# Process Instrumentation Systems [PIS]

T.E. Sem. VI [INST]

## EVALUATION SYSTEM

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | – | – |
| **Oral Exam** | | 25 |
| **Term Work** | – | 25 |

## SYLLABUS

1. **Process Dynamics**
   Dynamic elements in a control loop, Dead time processes and smith predictor compensator. Inverse response behavior of processes and compensator. Dynamic behavior of first and second order systems. Interacting and non-interacting systems.

2. **Process Controllers**
   Elements of process control, Controller Principle, Process characteristics, Control system parameters, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID).

3. **Analog and Digital Controllers**
   General features, construction and working of Pneumatic, Hydraulic, Electronic and Digital controller.

4. **Controller Tuning**
   Process reaction curve method, Zigler-Nichols method, Cohen-coon correction for quarter amplitude, Frequency response method, Relay based tuning.

5. **Control Schemes**
   Feedback, feedforward, cascasde, ratio, split range, selective control, adaptive control, and model based control.

6. **Multivariable Control**
   Block diagram analysis of multivariable systems, Interaction, Tuning of Multivariable, relative gain analysis, Decoupler design.

7. **Discrete-State Process Control**
   Discrete state process control characteristics of the system, variables, process specification and event sequence description, Physical ladder diagram-elements and examples.

8. **Batch and Continuous Process Control**
   Batch mode, nomenclature, formulation, Batch versus continuous process control. Types of control, Classifications, Batch recipe management. Design of control system for a complete plant.

**Reference :**


1. Process Control Instrumentation Technology (*Curtis Johnson*) PHI/Pearson Education − 2002.
2. Chemical Process Control (*George Stephenopolos*) PHI − 1999.
3. Computer Control of Processes (*M. Chidambaram*) Narosa − 2002.
4. Elements of Process Control Applications (*Deshpande P.B. and Ash R.H.*) ISA Press, New York 1995.
5. Principles of Process Control (*D. Patranabis*) TMH (2nd Edition).
6. Process Control System (*F.G. Shinsky*) TMH.
7. Condensed Handbook of Measurement and Control (*N.E. Battikha*) ISA Publication (3rd Edition).
8. Automatic Process Control (*Donald P. Eckman*) Wiley Eastern Ltd.


❑ ❑ ❑ ❑ ❑

# Power Electronics and Drives [PED]

T.E. Sem. VI [INST]

**EVALUATION SYSTEM**

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | 2 Hrs. | 25 |
| **Oral Exam** | – | – |
| **Term Work** | – | 25 |

**SYLLABUS**

1. **Power Semiconductor Devices**
   (a) Introduction to construction, characteristics, ratings, data sheets and applications of power diodes, power BJT, power MOSFET, SIT and IGBT.
   (b) Study of Thyristors : constructions, characteristics, ratings of SCR, TRIAC, MCT, GTO and LASCR.
   (c) Comparison and selection criteria for above devices.
   (d) Switching / triggering method : Switching methods / types of triggering, triggering devices DIAC, SUS, 585, UJT and PUT.
   (e) Thyristors Communication Techniques.
   (f) Protection Scheme against over-current, over-voltage, dv/dt and di/dt.

2. **Thyristor Application**
   (a) Controlled rectifiers : Principles of operations of phase controlled converters, single phase half bridge, semi converter and bridge converters.
   Design of SCR based DC power circuits including UJT as triggering device and application.
   (b) AC power control using SCR-UJT and TRIAC-DIAC like universal speed controller fan regulator. Design of SCR/TRIAC based AC power control circuits including UJT/DIAC as a triggering device.

3. **Inverters**
   Principles of operation of inverters, PWM inverter, series and parallel inverters, bridge inverter, basic circuit scheme of IGBT/Power MOSFET based inverter circuits. Suitability in different applications of different capacities and frequencies operation. Principle of ZVC/ZCS resonant converters.

4. **Choppers**
   Basic operation of choppers, study of different types of simple chopper circuits like step up choppers, step down choppers and Jones chopper, DC motor speed control application using chopper.

5. **Switch Mode Power Supplies**
   Basic concept schemes, Working principles of Buck, Boost, Buck-Boost converter merits and demerits and applications.

6. **Drives**
   (a) AC Motor Drives : Concept and requirement of drives, Current fed and voltage fed drives, PWM technique (using IGBT/BJT) for control.
   (b) DC Motor Drives : DC drives for brushed/brushless motors, methods of motor control using constant voltage and constant current techniques.

7. **Industrial Applications**
   (a) Induction and Dielectric heating process, Block diagram, Merits/demerits and applications.
   (b) Temperature controller using thyristor principle and circuit scheme.

**Reference :**


1. Power Electronics (*P.S. Bimbhra*) Khanna Publishers - 2004.
2. Power Electronics (*M.H. Rashid*) PHI - 2005 (2nd Edition).
3. Power Electronics (*P.C. Sen*) Tata McGraw Hill - 2005.
4. Power Electronics − Converters Application and Design (*Mohan, Undeland Robbins*) Wiley Eastern - 1996.
5. Thyristorised Power Controller (*Dubey, Doralda*) Wiley Eastern Ltd. - 1993.
6. Power Electronics and Control (*Samir K. Datte*) PHI - 1986.
7. Industrial Electronics and Control (*S.K. Bhattacharya*) Tata McGraw Hill - 2007.
8. Modern Power Electroncis (*P.C. Sen*) Wheeler Publications - 1992.
9. Practical Transistor Circuits − Design and Analysis (*Jerrald E. William*) Tata McGraw Hill - 1976.
10. Power Electronics System Theory and Design (*Jai P. Aggarwal*) Pearson Education Asia - 2001.
11. Power Electronics (*Vedam Subrahmanyam*) New Edge Intl - 2000.


❑ ❑ ❑ ❑ ❑

# Digital Signal Processing [DSP]

T.E. Sem. VI [INST]

**EVALUATION SYSTEM**

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | – | 25 |
| **Term Work** | – | 25 |

**SYLLABUS**

1. **Brief Review**
   Discrete time signals and systems, difference equations, Fourier series and Transform, Z-Transform, theorems, properties etc.

2. **Introduction to Digital Signal Processing**
   Block diagram of DSP, Advantages and Sampling Theorem, Classification of Digital Filter (IIR and FIR).

3. **Analysis of Digital Filter**
   Classification of filter on the their pole zero diagram. Frequency response of IIR filters frequency response analysis of all types of linear phase system. Difference between IIR and FIR Filters.

4. **Realization of Systems**
   Realization of IIR systems by Direct form-I, Direct form-II, Cascade and Parallel. Realization of FIR systems by Direct form, cascade and linear phase system.

5. **Digital Filter Design Techniques**
   Properties of IIR filter Discritization Methods like IIT and BLT. Design of Butterworth and Chebyshev-I IIR filter.

6. **FIR Filter Design**
   Design of FIR filter by using Different Windowing Technique. By using Frequency Sampling. Realization of system by using Frequency Sampling Technique.

7. **Discrete Fourier Transform**
   Introduction to DTFT, Fourier representation of finite duration sequences, the Discrete Fourier Transform, properties of the DFT, Linear convolution using the DFT and IDFT.

8. **Computation of the Discrete Fourier Transform**
   Decimation in frequency (DIF) algorithms, Decimation in time (DIT) algorithms for Radix 2, 3 composite. Overlap add and save Methods.

9. **Introduction to Digital Hardware and Applications**
   Digital signal processor series Texas 320, Motorola 56000. Applications to speech, Radar, CT scanner and Digital touch tone receiver.

**Reference :**


1. Discrete Signal Processing (*A.V. Oppenhiem & R.W. Scheifer*) PHI – 1999.
2. Introduction to DSP (*Johny Johnson*) PHI – 1996.
3. Theory and application of DSP (*Rabnier Gold*) PHI EEE Edition – 1996.
4. Digital Signal Processing (*Proakis and Manoliakis*) PHI (3rd Edition) – 1997.
5. Computer aided Approach to DSP (*Sanjit K. Mitra*) TMH – 1998.
6. Digital Filter Analysis, Design and Application (*A. Antonion*) TMH publication (2nd Edition) – 1993.
7. Digital Signal Processors (*B. Vankataramani & M. Bhaskar*) TMH – 2002.
8. Digital Signal Processing (*emmauel C. Ifeachor & Barrie W. Jervis*) Pearson Education (2nd Edition) – 2000.
9. Analogy and Digital Signal Processing (*Ashok Ambardar*) Thomson Learning (2nd Edition) – 1999.
10. Digital Signal Processing (*Thonas J. Cavicchi*) Jhon Wiley – 2000.


❑ ❑ ❑ ❑ ❑

# Industrial Data Communications [IDC]

T.E. Sem. VI [INST]

**EVALUATION SYSTEM**

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | – | – |
| **Oral Exam** | – | – |
| **Term Work** | – | 25 |

**SYLLABUS**

1. **Introduction**
   OSI reference model, Systems engineering approach, State transition structure, Detailed design, Media, Physical connections, Protocols, Noise, Cable spacing, Ingress protection.

2. **Communication and Control**
   Introduction, Evolution of industrial control process, communication interface – serial and parallel, communication mode-simplex, half duplex and full duplex, synchronization and timing.

3. **Industrial Network**
   Network requirements, OSI implementation, Enterprise network : types of networks, LAN-architecture, topology, transmission media: Cable characteristics, Cable selection, unshielded twisted-pair cable, shielded twisted-pair cable, Coaxial cables, Fiber optics, wireless media, physical and logical media access and arbitration methods – token passing, ring, bus master-slave, peer-peer, network and transport layer services, real time implications, Session, presentation, and application layers. LAN standards for open LAN, bridges, routers and gateways, Manchester coding.

4. **Open Control Network**
   RS232, RS422, EIA 485, Ethernet-MODBUS – structure, function codes and implementation, General Purpose Instrument Bus, specifications.
   **Proprietary control network :** MODBUS plus, data highway plus.

5. **Networks at Different Levels**
   Sensor level network : AS-i, CAN, Devicenet, Interbus and LON
   Device network : Foundation Fieldbus – H1, HART, PROFIBUS-PA
   Control network : BACnet, ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP

6. **HART**
   Architecture – physical, data link, application layer, communication technique, normal and burst mode of communication troubleshooting, benefits of HART.

7. **Foundation Fieldbus**
   Fieldbus requirement, features, advantages, fieldbus components, types, architecture-physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process.

8. **Wireless Technologies**
   satellite systems, Wireless LANs (WLANs), Radio and wireless communication, WiFi, GSM, GPRS and VSAT – their comparison, limitations and characteristics.

**Reference :**


1. Practical Industrial Data Communications (*Deon Reynders, Steve Mackay, Edwin Wright*). Elsevier – 2005 (1st Edition)
2. Industrial Data Communication (*Lawrence M. Thompson*) 1997 (2nd Edition).
3. Real Time Control Netwrok (*Daniel T. Miklovic*) ISA – 1993.
4. Process Software and Digital Networks (*Bela G. Liptak*) – 2002 (3rd Edition).
5. Computer Networks (*Andrew S. Tanenbaum*) PHI/Pearson Education – 2002 (4th Edition).
6. Data Communications and Networking (*Behrouz A. Forouzan*) Tata McGraw Hill Publishing Co. − New Delhi – 2000 (2nd Edition).
7. Computer Networks and Internets (*Douglas E. Corner*) Pearson Education Asia, 5th Indian reprint – 2001 (2nd Edition).


❑ ❑ ❑ ❑ ❑

# Control Systems Design [CSD]

T.E. Sem. VI [INST]

**EVALUATION SYSTEM**

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | – | – |
| **Term Work** | – | 25 |

**SYLLABUS**

1. **State – Space Analysis of Control System**
   Concept of state-space, and state model for Linear Systems – SISO and MIMO systems, Linearization, state model for Linear continuous time system - State-Space representation using phase variables, Phase variable formulation for transfer function with poles and zeros, state space representation using canonical variables, derivation of transfer function from state model, Diagonalization, eigenvalues and eigenvectors, Solution of State equations – properties of state transition matrix, computation of state transition matrix using Laplace Transformation, Cayley – Hamilton theorem.

2. **Controller and Observer Design using State-Space**
   Concept of controllability and observability, definitions, phase variable form, properties, effect of pole-zero cancellation in transfer function.
   **State Feedback and Pole placement –** Stabilizability, choosing pole locations, limitations of state feedback.
   **Tracking Problems –** Integral control.
   **Controller design –** for phase variable form, by matching coefficients, by transformation.
   **Observer design –** for observer canonical form, by observability matrix, by transformation, by matching coefficients.
   Control using observers, separation property
   **Reduced order observer design –** separation property, reduced order observer transfer function Application of above.

3. **Introduction to Compensator**
   Analysis of the basic approaches to compensation, cascade compensation, feedback compensation, Effect of measuring elements on system performance, block diagram of automatic control system. Derivative and integral error compensation.

4. **Compensator Design using Root Locus**
   Improving steady-state error and transient response by feedback compensation, cascade compensation, integral, derivative compensation, Lag, Lead, Lag-Lead compensation.

5. **Compensator Design using Frequency Response**
   Steady-state error characteristics of Type 0, 1 and 2 systems, Time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.

6. **PID Compensator Design**
   Tuning rules for PID controller, Ziegler-Nichols rules, Designing PID controller using Root-Locus technique.

**Reference :**


1. Modern Control Engineering (*K. Ogata*) Prentice Hall of India – 2002 (4th Edition).
2. Control Systems Engineering (*Norman S. Nise*) John Wiley and Sons Inc. – 2000.
3. Control Systems Principles and Design (*M. Gopal*) Tata McGraw Hill, New Delhi – 2002 (2nd Edition).
4. Design of Feedback Control Systems (*Stefani, Shahian, Savant, Hostetter*) Oxford University Press – 2007 (4th Edition).
5. Modern Control Systems (*Richard C. Dorf, Robert H. Bishop*) Addition − Wesley – 1999.
6. Control System Engineering (*I.J. Nagrath & M. Gopal*) New Age International (P) Ltd., Publishers – 2000 (3rd Edition).
7. Automatic Control Systems (*B.C. Kuo, FaridGdna Golnaraghi*) PHI – 2003 (7th Edition).
8. Control Engineering − an Introductory Course (*Jacqueline Wilkie, Michael Johnson, Reza Kalebi*) Palgrave – 2002.
9. Control Engineering – Theory & Practice (*M.N. Bandopadhay*) PHI – 2003.


❑ ❑ ❑ ❑ ❑

# Embedded Systems for Instrumentation [ESI]

T.E. Sem. VI [INST]

**EVALUATION SYSTEM**

| | Time | Marks |
|---|---|---|
| **Theory Exam** | 3 Hrs. | 100 |
| **Practical & Oral Exam** | 2 Hrs. | 25 |
| **Oral Exam** | – | – |
| **Term Work** | – | 25 |

**SYLLABUS**

1. **Embedded Systems**
   Definition, embedded system overview, classifications, Design challenges, processor technology, IC technology and Design Technology and trade offs. Examples of embedded system.

2. **MCS-51 Microcontroller**
   Architecture of MCS 51 family of microcontroller, and its variants and comparison. Comparison of microprocessor and microcontroller. CPU timing and machine cycle. Memory organization, SFRS. Integrated peripherals such as Timers/Counters, Serial port, parallel I/0 ports, Interrupt Structure, memory interfacing. Power saving and power down mode.

3. **Development Tools**
   Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers, Merits and demerits of above tools.

4. **8051 Programming**
   Assembly language programming process. Programming tools. Instruction set, addressing modes. Assembly language Programming practice using assembly and C compiler.

5. **Serial Communication Protocols**
   Operation of serial port. Programming for implementation of asynchronous serial communication.
   Buses like $I^2C$ (RTC/EEPROM Memory Example), SPI (ADC, DAC example), introduction to USB and CAN Bus.

6. **Case studies**
   Interfacing keyboard displays, ADC, DAC, relay, optoisolator, LEDs with following examples with assembly and C programming. Process parameter measurement example. (DAQ)
   Digital Weighing machine.
   Implementing digital PID Controller for temperature control application.
   Speed control of DC motor. Frequency counter. Stepper motor control.

7. **RISC Microcontroller**
   Difference between RISC and CISC Architecture. Study of RISC controller (PIC16F87x)
   Architecture. Memory organization. Interrupts. Inbuilt controller features (ADC, PWM, timer, etc). Assembly instruction set and Introduction to assembly and C programming.

8. **Real Time Operating System (RTOS)**
   Introduction to RTOS concept. RTOS Scheduling models interrupt latency and response times of the tasks as performance metrics. Example of any tiny RTOS.

**Reference :**


1. The 8051 Microcontroller & Embedded Systems (*Madizi M.A.*) Pearson Education (2nd Edition).
2. (*Kenneth Ayala*) Penram International Publishing (India) Pvt. Ltd. (2nd Edition).
3. Embedded Systems (*Rajkamal*) TMH (2nd Edition).
4. (*Tony Givargis*) Wiley (Student Edition).
5. Microcontroller Based System Design (*Manoharam et. al*) Scitech Publications (India) Pvt. Ltd.
6. Website : www.atmel.com
7. Website : www.microchip.com
8. Website : www.nxp.com


❑ ❑ ❑ ❑ ❑