleitner, IEEE press: Electrostatic Discharge and Electronic Equipment
8. Walter C Bosshart , "Printed Circuit Boards" CEDT Series, Tata McGraw Hill
9. S. Soclop, "Applications of Analog Integrated Circuit" Prentice Hall of India
10. Ott , "Noise Reduction Techniques"
11. Andrew Williams, "Applied Instrumentation in the Process Industries" Vol. I and Vol. II , GWF Publishing Company
12. Sawhney A. K. and Puneet Sawhney "A Course in Mechanical Measurements and Instrumentation" Dhanpat Rai and Co. (P) Ltd., New Delhi, 1998.

Term Work:

The term work shall consist of a record of at least eight experiments/designs and drawings based on the syllabus given above. Some of the experiments may be from the following list.

1. Case study: One lab instrument/field instrument and its detailed engineering drawings, circuit diagrams on a drawing sheet.
2. Design of any mini project like design of instrument/electronic device/transducer/instrumentation component/system, its procedure starting from preparation of specifications, designing, testing, and erection. [Drawings dimensional sketches, circuit diagram, details of different component on drawing sheet, testing its specifications, determining practical static and dynamic characteristics]

3. Designing and preparing a PCB layout for electronic circuit and drawing it on drawing sheet.
4. Designing of a control panel along with detailed engineering drawings.
5. Design of a filter for typical noise problem
6. Design of any electronic intrinsically safe circuit.
7. Designing a control valve for given specifications and detailing it with engineering drawings.
8. Designing any transmitter and drawing its details.
9. Design of any sensor/transducer for particular process variables like flow/temp/Pressure and drawing its dimensional details on a sheet.

Practical Examination:
It shall consist of an oral based upon the above term-work and syllabus.

IN402 Instrumentation Project Management
(4 Credits, L-3, T-0, P-2)

1. Introduction to Instrumentation Project, Definition of the project, Project objectives, Need, Scope, Indian Industries, Avenues for Instrumentation Project Management. (2)
2. Design practice in industry, Features of good design, Design methodology of product, Instrumentation system Design. (4)
3. General transducer design, selection of transducer, general procedure for testing of transducer, typical design of LVDT or any one transducer. (4)
4. Design of Instrument: Electronic instrument, Enclosure, design of intrinsically safe instrument, ergonomic design, Design of a typical instrument like ammeter and pressure gauge. (4)
5. Design of control panel, human engineering design, push button, Instrument, Announciator, layout design, control room layout design, typical control design for substation, testing of control panel. Erection and commissioning of control panel. (6)
6. Instrumentation system design for brick manufacturing, glass manufacturing, Ingot heating and typical like chemical, thermal industry. (4)
7. Project procedure, Project schedule, Work co-ordination, Project Manager and his functions, Project organization chart, Functions of key persons, Project documentation, Document system, Process flow sheet, Mechanical flow sheets, (P & I diagrams), Standard Symbols and Legends. (6)
8. Instrument index sheet, Instrument specifications sheets, Loop wiring diagram, Panel drawings and specifications, Plot plans, Installation details, Piping specifications, Electrical specifications, Bid documents, Engineering design criteria, Hazardous Area Instrumentation. (6)
9. PERT/CPM Project Monitoring. (4)

Term Work:
It shall consist of following work:

1. Visit to Engineering project
2. Drawing of Instrument and equipment symbol

3. Design of transducer, Instrument, control panel, instrumentation system.
4. Loop wiring diagram and PERT/CPM

Reference Books:

1. Andrew and William, "Applied Instrumentation in the Process Industries. Volume II" Gulf Publishing Company.
2. Liptak B. G., "Instrument Engineers Handbook, Process Measurement Volume I and Process Control Volume II" Chilton Book Company, 2001
3. Hiller and Lieberman, "Introduction to Operations Research", Tata McGraw Hill. 7th Edition, 2003.
4. B.D. Shinde, K.V. Gitapathi, " Electronic & Instrument system design" Centre of Technical coordination Pune.
5. B.M. Naik, " Project Management Scheduling and Monitoring by PERT/CPM", Vani Educational books, New Delhi.
6. Harold Kerzner, "Project Management- A systems approach to planning, scheduling and controlling", 5th Edition.
7. John Bacon, "Management Systems", ISA Publications.
8. Fisher T. G., "Batch Control System", ISA Publications
9. Instrument Installation Project Management, ISA Publications

IN403 Distributed Control Systems
(4 Credits, L-3, T-0, P-2)

1. Programmable logic controllers (PLC): Introduction, architecture, definition of discrete-state process control, discrete – state variables, process specifications, Event sequence description (02)
2. Study of Allen Bradely make Micrologix1200c and 1100 PLC (02)
3. Ladder diagram: Background, ladder diagram elements ladder diagram examples, programmable controllers: Relay sequencer, programmable controllers, programmable controller operation, programming, advanced features, ladder diagrams and programming for some typical examples of process control using ABB PLC (10)
4. Study of AB make PLC: Introduction, programming (02)
5. Introduction to supervisory control and data acquisition (SCADA) as applied to process control systems: Introduction to various SCADA packages, study of RSVIEW32 (AB make package) Development of mimics using RSVIEW32 SCADA package, Study of iFix SCADA package (06)
6. Distributed control Systems (DCS): Introduction, difference between DCS and centralized computing system. Block diagram of DCS, Data highways, multiplexers and remote sensing terminal units Study of various aspects of DCS like communication protocol etc. (04)
7. Study of TDC-3000, Experion SCADA, AB MOD 300: Yokogawa centum –CS (at least one) (04)

8. Hybrid DCS: Introduction, Introduction to control logix (AB make), programming techniques, Hardware details, Study of Panel view plus and programming using RSVIEW32 ME (08)
9. Field Bus: Introduction, Study of one of the field bus like foundation field bus(02)

Term Work: Termwork shall consist of at least six to eight assignment/tutorials/practical based on above syllabus. Some of the experiments may be from the following list.

1. Study of AB Micrologix 1200c and 1100 PLC
2. Development of simple ladder diagrams like AND/OR gate
3. Developments of Ladder diagram for the controlling motor operation
4. Development of ladder diagram and Simulation for the level control system.
5. Development of Ladder diagram for bottling plant.
6. Study of Software package RSVIEW32 (AB make) for SCADA
7. Development of mimic diagram for a particular process using SCADA software
8. Study of Hybrid controller control logix (AB MAKE)
9. Development of programs for control of processes using Hybrid controller
10. Study of Pane view plus and REVIEWME software package

Reference Books:

1. Gary Dunning, "Introduction to Programmable Logic Controllers" Second Edition, Thomson Delmar learning, 2002.
2. C. D. Johnson, "Process Control Instrumentation Technology" Seventh Edition, Pearson Education, New Delhi 2003.
3. Instrument Engineers Handbook –B. G. Liptak (Ed) Vol-II and III, Chilton book Company.
4. Technical Manual – Manuals of TDC – 3000, ABB MPD 300 Yokogawa centum-CS
5. "Programmable Controllers: Principles and Applications", Webb J. W., and Ronald A. Reis Prentice Hall of India Pvt. Ltd.fifth edition, 2005
6. Programmable Logic Controllers, John R. Hackworth and Frederick D. Hackworth, Jr. Third India Reprint 2005
7. "Programmable Controllers: An Engineer's Guide", Parr A , Newnes, Butterwoth-Heinmen Ltd. 1993.
8. "Microprocessor based Process Control", C. D. Johnson, Prentice Hall International Edition.
9. Manual of Hybrid DCS

IN404 PC Based Instrumentation

(4 Credits, L-3, T-0, P-2)

1. Introduction: Generalized measurement and control system, Features of PC expansion slots, ports, monitors, storage devices, Software packages such as LabVIEW, DASYLab, DADiSP for PC based Instrumentation and control, PC based data acquisition system, PC interfacing. Different sensor and actuator types. (08)

2. Signal conditioning: principles and operations using OPAMPs. OPAMP characteristics, amplifier types: differential, isolation, instrumentation,

Wheatstone bridge amplifiers, wiring connections, Filters: RC and active filters, OPAMP circuits such as Differentiator, Integrator, comparator, Logarithmic amplifier, V to I and I to V converters, Voltage controlled oscillators. Noise and noise reduction techniques: Induced noise, ground noise, shielding and filtering. (08)

3. Principles of data acquisition, sampling concepts, D/A and A/D converters, Data acquisition system and configurations, Interface bus: Local, GPIB, parallel, serial interface, Networked data acquisition, communication, LAN, HART, Field buses. Plug in data acquisition and control boards, ADC, DAC, Digital I/O, PCI plug in boards. (08)
4. Hardware organization of IBM PC and its Interfacing: Motherboard components: Microprocessor, memory, chipset. System resources: IRQ lines, DMA channels, I/O space, expansion buses and I/O ports: ISA, EISA, PCI, parallel ports SPP, EPP, ECP. Serial ports RS 232, RS 422, RS 485, USB standards. Microcontroller serial interface: UART, I^2C, SPI, USB, Microwire, IEEE 1394, Remote I/O modules. (10)
5. Case studies for a few PC-based process control systems- open loop control system-stepper motor interfacing and control, Closed loop control system-position control system, PC based measurement and control of physical quantities like temperature, flow etc. (06)

Term Work:
The term shall consist of a record of minimum six experiments from the given list

1. Study of BIOS and DOS services of IBM PC.
2. To study Handling of mouse events using INT 33H.
3. Using timer interrupt and writing TSR programs.
4. Study of LabVIEW software for development of VI.
5. Use of data acquisition card for voltage, frequency measurements, waveform generation etc.
6. ADC and DAC interfacing.
7. Study of parallel port for bidirectional data transfer.
8. Serial port interfacing for data communication.
9. Interfacing of stepper motor with PC.
10. Design of PC based temperature ON/OFF controller.

Practical Examination: Examination shall consist of performing one experiment based on the above list along with practical/oral. The practical examination will not be of less than 3 hours duration**.**

Term Work:
The term shall consist of a record of minimum six experiments from the given list

1. Study of BIOS and DOS services of IBM PC.
2. To study Handling of mouse events using INT 33H.
3. Using timer interrupt and writing TSR programs.
4. Study of LabVIEW software for development of VI.
5. Use of data acquisition card for voltage, frequency measurements, waveform generation etc.

6. ADC and DAC interfacing.
7. Study of parallel port for bidirectional data transfer.
8. Serial port interfacing for data communication.
9. Interfacing of stepper motor with PC.
10. Design of PC based temperature ON/OFF controller.

Practical Examination: Examination shall consist of performing one experiment based on the above list along with practical/oral. The practical examination will not be of less than 3 hours duration**.**

Reference Books:

1. N. Mathivanan, " PC based Instrumentation: Concepts and Practice" PHI Pvt. Ltd, 2007
2. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Author, Newnes publisher, 2009.
3. Mike Tooley, "PC based Instrumentation and control", Third Kindle edition , Newness publisher 2005.
4. A. K. Ray and K. M. Bhurchandi, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing", Tata McGraw Hill publication, New Delhi, 2000.
5. J. L. Antonakos, "An Introduction to the Intel Family of Microprocessors", Pearson Education, New Delhi, 2003.
6. Web source: www.ni.com

IN405 Elective-I

IN405 (I) Wireless Sensor Networks

(3 Credits, L-3, T-0, P-0)

1. **Introduction**: Unique Constraints and Challenges, Advantages of Sensor Networks, Energy advantage, Detection advantage Sensor Network Applications, Habitat monitoring: wildlife, conservation through autonomous, nonintrusive sensing Tracking chemical plumes: adhoc, just-in-time deployment mitigating disasters Smart transportation: networked sensors making roads safer and less congested Collaborative Processing, Key Definitions of Sensor Networks. (06)
2. **Canonical Problems: Localization and Tracking**
   A Tracking Scenario, Problem Formulation, Sensing model, Collaborative localization Bayesian state estimation, Distributed Representation and Inference of States Impact of choice of representation, Design desiderata in distributed tracking Tracking Multiple Objects, State-space decomposition, Data association, Sensor Models Performance Comparison and Metrics. (06)
3. **Networking Sensors**
   Key Assumptions, Medium Access Control, The S-MAC Protocol, IEEE 802.15.4 Standard and ZigBee , General Issues Geographic, Energy-Aware Routing Unicast Geographic Routing Routing on a Curve Energy-Minimizing Broadcast Energy-Aware Routing to a Region Attribute-Based Routing Directed Diffusion Rumor Routing Geographic Hash Tables. (04)
4. **Infrastructure Establishment**

Topology Control, Clustering, Time Synchronization, Clocks and Communication Delays, Interval Methods, Reference Broadcasts, Localization and Localization Services Ranging Techniques, Range-Based Localization Algorithms, Other Localization Algorithms, Location Services. (04)

5. **Sensor Tasking and Control**
   Task-Driven Sensing,Roles of Sensor Nodes and Utilities, Information-Based Sensor Tasking, Sensor selection, IDSQ: Information-driven sensor Querying, Cluster leader based protocol,Sensor tasking in tracking relations Joint Routing and Information Aggregation Moving center of aggregation Multi-step information-directed routing Sensor group management Case study: sensing global phenomena. (06)

6. **Sensor Network Databases**
   Sensor Database Challenges**,** Querying ,The Physical Environment**,** Query Interfaces Cougar sensor database and abstract data types Probabilistic queries High-level Database Organization , In-Network Aggregation ,Query propagation and aggregation TinyDB query processing , Query processing scheduling and optimization Data-Centric Storage, Data Indices and Range Queries, One-dimensional indices, Multi-dimensional indices for orthogonal range searching, Non-orthogonal range searching Distributed Hierarchical Aggregation, Multi-resolution summarization Partitioning the summaries, Fractional cascading, Locality preserving hashing Temporal Data, Data aging. (08)

7. **Sensor Network Platforms and Tools**
   Sensor Network Hardware, Berkeley motes, Sensor Network Programming Challenges, Node-Level Software Platforms, Operating system: TinyOS, Imperative language: nesC , Dataflow style language: TinyGALS, Node-Level Simulators, ns-2 and its sensor network extensions, TOSSIM, Programming Beyond Individual. (06)

Reference books

1. Feng Zhao, Leonidas Guibas , “Wireless Sensor Networks An Information Processing Approach” Morgan Kaufmann Publishers, An Imprint of Elsevier First Indian Reprint 2005.
2. Wireless Sensor Networks, C. S. Raghavendra, Krishna M. Sivalingam and Taieb Znati Kluwer Academic Publishers
3. Anna Hac, "Wireless Sensor Network Desig**ns**," John Wiley and Sons, December 2003.
4. Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols," CRC Press, August 2003, 352 pages.
5. Victor Lesser, Charles L. Ortiz, and Milind Tambe, "Distributed Sensor Networks: A Multiagent Perspective," Kluwer, October 2003, 367 pages.

6. Azzedine Boukerche, Handbook of Algorithms for Wireless Networking and Mobile Computing, Chapman and Hall/CRC, 2006
7. Mohammad Ilyas and Imad Mahgoub, Handbook of Sensor Networks: Compact Wireless and Wired sensing systems, CRC Press, 2005.
8. Nirupama Bulusu and Sanjay Jha, Wireless Sensor Networks : A systems perspective, Artech House, August 2005.
9. C.S. Raghavendra, Krishna M. Sivalingam and Taieb Znati, Wireless Sensor Networks, Springer, 2005.

IN405 (II) Instrumentation For Agriculture And Food Processing
(3 Credits, L-3, T-0, P-0)

1. Introduction, necessity of instrumentation and control for food processing and agriculture sensor requirement, remote sensing, biosensors in Agriculture, standards for food quality. (4)
2. Soil science and sensors: P^H, conductivity, resistivity, temperature, soil moisture and salinity, ion concentration, measurements, methods of soil analysis, Instrumentation for environmental conditioning of seed germination and growth. (6)
3. Flow diagram of sugar plant, sensors and instrumentation set-up for it, Flow diagram of fermenter and control (Batch process), Oil extraction plant and instrumentation set-up, Pesticides manufacturing process and control (6)
4. Flow diagram of Diary and confectionary industry and instrumentation setup, juice extraction control set-up (4)
5. Application of SCADA for DAM parameters and control, Water distribution and management control, Auto-Drip irrigation systems, Irrigation Canal management, upstream and downstream control concepts, supervisory control. (6)
6. Green houses and Instrumentation; ventilation, cooling and heating wind speed, temperature and humidity, rain gauge, carbon dioxide enrichment measurement and control. (6)
7. Automation in Earth Moving Equipment and farm implements, pneumatic, hydraulic and electronic control circuits in harvesters, cotton pickers, tractors etc., Application of SCADA and PLC in packaging industry. (6)
8. Leaf area, length, evapotranspiration, temperature, wetness and respiration measurement and data logging. Electromagnetic, radiation, photosynthesis, infrared and CV, bio sensor methods in agriculture, Agro meteorological instrumentation weather stations. (6)

Reference Books:

1. Considine D. M., “Process Instrumentation, and Control Handbook” McGraw Hill International
2. Liptak B. G., “Instrument Engineers Handbook, Process Measurement Volume I and Process Control Volume II” Chilton Book Company, 2001
3. Johnson C. D., “Process Control Instrumentation Technology” 7^{th} Edition, Pearson Education, New Delhi, 2003.

4. D. Patranabis, “Industrial Instrumentation” TaTa McGraw Hill publications, New Delhi.

IN405 (III) Mechatronics
(3 Credits, L-3, T-0, P-0)

1. Introduction: Meachatronics, Measurement system, Overview of Mechatronics, Mechatronic Design Approach, System Interfacing, Instrumentation and Control Systems, Microprocessor-Based Controllers. (04)
2. Actuators: Introduction, electromagnetic principles. Solenoids and relays electric motors: dc motors, staple motors; hydraulics and pneumatics. (02)
3. Design of sensor and signal conditioning for displacement, position, velocity, force, pressure, temperature. (04)
4. Data Acquisition: Introduction, quantizing theory, Analog to Digital conversion: introduction, analog to digital converters, Digital to analog conversion, data acquisition and control. (04)
5. Process Switches: Temperature switches, pressure switches, flow switches, level switches, electrically operated switches, magnetic switches. (04)
6. Transmitters: Desirable features of transmitter, transmitter classification, four wire transmitter, two wire transmitter, three wire transmitter, differential pressure transmitter and its specifications.
7. Close loop controllers: Continuous and discrete processes, control modes, controller tunings, adaptive control, optimal control.
8. Study of Advance Process control blocks: Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control. Higher Level Operations: Control & Instrumentation for process optimization Applications of the above techniques to the some standard units/processes.
9. Mechatronics systems :
   Case study-1: Design of electrically controlled robot arm for sorting application
   Cast Study-2: Design of a robotic walking machine
   Case study-3: Design of control scheme for automatic bottle filling plant
   Case study-4: Design of control scheme for Automatic Baggage Handling System.
   Case study-5: Design of control scheme Home Automation

Reference books:

1. David G Alciatore and Michal B Histand, Introduction to Mechatronics and Measurement system, 3rd edition, Tata McGraw Hill publishing company New Delh, 2007
2. W. Bolton, Mechatronis: Electronic Control Systems in mechanical and electrical engineering,3rd edition, Pearson education (Singapore) Ltd., 2005
3. Devdas Shetty and Richard A. Kolk, Mechatronics system design, PWS publishing company Boston, MA02116, 1997
4. Robert H. Bishop. Editor-in-chief. “The Mechatronics Handbook”, CRC Press, with ISA–The Instrumentation, Systems, Automation Society, 2002.

5. B.G. Liptak 'Handbook of Instrumentation- Process Control'

IN405 (IV) Biomedical Signals and Processing
(3 Credits, L-3, T-0, P-0)

1. Basic Neurology: Nervous system, neuron, resting potential, biopotential, Nernst equation, electrical equivalents. (2)
2. Electrical activity of the heart: Cardiac system, bipolar and unipolar lead system, Einthoven triangle, electrodes, electrocardiogram-normal and abnormal, exercise ECG, lead positioning, electrode positioning for Holter ECG recording, vector cardiography, signal conditioning and processing. (4)
3. Electrical activity of neuromuscular system: muscular system, electrical signals of motor unit and gross muscle, human motor coordination system, electrodes, correlation of force and work, EMG integrators, signal conditioning and processing. (6)
4. Electrical activity of the brain: Sources of brain potential, generation of signals, component waves, EEG recording electrodes, 10-20 electrode system, EEG under Grand mal and petit mal seizures, signal conditioning and processing. (6)
5. Electrical signals from visual system: Sources of electrical signals in eye, generation of signals, electro-retinogram, eletro-occulogram. (4)
6. Electrical signals from auditory system: Generation of cochlear potential and nature, evoked responses, auditory nerves, signal conditioning and processing. (4)
7. Noise and interference in biomedical signals: Sources of noise in biomedical signal recordings, filtering techniques-active and passive filters, digital filtering, grounding and shielding. (4)
8. Computer applications and Bio-telemetry: Real time computer applications, data acquisition, compression and processing, remote data recording and management. (4)
9. Digital signal processing and data compression: Typical signal processing operations, time-domain operations, correlation and covariance, convolution, Digital filters: Smoothing filters, least square polynomial smoothing, windowing, FFT, DFT, Decimation in time and decimation in frequency FFT program. Data compression techniques: Direct data compression methods, Tolerance-comparison data compression techniques, polynomial predictors: Zero order predictor (ZOP), First order predictor (FOP), Polynomial interpolation: Zero order interpolator ZOI and FOI. AZTEC, MAZTEC, TP, CORTES, FAN, SAPA, DPCM, Entropy coding method, Peak picking method, cycle-to-cycle compression technique, Huffman coding, EBP-ANN based technique: Data compression-retrieval performance indices. (10)
10. Medical imaging: Diagnostic X-rays, CAT, MRI, thermography, ultrasonography, medical uses of isotopes, endoscopy. (4)

Reference Books:

1. W. J. Jonkins, “Biomedical Digital Signal Processing”, Prentice Hall of India, New Delhi.
2. G. F. Ihbar, “Signal Analysis and Pattern Recognition in Biomedical Engineering”, John Wiley and Sons.
3. R.S. Khandpur , “Hand Book of Biomedical Instrumentation.”, Tata Mcgraw Hill Publ.
4. H.K. Wolf and P.W. Macfarlane (Editors) , “Optimization of Computer ECG Processing.”, North Holland Publishing Co., Amsterdam
5. Carr and Brown, “Biomedical Instrumentation.”
6. M.J. Goldman, “Principles of Clinical Electrocardiography.”

IN405(V) Opto-electronics Instrumentation
(3 Credits, L-3, T-0, P-0)

1. Light and Elements of solid state physics nature of light, wave nature of light, light sources black body radiation, units of light Energy bands in solids, semiconductor types, works function, functions. (4)
2. Display Devices: Luminescence, Insertion Luminescence and the light emitting diode, Radiative recombination processes LED materials, commercial LED materials LED construction, response time of LEDs, LED drive circuitry plasma display liquid crystal displays. (5)
3. Lasers: Emission population inversion, optical feedback classes of laser, doped insulator lasers semiconductor lasers, gas lasers, liquid dye lasers, laser applications, measurement of distance holography. (9)
4. Photodetector: Thermal detectors: thermoelectric detectors, the bolometer, pneumatic detector, pyroelectric detector photo devices photoemissive devices vacuum photo diodes photo multipliers, noise in photo multipliers, image intensifier photo conductive detection photo transistor etc. (8)
5. Optical Fibers: Classification of optical fiber, principle of light transmission through a fiber, fabrication of optical fibers, material consideration loss and band width limiting mechanism, preform fabrication technique, fiber drawing, fiber optic communication system introduction to fiber optic sensors: Temperature pressure, level etc. (9)
6. Opto Electronic Power Devices: Solar cells and their application (3)
7. Opto Isolators: Different types and their configuration applications. (3)
8. Optical Instruments: Calorimeter, spectrophotometer, flame photometer fluorimeter and turbidity meter. (5)

Reference Books:

1. Semiconductor Optoelctronic Devices, Second Edtion, Pallab Bhattacharya, Pearson Education, New Delhi, 2002.
2. Opto Electronics – An Introduction J. Wilson J.F.B.Hawkes, Prentice Hall of India New Delhi 1996.
3. Integrated circuits and semiconductor devices: theory and application – Deboo Burrous McGraw Hill second edition.

4. Optical fiber communications Principals and Practice J. M. Senior Prentice Hall of India, second Edition, 1996.
5. Fiber optics – communication and other application H. Zanger and C. Zanger McGraw Publication
6. Optical Fiber Communication, Gerd Keiser

IN405 (VI) Introduction to MEMS
(3 Credits, L-3, T-0, P-0)

1. Introduction: history of MEMS, market for MEMS, overview of MEMS processes, properties of silicon, a sample MEMS process. Basics of Microtechnology: definitions and terminology, a sample process, lithography and etching. Micromachining: subtractive processes (wet and dry etching), additive processes (evaporation, sputtering, epitaxial growth). (04)
2. Fundamental Devices and Processes: basic mechanics and electrostatics for MEMS, parallel plate actuators, comb drives. CMOS MEMS: CMOS foundry processes, coupled IC/MEMS technologies, MEMS post-processing, applications. Cleanroom Lab Techniques: clean rooms, gowning procedures; safety, fire, toxicity; acids and basis; photolithography. (04)
3. Thermal Transducers: Electrothermal actuators, MicroOptoElectroMechanical Systems (MOEMS): micro scanners, digital mirror display, optical switches, other micro-optical devices. Micromachined mechanical sensors: Accelerometers , Basic accelerometer concepts, Force-balanced accelerometer concepts, Strain guage accelerometers, Capacitive accelerometers, Gryoscopes, Pressure sensors, Piezoresistive pressure sensors, Capacitive pressure sensors. (06)
4. Electrostatic actuators : Actuation mechanisms, Electrostatic actuation, Parallel plate actuators, Torsional electrostatic actuators, Electrostatic comb drives, Electrostatic cantilever actuators, Electrostatic linear micromotors (scratch drive), Electrostatic rotary micromotors. (04)
5. Microfluidic devices: Introduction, Basic fluid properties and equations, Types of flow, Bubbles and particles in microstructures, Capillary forces, Fluidic resistance, Fluidic capacitance, Fluidic inductance, Flow channels, Bulk micromachined channels, Surface micromachined channels, Valves and Pumps. (04)
6. BioMEMS and BioMaterials: gas chromatography systems and electrophoretic systems. Wireless MEMS: mechanical and electrical resonators, Q-factor, switches, filters. (04)
7. MEMS Packaging and Assembly: microassembly: serial and parallel, deterministic and stochastic; microgrippers; packaging techniques. (03)
8. The Future of MEMS: bioMEMS - neural implants, gene chips, diagnostic chips; MEMS in space; mechanical computers; invisible and ubiquitous computing. (04)

9. MEMS device simulation: Design and Layout using CAD tools, L-Edit Technology files, Cross-sections, Drawing, Design Techniques (MEMS-Pro): MEMS physical layout, Solid modeling and 3-D tools, MEMS verification, 3-D analysis, MEMS simulation, MEMS optimization principles. (05)

Reference books:

1. Marc Madou, "Fundamentals of Micro fabrication", CRC Press, 1999.
2. Gary S. May, Simon M. Sze, " Fundamentals of Semiconductor Fabrication", John Wiley & Sons, 2004.
3. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Aatre, "Micro and Smart Systems", John Wiley & Co. Indian Edition, New Delhi, 2010.
4. Tai Ran Hsu, "MEMS & Microsystem Design and Manufacture", Tata McGraw Hill, New Delhi 2002.
5. Julian W. Gardner and Vijay K. Varadan, "Microsensors, MEMS, and Smart Devices", John Wiley & Sons Ltd, 2001.
6. S. Senturia, *Microsystem Design*, Kluwer 2000
7. G. Kovacs, *Micromachined Transducers Sourcebook*, McGraw-Hill 1998.

IN406 Seminar on Industrial Training

(1 Credit, L-0, T-0, P-2)

A Talk will be delivered by the student based on Industrial Training work undertaken by the student during summer vacation after 3rd year. Industrial work of each student will be evaluated by two teachers appointed by Head of the Institution for giving term work marks. In case a student fails to obtain permission for program training from any industry, the department concerned can plan an equivalent program in the different laboratories under the guidance of faculties. The organizations where practical training will be preferred are: Process Industries, Instrumentation System Design, Instrument Manufacturing organizations, Research and Development establishments, Consultancy firms, Standards and Calibration laboratories.

IN407 Project Work-I

(1 Credit, L-0, T-0, P-2)

Term Work: Term work will be carried out by a batch of at the most two candidates. It shall consists of a report based on –

1. Laboratory work involving design and construction aspects for any instrumentation applications.
2. Design modification with fabrication of an existing equipment.
3. Investigation of practical problems in the manufacture and or testing of electronic or process equipment.
4. Proposing a theoretical design methodology/ or existing method for any instrumentation and control application and development of software for its simulation showing the validity of the results obtained.

The candidates will have to complete at least the design methodology and aspects of the project work.

Term Work Assessment: The following shall be the break up for term work.
The presentation will be given by the candidate. The presentation will be attended and evaluated by a group of three teachers, one of whom shall be the guide and the remaining two will be appointed by Dircetor of the Institute. The guide will assess the report based on – Quantum of work, Quality of the report Regularity of the candidate in the project work and in submission and discussion with guide.

SEMESTER-II

IN408 Modern Control Theory
(4 Credits, L-3, T-0, P-2)

1. State variable method: Modeling and Analysis (10)
   Concept of state, state variable, and state model, state space representation using physical, phase and canonical variables and their block diagram representation, state model and transfer function, diagonalization, solution of state equation, state transition matrix its properties and computation, concept of controllability and observability and their test criterion.

2. State Variable Method: Design (08)
   pole placement design using state feedback, state observer, reduced order and full-order observer design, Design of control systems with observers, Design of servo system, Study of some physical plant like inverted pendulum for analysis and design.

3. Introduction to Optimal Control systems, Linear Quadratic regulator (LQR): Theory and Design: LQR solution using the minimum principle, Generalization of LQR; LQR properties with classical interpretations; Optimal observer design-Kalman-Bucy filter: Problem formulation and Solution, The Linear Quadratic Gaussian (LQG) problem: Introduction, LQG problem formulation and solution, Performance and Robustness of optimal state feedback. (12)

4. Non-linear system analysis:
   Behavior of non linear systems, common physical nonlinearities, describing function method, Concept and derivation of describing function method, phase plane method, singular points, stability of non linear system,
5. Fundamentals of Lyapunov Theory: Equilibrium points, concept of stability, linearization and local stability, Lyapunov's Direct method: positive definite functions and Lyapunov functions, equilibrium point theorems, System Analysis based on Lyapunov's Direct Method: Lyapunov analysis of LTI systems, Krasovski's method, the variable gradient method, physically motivated Lyapunov functions, Performance analysis. (12)

Term Work

Term work shall consist of at least eight-assignment/ programs/ tutorials based on above syllabus. Some of the assignment/programs/tutorials may be from the following list:

1. Introduction to MATLAB/Simulink and control systems toolbox (with some examples) or any other control system related software package.
2. MATLAB/SIMULINK programme to demonstrate the concept of
    a. Pole placement using linear state variable feedback
    b. Pole placement using Ackermann's formula
    c. Reduced and Full order observer design
    d. Linear Quadratic Regulator Design (LQR)
    e. Linear Quadratic Gaussian (LQG) Design, Kalman Bucy filter
3. Study of WinCon software and introduction to rotary servo plant.
4. Implementation of Simulink based controller and running it in real time using WinCon.
5. Step response of first order system using dSPACE card.
6. Obtaining the mathematical model for Rotary inverted pendulum, Rotary flexible joint, Rotary flexible link and Ball and beam control experiment.
7. Implementation of Simulink models for control of Rotary inverted pendulum, Rotary flexible joint, Rotary flexible link and Ball and beam control experiment.
8. Design and evaluation of performance of a state feedback controller for Rotary inverted pendulum, Rotary flexible joint, Rotary flexible link and Ball and beam control experiment.
9. Design and evaluation of performance of a Linear quadratic regulator controller for Rotary inverted pendulum, Rotary flexible joint, Rotary flexible link and Ball and beam control experiment.
10. Study of dSPACE card for real time control applications.
11. Obtain the expression for the describing function for the different non-linearity.
12. Solve the problems on the methods of isocline method, nonlinear system analysis by phase plane method

Reference Books:

1. K. Ogata, "Modern Control Engineering", Fourth Edition, Prentice Hall of India, 2002.
2. G. Franklin, J. D. Powell and A. E. Naeini, "Feedback Control of Dynamic Systems", Fourth Edition, Pearson Education, 2002.
3. J. Nagrath and M. Gopal, "Control System Engineering",Second Edition, Wiley Eastern Limited, Sixteenth reprint 1990.
4. M. Gopal, "Control Systems, Principles and Design", Second Edition, TMH, New Delhi, 2002.
5. B. C. Kuo, "Automatic Control Systems", Seventh Edition, Prentice Hall of India, New Delhi, 2002.

6. J. E. Slotine and W. Li, “Applied Nonlinear Control”, Prentice Hall International, 1991.
7. A. Tewari, “Modern Control Design with MATLAB and SIMULINK”, John Wiley and Sons, Ltd., 2002.
8. B. Friedland, “Control System Design: An Introduction to State-space Methods”, McGraw Hill International Edition, Singapore, 1987.

Practical Examination: It shall consist of any one experiment based upon the termwork and syllabus. The examination shall not be less than three hours duration.

IN409 Industrial Management
(4 Credits, L-3, T-0, P-0)

1. Management Concept : (8)
   Management, Administration, Organization, Characteristics of management, Managerial objectives, Managerial skills, Principles of management, Types of management, management chart, Project management, MIS.
2. Industrial Ownership : (4)
   Types, single, Partnership, JSC, Co-Operative, public sector, Private sector, Merits and demerits.
3. Industrial Psychology: (6)
   Concept, Scope, Group Dynamic, Difi Behavior, Objectives of Industrial psychology, Motivation, Theory of X and V, Industrial fatigue,
4. Personal management: (5)
   Aims, Objectives, Principle of personal management, Recruitment, Selection, Educating, Testing, A. Test, G.D. , P.I., Promotions, Various selections, Tests, Interviews, Techniques, T.A.
5. Engineering Economics: (6)
   Wealth, Wants, capital, Income, Demand and supply, Law of substitution, Supply Equilibrium, and price determination.
6. Financial Management: (6)
   Purpose of investment, Source of finance, Reserve, Surplus, Assets, Liabilities, Trial Blanca, Fanatical statement, Fanatical Ratio.
7. Entrepreneurial qualities, Skills, Role of Government (5)
8. Theory “i” Management: Global Management Practices (4)
9. Information Technology for Management: Management Information Systems (6)

Text Book:

1. Industrial Engineering and Management : O.P. Khanna, Dhanpatrai and Sons, (1992)
2. Management Today - Principles and practice - Gene, Burton, Manab Thakur-McGraw Hill. (1996).
3. Industrial analysis and management systems by S.Dalela and Manssoor ali-Standard Publisher (1997).

4. Count your Chiken's before they Hatch by Arindam Choudhari, Vikas Publishing House, New Delhi, 2001.

IN410 Embedded System Design
(4 Credits, L-3, T-0, P-2)

1. Embedded system definition, different scales of embedded systems, design with small scale embedded systems, CISC and RISC architecture, 32 bit Microcontrollers: Internal Block Diagram, CPU, ALU, address bus, data bus, control signals, Working Registers, SFRs, Clock and Reset circuits, Stack and use of Stack Pointer, Program Counter. I/O Ports, Memory structure, Data Memory, Program Memory , Architecture, Instruction set, different addressing modes, I/O ports, TIMER2 and interrupts, UART, External Interrupts and Timers. (10)
2. ARM processor: Architecture, Processor modes, Register organization, Exceptions and its handling, Memory and memory management, ARM and THUMB instruction sets, addressing modes, ARM floating point architecture. Real-Time system (RTOS) concepts, Kernel structure, Task management, Inter task communication & synchronization, Understanding Device Drivers. (08)
3. Assembly language programming and hardware interfacing techniques. Introduction to development tools like cross assembler, simulator, HLL cross compilers and in circuit emulators for system development. On-chip interfaces: Digital I/O pins, ADC, DAC, timers, counters, PWM, watchdog timers, LCD, LEDs, seven segment displays, I^2C E^2PROM and their applications. External Interfaces: Stepper motor interfacing, DC Motor interfacing, sensor interfacing, SPI, CAN Protocols, USB protocol, Blue-tooth protocol. Writing application level programs for these interfaces using High level languages. (12)
4. Introduction to Real-Time /Embedded Operating Systems. Real Time Scheduling, Inter process communication, Programming paradigms: FSM and concurrent process models, Performance Metrics of RTOS, Linux & RTLinux Internals, Programming in Linux & RTLinux, Configuring & Compiling RTLinux, Overview of other RTOS. (10)

Reference Books:

1. Frank Vahid and Tony Givargis, Embedded system design: A unified hardware/software introduction, John Wiley and sons, 2002
2. Raj Kamal, "Embedded Systems" TATA McGraw Hill Edition.
3. Sloss Andrew N, Symes Dominic, Wright Chris; ARM System Developer's Guide: Designing and Optimizing; Morgan Kaufman Publication.
4. An Implementation guide to Real Time Programming - David L. Ripps, Yourdon Press, 1990.
5. D. E. Simon, An embedded software primer, Pearson Education, 2002

6. D. W. Lewis, Fundamentals of embedded software, Pearson Education
7. J. W. S. Liu, Real time systems, Pearson Education
8. Silberchatz, Galvin, Gagne, Operating system concepts, John Wiley
9. Dr. K. V. K. K. Prasad, "Embedded / Real – Time Systems: Concept, Design & Programming", Dreamtech Press.
10. Technical references on www.arm.com

Term Work:

The term work shall consist of Embedded "C" programming for ARM processor using Keil Cross Compiler or SCARM compiler. Minimum 8 of the following experiments are required.

1. Digital input output.
2. Flashing LEDs.
3. 7-segment display.
4. LCD display.
5. Use of ADC for voltage measurement.
6. Waveform generation using DAC.
7. Sensor interfacing.
8. RTC interfacing.
9. E^2PROM interfacing.
10. Use of I^2C, CAN interfaces.
11. Motor control experiments: Stepper motor, DC Motor.
12. Remote control interfacing.
13. RTOS programming.

IN411 ELECTIVE –II

IN411 (I) Advanced Sensors

(4 Credits, L-3, T-0, P-2)

1. The General measurement system: Measurement system-purpose, structure and elements. (04)
2. An introduction to Multi-sensor: Data fusion Techniques, Application of Data Fusion, Process models for Data Fusion, Limitation of Data Fusion system. (04)
3. Smart Sensors: Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Nonlinearity, Approximation and regression, Noise and interference, response time, drift, cross-sensitivity, Information Coding/Processing, Data communication, standards for smart sensor interface, the Automation. (06)
4. Recent trends in sensor technology: Introduction, film sensors, thick film sensors, Thin film sensors, semiconductor IC technology-standard methods. (04)
5. MEMS/NANO: Microelectromechanical systems (MEMS), Micromachining, Biomedical Applications, Nano-sensors, Carbon Nanotubes. (04)
6. Chemical Sensors: Introduction, semiconductor gas detectors, Ion Selective electrodes, Conductometric sensors, Mass sensors. (04)

7. Robotics sensors: Introduction, characteristics,types of sensors, touch or tactile sensors, binary and analog sensors, proximity sensors, types of proximity sensors, contact and non-contact proximity sensors, robotic vision. (06)
8. Fiber optic sensors: Fiber optic sensors for the measurement of temperature, Pressure, displacement, turbidity, pollution. (04)
9. Biosensors: Enzyme sensors, Cell based biosensors using Microelectrodes, Biosensors in Food Analysis. (04)

References:

1. Principles of Measurement systems John P. Bentley, Third edition 2000, Pearson Education Asia pvt. Ltd.
2. Sensors and Transducers, D. Patranabis, Second Edition Prentice Hall of India Pvt. Ltd. New Delhi, 2006
3. Middlehook S. and Audet S. A., "Silicon Sensors", Academic Press, London 1999.
4. Sensors, Nanoscience, Biomedical engineering and instruments, Richard C. Dorf, CRC Press, Taylor and Francis group USA, third edition, 2006
5. Fiber optics Communication and other applications, Henry Zanger, Cynthia Zanger, Macmillan publishing company, New York, 1991
6. Biosensors, Raj Mohan Joshi, First Edition, ISHA Books, Delhi, 2006.
7. Robotics and Industrial Automation, R.K.Rajput, S.Chand & company Ltd., First edition, 2008.
8. Transducers and Instrumentation, D.V.S.Murty, Second edition, PHI publication, Second edition, 2010.

Term Work:

Term work shall consist of minimum 08 experiments from the list given below with various applications in the instrumentation field:

1. To determine the smart pressure sensor characteristics.
2. To determine the characteristics of oxygen sensor transducer.
3. To determine carbon dioxide sensor characteristics.
4. To determine humidity sensor characteristics.
5. To determine piezoelectric sensor characteristics.
6. To determine ultrasonic sensors characteristics.
7. To study various robotics sensors.
8. To determine level transducer characteristics.
9. To determine soil moisture sensor characteristics .
10. To determine fiber optics sensors characteristics.

Practical Examination:

It shall consist of practical and oral based on syllabus. Practical examination shall consist of performance of the experiment carried out at the time of examination and viva- voce based on the term work submitted by the student for the subject.

IN411 (II) Virtual Instrumentation

(4 Credits, L-3, T-0, P-2)

1. Virtual Instrumentation: Historical perspective, advantages, Need of VI, Advantages of VI, Define VI, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming. (08)
2. VI programming techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web. (08)
3. Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements. (08)
4. VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office and Industrial applications, VISA and IVI. (08)
5. VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. (08)

Text Books:

1. Gary Johnson, "*LabVIEW Graphical Programming*", 2nd Edition, McGraw Hill, New York, 1997.
2. Lisa K. wells & Jeffrey Travis, "*LabVIEW for everyone*", Prentice Hall, New Jersey, 1997.
3. Jane W. S. Liu, *"Real-time Systems"*, Pearson Education India, 2001.
4. Jean J. Labrosse, *"Embedded Systems Building Blocks:Complete and Ready-to-use Modules in C"*, 2nd Edition, CMP Books, 1999
5. Kevin James, "*PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*", Newnes, 2000.
6. Jean J. Labrosse, *"MicroC/OS-II. The Real-time Kernal"*, CMP Books, 2002.
7. Robert H. Bishop, "Learning with LabVIEW 7 Express", Pearson Education, 2005 (Indian Edition)
8. Sanjay Gupta and Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw-Hill, New Delhi, 2005.

Web Resources:

1. www.ni.com
2. www.ltrpub.com

Term Work

Term work shall consist of at least eight-assignment/ programs/ tutorials/experiments based on above syllabus. Some of the assignment/programs/tutorials may be from the following list:

1. Data Acquisition using Virtual Instrumentation from Temperature transducer.
2. Data Acquisition using Virtual Instrumentation from a Pressure Transducer
3. Creation of a CRO using Virtual Instrumentation.
4. Creation of a Digital Multi-meter using Virtual Instrumentation.
5. Design Variable Function Generator Using Virtual Instrumentation.
6. Creation of Digital Temperature Controller using Virtual Instrumentation.
7. Machine Vision concepts using Virtual Instrumentation

IN411(III) Digital Image Processing

(4 Credits, L-3, T-0, P-2)

1. Introduction: Digital Image processing, the origins of Digital Image Processing, Examples of Fields that use Digital Image Processing, Fundamentals Steps in Digital image processing, Components of an Image processing system. (04)
2. Digital Image Fundamentals: Elements of visual perception, Light and the electromagnetic spectrum, Image sensing and Acquisition, Image sampling and quantization, some basic Relationships between Pixels, Linear and nonlinear Operations. (04)
3. Image Enhancement in the spatial Domain: Background, Some basic Gray level Transformation, Histogram processing, Enhancement using arithmetic/logic operations, Basics of spatial Filtering, Smoothing spatial Filters, sharpening spatial Filters, Combining Spatial Enhancement Methods. (04)
4. Image Enhancement in the Frequency Domain: Background, Introduction to the Fourier transform and the Frequency domain, Smoothing Frequency –Domain Filters, Sharpening frequency Domain filters, Homomorphic filtering, Implementation. (04)
5. Image Restoration: A model of the Image Degradation/Restoration process, Noise Models, Restoration in the Presence of Noise only-spatial filtering, Periodic Nose Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of the Degradation function, Inverse filtering, Minimum Mean square Error (Wiener) filtering, Constrained Lease Squares Filtering, Geometric Mean Filter, Geometric Transformations. (04)
6. Color Image Processing: Color Fundamentals, Color models, Pseudo color Image Processing, Basics of full-color Image Processing, Color Transformations, Smoothing and sharpening, Color Segmentation, Noise in color Image, Color Image compression. (04)
7. Wavelets and Multiresolution Processing: Multiresolution Expansion, Wavelet transforms in One Dimension, The Fast wavelet Transform, Wavelet Transform in Two dimensions, Wavelet packets. (04)
8. Image Compression: Fundamentals, Image Compression Methods, Elements of Information Theory, Error-Free Compression, Lossy compression, Image compression standards. (04)

9. Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-based segmentation, the use of motion in segmentation. (04)
10. Representation and Description: Representation, Boundary Description, Regional Description. (04)

References:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education (Singapore), 2nd edition, 2002.
2. K. Jain, Fundamentals of Digital Image Processing, Prentice Englewood Cliffs, N. J., 1989.
3. S. Burrus, R. A. Gopinath and H. Guo, Introduction to Wavelets and Wavelet Transforms, Prentice Hall, N. J., 1998.
4. G. Haskell and A. N. Netravali, Digital Pictures: Representation, Compression and Standards, Perseus Publishing, N. Y., 1997.

Term Work

Term work shall consist of at least eight-assignment/ programs/tutorials/ experiments based on above syllabus.

IN411(IV) Neural Network and Fuzzy Logic based Control Systems
(4 Credits, L-3, T-0, P-2)

1. Artificial Neural Systems: Preliminaries, fundamentals concepts and models of artificial neural system, neural network learning rules, Hebbian, Perceptron, delta Windrow-Hoff learning rules. (04)
2. Single layer Perceptron Classification: Classification model, features and decision regions, training and classification using discrete perception, algorithm and example, single layer continuous Perceptron networks for linear separable classification (06)
3. Multilayer Feed forward Networks: Generalized delta learning rule, feed forward recall and error back propagation training, learning factors. (02)
4. Single layer feedback networks: Basic concepts of dynamical systems mathematical foundation of discrete time and gradient type Hopfield networks, transient response of continuous time networks solution optimization problems (06)
5. Neural network in control system: Neuro control approaches, training algorithms, evaluation of training algorithms, through simulation, self running neuro-control scheme, self tuning PID neuro controller, neuro control scheme feed water bath temperature control system. (06)
6. Introduction of fuzzy control: Introduction fuzzy control from an industrial perspective, mathematical of fuzzy control fuzzy sets, fuzzy relation, approximate reasoning representing a set of rules. (04)
7. Fuzzy knowledge based controllers FKBS design parameters: Structure of FKBC fuzzification and defuzzification module, rule base choice of variable and contents of rules, derivation of rules, data base choice of membership function and scaling factors, choice of fuzzification, defuzzification procedure. (06)

8. Introduction to Genetic Algorithms: Fundamentals, History, Creation of offsprings, Working Principle, Encoding, Fitness function, Reproduction, Inheritance Operators, Cross over, Inversion and Deletion, Mutation operator, Bit-wise operations, Generational cycle, Convergence of Genetic Algorithms, Applications in Control. (06)

Term Work:

Term work shall consist of at least eight-experiment/ programs/ assignment based on above syllabus. Some of the experiments/assignments/programs may be from the following list.

1. Write a program to test the functioning of the artificial neuron with binary and continuous actuation function.
2. Write a generalized program to process the data by using the feed-forward neural network.
3. Write a program for the learning of the feed forward neural network-using delta learning neural network.
4. Write a program to study the effect of different network parameter on the performance of the neural networks.
5. Write a program to generate the different membership functions.
6. Develop an experimental set-up of water bath and associated electronic circuitry to acquire the data from the process.
7. Develop an experimental set up to control the temperature of water bath using direct neural controller.
8. Develop an experimental set up to control the temperature of water bath fuzzy PID controller.
9. Write a program to implement Genetic Algorithm and test it on some application.

Reference Books:

1. M. T. Hagan, H. B. Demuth and M. Beale, "Neural Network Design" Thomson Learning, Vikas Publishing House, New Delhi, 2002.
2. J. M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publication House 1997.
3. S. Haykin, "Neural Networks: A Comprehensive Foundation", Pearson Education, New Delhi, 2002.
4. John Yen and Reza Langari, "Fuzzy Logic: Intelligence, Control and Information", Pearson Education New Delhi, 2003.
5. S. Rajsekaran, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms, Synthsis and Applications", Prentice Hall of India, 2003.
6. S. Omatu, M. Khalid and R Yusof, "Neuro Control and its Applications", Springer – Verlag, London Limited 1996.
7. D. Driankov H. Hellendoorn and M. Reinfrank, "An Introduction to Fuzzy Control", Narosa Publication House, Second Reprint, New Delhi, 1997.

IN411(V) Digital Control

(4 Credits, L-3, T-0, P-2)

1. Digital control systems – Introduction, description of some physical systems, continuous versus digital control, Discrete-time signals, discrete time systems, sampling and reconstruction, digitizing analog controllers (06)
2. The Z Transforms – Definition and evaluation of Z-Transform, mapping between the s-plane and the z-plane, the inverse z-transform, theorems of z-transform, limitation of z-transform method. The pulse transfer function, pulse, transfer function of zero order hold, responses between the sampling instants, signal flow graph method applied to digital systems, stability of digital control systems, jury stability criterion (10)
3. State variable analysis of digital control systems: Introduction, state description of digital processors, state description of sampled continuous- time plant, state description of systems with dead time and sample and hold discrete state models using phase physical and canonical variables. Relation between state equation and transfer function and solution of state difference equations, controllability and observability (08)
4. Pole-placement design and digital state observer: Stability improvement by state feedback, digital control systems, with state feedback, dead beat control by state feedback, design of the full order and reduced- order state observers, linear digital regulator design (Finite time and infinite time problems) (08)
5. Design of Sampled Data Control systems : Descretising the differential equation of continuous PID controllers, Parameter optimized discrete control algorithms of low order, PID control algorithm through Z transformations, Deadbeat algorithm, Dahlin's algorithm, Digital Equivalent of convention controller, Smith Predictor algorithm, Internal Model control, Analytical Predictor Algorithm, Kalman algorithm, Algorithm of Gautam and Mutharasan, Treatment of noisy process signals. (10)

Reference Books:

1. Ogata K -. Discrete time control system Englewood cliffs prentice-Hall 1987.
2. Kuo B. C. – Digital control system 2nd edition Orlando florida saunders college publishing 1992.
3. M.Gopal- Digital control and state variable methods, Second Edition, Tata McGraw Hill 2002.
4. M. Gopal - Digital Control Engineering Wikey eastern 1988.
5. Houpls C. H. and G. B.Lamont – Digital control systems, McGraw Hill 1984.
6. P. B. Deshpande and R. H. Ash – Computer Process control with advanced control applications, Second Edition, Instrument Society of America (ISA) publications, 1988.
7. R. Iserman – Digital Control Systems, Vol.I; Fundamentals, Deterministic Control, Second Edition, springer- Verlag, Berlin, Heidelberg 1989.

Term Work

Term work shall consist of at least eight-assignment/ programs/ tutorials based on above syllabus. Some of the assignment/programs/tutorials may be from the following list:

1. Design and implementation of microprocessor/microcomputer based temperature control system.
2. Interfacing of ADC/DAC cards with microcomputer for data acquisition.
3. Interfacing of steeper motor with microcomputer.
4. Implementation of state feedback algorithm using MATLAB and its applications to transfer function of representative practical control system.
5. Implementation of pole placement algorithm using Ackermann's formula algorithm using MATLAB and applications to transfer function of representative practical control system.
6. Design of full order and reduced order state observer.
7. Implementation of Deadbeat and Dahalins algorithms in MATLAB
8. Design of Kalman algorithm.
9. Study and implementation of Smith Predictor algorithm.

IN411 (VI) PROCESS MODELING AND OPTIMIZATION

(4 Credits, L-3, T-0, P-2)

1. Mathematical models of Physical and Chemical systems: System modeling: Principles of formulation and applications of mathematical models. Different types of models: White box model (using fundamental physical and chemical laws), Black box model (using input-output data), Gray box model. Fundamental laws: Continuity equations, Energy equation, Equations of motion, Equations of state, Equilibrium, Chemical kinetics. Examples of models: Modeling of CSTR's (isothermal, non-isothermal, constant holdup, variable holdup), Batch reactor, Ideal binary distillation column, Stirred tank heater (mixing tank), Field controlled and Armature controlled D.C. Motors. (10)

2. Numerical methods for solving algebraic and differential equations and curve fitting: Solution of algebraic equations: Interval halving method, Newton Raphson method. Solution of differential equations: Euler method, Modified Euler method, Runge Kutta methods (2^{nd} and 4^{th} order), Adom Bashforth method. Curve fitting: Lagrange interpolation method, Least squares method. (06)

3. Computer simulation of chemical and physical systems: Gravity flow tank, three isothermal CSTR's in series, non-isothermal CSTR, Batch reactor, Ideal binary distillation column. (06)

4. Basic concepts of optimization and unconstrained optimization: Basic concept of optimization: Continuity of functions, Concave and convex functions, Unimodal and Multimodal functions, Necessary and sufficiency condition for an extremum of an unconstrained function. Unconstrained single-variable optimization: scanning and bracketing procedures. Numerical methods: Newton, Quasi Newton and Secant methods. Unconstrained Multivariable optimization: Direct methods: Conjugate search directions, Powell's method. Indirect methods: Gradient methods, Conjugate gradient method, Newton's method. (10)

5. Constrained optimization: Linear and nonlinear programming. Linear programming: Degeneracies, Graphical method, Simplex method, Karmarkar algorithm. Nonlinear programming: Lagrange multiplier method, Quadratic programming. (08)

References:

1. W. L. Luyben, "Process, Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publications.
2. T. F. Edgar, D. M. Himmelblau, "Optimization of Chemical Processes", McGraw Hill Publications.
3. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publications.

Term Work

Term work shall consist of at least eight-assignment/ programs/ tutorials based on above syllabus.

IN412 Project Work-II

(8 Credits, L-0, T-0, P-12 Hrs/week)

PROJECT WORK-II will be the continuation of project work-I undertaken by the candidates in the first term. The term work shall consist of report of the work carried out by the candidates in respect of the project assigned. The candidate must bring the project work-I report along with project work-II report while appearing for project work-II submission.

Practical Examination:

It shall consist of presentation and oral examination based upon the project work report submitted by the candidates and or upon the demonstration of the fabricated/designed equipment or software developed for simulation. The said examination will be conducted by a panel of two examiners, consisting of preferably guide working as internal examiners and another external examiner preferably from an industry or other university.

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