# DEPARTMENT OF INSTRUMENTATAION AND CONTROL ENGINEERING
# B.E. SYLLABUS 2010 (10 POINT CREDIT)

| Y | Sl. No. | Subject Code | Subject Name | L | T | P | C | Sl. No. | Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1. | MAT 201 | ENGG. MATHS – III | 3 | 1 | 0 | 4 | 1. | MAT 202 | ENGINEERING MATHEMATICS – IV | 3 | 1 | 0 | 4 |
| | 2. | ICE 201 | ELECTRICAL CIRCUIT ANALYSIS | 3 | 1 | 0 | 4 | 2. | ICE 202 | INDUSTRIAL INSTRUMENTATION-I | 4 | 0 | 0 | 4 |
| | 3. | ICE 203 | INSTRUMENTATION & TRANSDUCERS | 4 | 0 | 0 | 4 | 3. | ICE 204 | OPEN ELECTIVE - I | 3 | 0 | 0 | 3 |
| | 4. | ICE 205 | ELECTRICAL & ELECTRONIC MEASUREMENTS | 4 | 0 | 0 | 4 | 4. | ICE 206 | ELECTRICAL MACHINES | 4 | 0 | 0 | 4 |
| | 5. | ICE 207 | DIGITAL ELECTRONIC CIRCUITS | 3 | 1 | 0 | 4 | 5. | ICE 208 | LINEAR CONTROL THEORY | 3 | 1 | 0 | 4 |
| | 6. | ICE 209 | ANALOG ELECTRONIC CIRCUITS | 3 | 1 | 0 | 4 | 6. | ICE 210 | ANALOG SYSTEM DESIGN | 3 | 1 | 0 | 4 |
| | 7. | ICE 211 | CIRCUITS & MEASUREMENTS LAB. | 0 | 0 | 3 | 1 | 7. | ICE 212 | TRANSDUCERS LAB. | 0 | 0 | 3 | 1 |
| | 8. | ICE 213 | CIRCUITS SIMULATION LAB. | 0 | 0 | 3 | 1 | 8. | ICE 214 | ANALOG ELECTRONIC CIRCUITS LAB. | 0 | 0 | 3 | 1 |
| TOTAL | | | | 24 | | 6 | 26 | TOTAL | | | 23 | | 6 | 25 |
| | Sl. No. | Subject Code | Subject Name | L | T | P | C | Sl. No. | Subject Code | Subject Name | L | T | P | C |
| 3 | 1. | ICE 301 | MODERN CONTROL THEORY | 3 | 1 | 0 | 4 | 1. | ICE 302 | ANALYTICAL INSTRUMENTATION | 4 | 0 | 0 | 4 |
| | 2. | ICE 303 | INDUSTRIAL INSTRUMENTATION – II | 4 | 0 | 0 | 4 | 2. | ICE 304 | DIGITAL CONTROL SYSTEMS | 3 | 1 | 0 | 4 |
| | 3. | ICE 305 | MICROPROCESSORS & MICROCONTROLLERS | 4 | 0 | 0 | 4 | 3. | ICE 306 | POWER ELECTRONICS | 3 | 1 | 0 | 4 |
| | 4. | ICE 307 | SYSTEM MODELING | 3 | 1 | 0 | 4 | 4. | ICE 308 | ELECTIVE-I | 4 | 0 | 0 | 4 |
| | 5. | ICE 309 | DATA ACQUISITION & INTERFACING | 4 | 0 | 0 | 4 | 5. | ICE 310 | DIGITAL SIGNAL PROCESSING | 3 | 1 | 0 | 4 |
| | 6. | ICE 311 | DIGITAL SYSTEM DESIGN | 4 | 0 | 0 | 4 | 6. | ICE 312 | OPEN ELECTIVE - II | 3 | 0 | 0 | 3 |
| | 7. | ICE 313 | MICROPROCESSORS LAB. | 0 | 0 | 3 | 1 | 7. | ICE 314 | CONTROL SYSTEM SIMULATION LAB. | 0 | 0 | 3 | 1 |
| | 8. | ICE 315 | INSTRUMENTATION LAB. | 0 | 0 | 3 | 1 | 8<br>9. | ICE 316 | MICROCONTROLLER LAB. | 0 | 0 | 3 | 1 |
| TOTAL | | | | 24 | | 6 | 26 | TOTAL | | | 23 | | 6 | 25 |
| | Sl. No. | Subject Code | Subject Name | L | T | P | C | Sl. No. | Subject Code | Subject Name | L | T | P | C |
| 4 | 1. | ICE 401 | PROCESS INSTRUMENTATION & CONTROL | 3 | 1 | 0 | 4 | 1. | ICE 497 | SEMINAR | 0 | 0 | - | 1 |
| | 2. | HUM 401 | ESSENTIALS OF MANAGEMENT & ECONOMICS | 4 | 0 | 0 | 4 | 2. | ICE 498 | INDUSTRIAL TRAINING/TOUR | 0 | 0 | - | 1 |
| | 3. | ICE 403 | VIRTUAL INSTRUMENTATION | 3 | 1 | 0 | 4 | 3. | ICE 499 | PROJECT WORK | 0 | 0 | - | 20 |
| | 4. | ICE 405 | ELECTIVE – II | 4 | 0 | 0 | 4 | | | | | | | |
| | 5. | ICE 407 | ELECTIVE – III | 4 | 0 | 0 | 4 | | | | | | | |
| | 6. | ICE 409 | ELECTIVE – IV | 4 | 0 | 0 | 4 | | | | | | | |
| | 7. | ICE 411 | PROCESS CONTROL LAB. | 0 | 0 | 3 | 1 | | | | | | | |
| | 8 | ICE 413 | DIGITAL SIGNAL PROCESSING LAB. | 0 | 0 | 3 | 1 | | | | | | | |
| TOTAL | | | | 24 | | 6 | 26 | TOTAL | | | 00 | | - | 22 |

| ICE 308 ( ELECTIVE I) | | ICE 405 ( ELECTIVE II) | |
|---|---|---|---|
| ICE 308.1 | COMPUTER CONTROL OF PROCESS | ICE 405.1 | OPTICAL INSTRUMENTATION |
| ICE 308.2 | BIOMEDICAL INSTRUMENTATION | ICE 405.2 | MICROPROCESSOR BASED SYSTEM DESIGN |
| ICE 308.3 | CHEMICAL PROCESS SYSTEMS | ICE 405.3 | ROBOTIC SYSTEMS & CONTROL |
| ICE 308.4 | OBJECT ORIENTED PROGRAMMING WITH C++ | ICE 405.4 | LOGIC AND DISTRIBUTED CONTROL SYSTEMS |
| ICE 308.5 | NEURAL NETWORKS AND FUZZY LOGIC | ICE 405.5 | INSTRUMENTATION SYSTEM DESIGN |
| ICE 407 ( ELECTIVE III) | | ICE 409 ( ELECTIVE IV) | |
| ICE 407.1 | ANALOG & DIGITAL COMMUNICATION SYSTEMS | ICE 409.1 | REAL TIME EMBEDDED SYSTEMS |
| ICE 407.2 | BIOMEDICAL EQUIPMENTS | ICE 409.2 | NONLINEAR CONTROL SYSTEM DESIGN |
| ICE 407.3 | MULTI SENSOR DATA FUSION | ICE 409.3 | MICRO ELECTRO MECHANICAL SYSTEMS |
| ICE 407.4 | POWER PLANT INSTRUMENTATION AND CONTROL | ICE 409.4 | IMAGE PROCESSING |
| ICE 407.5 | ROBUST & OPTIMAL CONTROL | ICE 409.5 | DIGITAL NETWORK & PROCESS CONTROL |
| ICE 407.6 | INSTRUMENTATION AND CONTROL IN PETROCHEMICAL INDUSTRIES | ICE 409.6 | OPERATIONS RESEARCH |
| ICE 204 (OPEN ELECTIVE - I) | | ICE 312 (OPEN ELECTIVE – II) | |
| ICE 204.1 | INDUSTRIAL INSTRUMENTATION | ICE 312.1 | PROGRAMMABLE LOGIC CONTROLLER (PLC) |
| ICE 204.2 | CONTROL SYSTEMS | ICE 312.2 | VIRTUAL INSTRUMENTATION |

# SYLLABUS

## III SEMESTER INSTRUMENTATION & CONTROL
## MAT 201: ENGINEERING MATHEMATICS – III [3 1 0 4]

**Hours/ week: 3L+1T**
**Number of credits: 4**

Fourier series, periodic functions. Euler's formulae: Fourier series of odd & even functions and function with arbitrary period. Half range expansions. Fourier sine & cosine integrals & Fourier integrals. **(08 hrs.)**

Partial differential equations, basic concepts, solutions of equations involving derivatives with respect to one variable only. Solution by indicated transformations and separation of variables derivation of one dimensional wave equation (Vibrating String) and its solution by using method of separation of variables. Simple problems. D'Alemberts solution of wave equation. Derivation of one dimensional heat equation using gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables. **(08 hrs.)**

Vector calculus – gradient divergence and curl, their physical meaning and identities. Line, surface and volume integrals. Simple problems – Green's theorem, divergence and Stoke's theorems – simple applications. Curvilinear co-ordinates. **(12 hrs.)**

Functions of complex variables, continuity, differentiability, analyticity, Cauchy-Reimann equations and properties of analytic functions. Line integrals in complex plane and basic properties. Cauchy's theorem. Cauchy's integral formula, derivatives of analytic functions.

**(08 hrs.)**

Taylor, Maclaurin and Laurent series. Residue theorem-Evaluation of standard real integrals using contour integration. **(08 hrs.)**

Conformal mapping, bilinear transformations and its properties. The mappings defined by $e^z$, $Z^2$, sinz, cosz, logz, Z+(1/Z). **(04 hrs.)**

**REFERENCES:**

1. B.S. Grewal (1989)- Higher Engg. Mathematics. Khanna Publishers
2. E. Kreyszig**(1999)** - Advanced Engg. Mathematics. John Wiley
3. Murray R. Spiegel –- Vector Analysis. Schaum Publishing Co

# ICE 201: ELECTRICAL CIRCUIT ANALYSIS [3 1 0 4]

**Hours/ week: 3L+1T**
**Number of credits: 4**

**Network Theorems:** Superposition theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem. **(06 hrs.)**

**Steady-state Analysis:** Node voltage analysis and mesh current analysis in AC circuits. Power and Power factor improvement of a fluorescent lamp. **(03hrs.)**

**Resonance:** Series and parallel resonance, half power frequencies, selectivity, bandwidth, Q- factor. **(05 hrs.)**

**Two Port Network Analysis:** Network elements, classifications, network configurations, Network Parameters: Z parameter, Y parameter, ABCD parameter, Inverse ABCD parameter, Hybrid parameter and Inverse Hybrid parameter and their Inter-relationships, Two Port Symmetry and Reciprocity, Network Interconnections: Series, Cascade and Parallel, OC Impedance, SC Impedance, Image Impedance and their Inter-relationship. **(08 hrs.)**

**Signals and Waveforms:** Linearity, time invariance, step, ramp, impulse and doublet signals and their characteristics, equations of waveforms and their derivatives. **(03 hrs.)**

**The Laplace Transform Analysis:** Laplace transform of certain standard signals, properties of Laplace transform, initial and final value theorems, Laplace transform of periodic and non-periodic waveforms, inverse Laplace transform, complex frequency, poles and zeros, evaluation of residues, the system function, analysis of networks by Laplace transform method, convolution integral. **(08 hrs.)**

**Time Domain Analysis:** Initial and final conditions RL and RC circuits, time constant, multi-loop RL and RC circuits, ramp response, impulse response, step response, response to sinusoidal and exponential excitations of RLC circuits, damping factor. **(07 hrs.)**

**Fourier Series:** Waveform symmetry, trigonometric and exponential Fourier series, relation between trigonometric and exponential Fourier coefficients, evaluation of exponential Fourier coefficients by the method of impulse signal, magnitude and phase spectra, effective value and power of non-sinusoidal periodic signals. **(08 hrs.)**

**REFERENCES:**

1. Hayt, W.H & J.E. Kemmerly (2001) Engineering Circuit Analysis MGH.
2. Schaum's outline series (1992) Electric Circuits.MGH
3. Kuo, F.F (1966). - Network Analysis and Synthesis. John Wiley & Sons.
4. Van Valkenberg (1974)- Network Analysis
5. C L Wadhwa (2003), Network Analysis and Synthesis, New Age International Publishers
6. A. Chakrabarti (2004), Circuit Theory (Analysis and Synthesis), Dhanpat Rai & Co.
7. D Roy Choudhury (2002), Networks and Systems, New Age International Publishers

# ICE 203: INSTRUMENTATION & TRANSDUCERS [4 0 0 4]

**Hours/week : 4L**
**No. of credits: 4**

**Transducers:** Introduction, Classification – Active, Passive, Mechanical, Electrical, Comparison. Selection of Transducers : Desirable characteristics of transducers. Selection criterion. **(04 hrs.)**

**Generalized Measurement System:** Block Diagram, functional description of measuring systems. Desired, Modifying, Interfering inputs. Methods of Eliminating, Modifying & Interfering Inputs. **(04 hrs.)**

**Generalized Performance Characteristics:** Static characteristics, Dynamic characteristics, Step response of Zero order, First order, Second order measurement systems. Errors and its classification, statistical analysis. **(09 hrs.)**

**Variable Resistance Transducers:** Types – Potentiometric Transducers – Loading Error, Sensitivity and Linearity, Strain Gauges – Types, Gauge Factor-Strain gauge bridge circuits, Temp Compensation. Semi-conductor strain gauge, Calibration of strain gauge., case study **(06 hrs.)**

**Variable Capacitance Transducers :** Principle, Types- variable air gap, variable area, variable permittivity type, Sensitivity and Linearity and frequency response of capacitive transducer, case study . **(04 hrs.)**

**Variable Inductive Transducers :** Various types. LVDT-Principle and characteristics. Block diagram approach for a typical set up used for displacement measurement. Hall effect sensors, magneto elastic and magneto strictive transducers, synchros and resolvers, eddy current transducers, case study. **(07 hrs.)**

**Piezo Electric Transducers :** Piezo Electric, Element and their properties. Piezo Electric coefficients. Equivalent circuit and frequency response of P.E. Transducers, case study. **(03 hrs.)**

**Optoelectronic Transduceers:** Semiconductor sensors, LDR photoelectric transducers, photo multipliers, photo voltaic, photo conductive, photo diode and photo transistors.Encoders, Classification and construction, Brush type optical displacement transducers, shaft encoder codes and decoding, optical encoders- photo optic transducers. **(11 hrs.)**

**REFERENCES:**

1. Doeblin (1992)- Measurement Systems, 4/e McGraw Hill, New York.
2. DVS Murthy (1999) – Transducers & Instrumentation, PHI, New Delhi.
3. A.K. Sawhney (2002) - Electrical & Electronic Measurements and Instrumentation, Dhanpat Rai & Co, New Delhi.
4. A. K. Ghosh (2005) - Introduction to Instrumentation and Control .PHI
5. John P. Bentley (2000)-Principle of Measurement Systems, 3/e Addison Wesley Longman Ltd., UK.
6. H.K.P. Neubert (1988) – Instrument Transducers Oxford University press Delhi.

## ICE 205: ELECTRICAL & ELECTRONIC MEASUREMENT [4 0 0 4]

**Hours/ week: 4L** **Number of credits: 4**

D'Arsonval Galvanometer and recorder, Moving iron and Rectifier type instruments **(04 hrs.)**

Measurement of Resistance: Kelvin's Double bridge, Wheatstone bridge, Loss of charge method, Murray Loop Test **(05 hrs.)**

A.C Bridges: Maxwell bridge, Anderson Bridge, Desauty bridge, Schering Bridge, Shielding. **(04 hrs.)**

D.C. Potentiometer: Student type, Calibration of voltmeter, ammeter & wattmeter **(03hrs.)**

Instrument Transformers: CT & PT construction, operation. Testing-Silsbee's method. **(04hrs.)**

Measurement of power & Energy: Electro dynamometer type wattmeter, Single phase and 3-phase energy-meters, errors and their compensation. **(04hrs.)**

Oscilloscopes: Brief idea about CRO, storage oscilloscopes, voltage probes, current probe **(06 hrs.)**

Measurement using CRO's: Measurement of voltage, current, frequency, frequency comparison methods-Lissajous pattern method, broken ring pattern method, modulated ring pattern method, phase angle measurement-direct method, X-Y method **(05hrs.)**

Display devices: Light emitting diode, Liquid Crystal Display, Dot matrix and segmental display **(04 hrs.)**

Digital Voltmeters: DVMs based on single slope and double slope integrating type using A/D converters **(04 hrs.)**

Digital frequency meter: Principle of operation, basic operation, Time-base digital frequency meter, time period & time interval measurements **(05 hrs.)**

**REFERENCES**

1. A.K. Sawhney (1994), 'A Course in Electrical & Electrical Measurement & Instrumentation', Dhanpath Rai publishing.
2. E.W. Golding & Widdis F.C, 'Electrical Measurements & Measurement Instruments'
3. David A. Bell (1983), 'Electronic Instrumentation & Measurements', Reston Publication, Varginia
4. Oliver & Cage (1975), 'Electronic Measurements & Instrumentation', MGH
5. Cooper W.D & Helfrick A.D (1975), 'Electronic Instrumentation & Measurement Techniques (Edition-3), MGH
6. B.S. Sonde (1977), 'Transducers and Display Systems', TMH.

# ICE 207: DIGITAL ELECTRONIC CIRCUITS [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Number Systems and Codes:** Concept of digital system; decimal, binary, octal and hexadecimal systems; BCD, Excess-3 code, Gray code and ASCII code. **(05 hrs)**

**Logic Gates and Boolean Algebra:** Boolean constants and variables; OR, AND, NOT, NAND and NOR gates; truth tables; Boolean expressions; Boolean algebra; Boolean theorems; De Morgan's theorem. **(05 hrs.)**

**Combinational Logic Circuits:** Algebraic simplification of Boolean expressions and realization using logic gates; sum of products and product of sums; min terms and max terms; Karnaugh map, minimization using Karnaugh map; don't care conditions;variable entered mapping; minimization using variable entered maps. **(07 hrs.)**

**Digital Arithmetic:** Binary addition; binary subtraction; signed magnitute numbers;2's complement arithmetic; hexadecimal arithmetic. **(03 hrs.)**

**Arithmetic Circuits:** EXOR and EXNOR gates; half adder; full adder; parallel binary adder, half subtractor, full subtractor **(04 hrs.)**

**Data Processing Circuits:** Multiplexers; demultiplexers; decoders; BCD to decimal decoder; seven segment decoder; encoders; parity generators; parity checkers. **(06 hrs.)**

**Flip-Flops:** NAND gate latch; NOR gate latch; SR, DT, and JK clocked flip-flops; edge triggered flip- flops, T flip flops. **(04 hrs.)**

**Sequential Logic Circuits:** Registers and counters, shift registers (left, right), ring counter, ripple counter, mod number, mod-3, mod-5 and mod-10 counters, asynchronous down counter, synchronous counters, pre-settable counters. **(06 hrs.)**

**D/A and A/D Converters:** D/A converters, binary weight, resistive divider binary ladder, accuracy, resolution, offset error, settling time, AD7524 8-bit DAC, A/D converters, counter type, successive approximation converter, principle of dual-slope ADC. **(08 hrs.)**

**REFERENCES:**

1. Donald P Leach & Albert Paul Malvino (1991)- Digital Principles and Applications ( Ed. 4), TMH,.
2. Ronald J. Tocci - Digital Systems - Principles & Applications.
3. M. Morris Mano Digital Design by (PHI).

# ICE 209: ANALOG ELECTRONIC CIRCUITS [4 0 0 4]

**Hours/ week 4L**
**Number of credits: 4**

**Review of Semiconductor Physics, P-N Junction:**
Open circuited P-N Junction, Bias conditions. The current components in a P-N junction diode, The volt- ampere characteristics, Reverse saturation current, Breakdown, The effect of temperature on V-I characteristics, Diode resistance, Transition capacitance, Diffusion capacitance, Switching times, Diode specification, Zener diodes, Semiconductor photo - diode, Light emitting diode. **(06 hrs.)**

**Diode Circuits:** Diode as a circuit element, load line concept, diode model, clipping circuits, clipping at two independent levels, clamping circuits. **(04 hrs.)**

**Transistor Characteristics:** Bipolar junction Transistor, Bias conditions, Transistor current components, Common base configuration, Transistor amplifying action, Transistor as a switch, Common emitter configuration, Common collector configuration, Maximum voltage rating, Limits of operation, Transistor specifications. **(06 hrs.)**

**Biasing and Stability of Q:** Fixed bias and emitter bias circuit, Stabilization against variation in $I_{co}$, $V_{be,}$ and $\beta$. **(04 hrs.)**

**Small signal model (h-parameter model) :** Comparison and applications of the CE, CB, CC configuration (with CE hybrid model only), Cascade connections, Darlington configuration, Current sources and Current mirror circuits (using Transistor only)
(**06 hrs.)**

**Field Effect Transistors :** Characteristics of FETs, Transfer characteristics, specification, Depletion type MOSFET, Enhancement type MOSFET, VMOS, CMOS, FET and MOSFET biasing. **(06 hrs.)**

**Rectifier and Power Supplies:** Voltage regulation, Capacitor filter, R-C filter, Series voltage regulator, shunt voltage regulator, I.C.voltage regulator. **(06 hrs.)**

**Amplifiers :** Classification of amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Polar plots, Gain bandwidth product. **(04 hrs.)**

**Large Signal Amplifiers (Class A, Class B, and Class AB):** Transformer coupled amplifier, Thermal run-away, Theoretical efficiency, distortion analysis, complementary and quasi complementary push-pull amplifier. **(06 hrs.)**

**REFERENCES:**
1. Sedra A. S., & K. C. Smith (1999) - Micro Electronic Circuits, OUP.
2. Millman and Halkias(1992) - Integrated Electronics: Analog and Digital Circuits and Systems, TMH.
3. Boylestad and Nashelsky (1993) - Electronic Devices and Circuit Theory (Ed. 5), PHI.

## ICE 211: CIRCUITS & MEASUREMENTS LABORATORY [0 0 3 1]

1. Power, power factor & its improvement of fluorescent lamp.
2. Measurement of low and medium resistance
3. Measurement of self & mutual inductance
4. Three phase power measurement
5. Calibration of single phase energy meter
6. Calibration & direct measurements using dual trace oscilloscope - Voltage, Current, Frequency, phase difference and Impedance.
7. D.C. potentiometer- Calibration of Voltmeter, Ammeter and Wattmeter and Frequency measurement using Lissajous figures, broken ring and modulated ring pattern method.
8. Maxwell's inductance bridge
9. Schering's capacitance bridge
10. Superposition & Reciprocity theorems
11. Thevenin's theorem & Maximum power transfer theorem
12. C. T. testing

**REFERENCES:**

1. A.K. Sawhney (1994) - A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai & Co.
2. Edminister (1992 )- Electric Circuits, Schaum's outline series.

# ICE 213: CIRCUIT SIMULATION LAB [0 0 3 1]

**ELECTRIC CIRCUIT SIMULATION USING MATLAB**

1 Introduction to MATLAB, Interactive Computation

2 Script files, File I/O, Function I/O, Steady-state analysis of circuits: Solution of algebraic equation.

3 Graphics using MATLAB

4 Steady state analysis of circuits: Solution of algebraic equation.

Transient analysis RC Circuits using ODE solvers.

**INTRODUCTION TO SIMULINK**

5 Introduction to Simulink and Simulation of RL circuits

6 Simulation of RC and RLC

**ELECTRIC CIRCUIT SIMULATION USING PSPICE**

7 Introduction to PSPICE Steady-state analysis of DC circuits

8 Steady-state analysis of single and three phase AC circuits coupled circuits

9 Transient analysis of RL and RC and RLC Circuits

10 Frequency Response of circuits A) Series Resonance

B) Parallel Resonance

11 Analysis of simple diode circuits

12 Analysis of BJT and FET Circuits

## Reference Books:

1. *MATLAB online help and documentation*
2. William Palm III (2001), *Introduction to MATLAB 6.0 for Engineers,* MGH
3. Rudra Pratap (2002) *Getting started with MATLAB 6*, OUP
4. D.M. Etter (1993) *Engineering Problem Solving with MATLAB,* PH
5. D. Hanselman and B. Littlefield (2002) *Mastering MATLAB 6,* PHIPE
6. *MATLAB User guide,* Mathworks Inc.
7. Rashid M.H (1995) *Spice for Circuits and Electronics using PSPICE,* PHI
8. Tuinenga P.W (1990) *SPICE a Guide to circuit simulation and analysis using PSPICE,* PHI
9. Irwin J. D (1990), *Basic Engineering Circuit Analysis,* Macmillan
10. Rashid M. H (1999) *Micro Electronic Circuits – Analysis & Design,* PWS
11. Boylestad and Nashelsky (2003) *Electronic Devices and Circuit Theory (8e),* Pearson

## IV SEMESTER INSTRUMENTATION & CONTROL

# MAT 202: ENGINEERING MATHEMATICS – IV [3 1 0 4]

**Hours/ week: 3L+1T**
**Number of credits: 4**

Introduction to probability, finite sample spaces, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance, Chebyschev's inequality. **(08 hrs.)**

Two and higher dimensional random variables, covariance, correlation coefficient, Regression, least squares principles of curve fitting. **(08 hrs.)**

Distribution: binomial, Poisson, uniform, normal, gamma, Chi-square & and exponential, problems. **(08 hrs.)**

Fourier transforms and Z-transforms, solution of deference equations using Z-transforms-Fourier transforms, Fourier sine and cosine transforms, Parsevals identity, convolution theorem, solution of boundary value problems by Fourier transforms **(10 hrs.)**

Interpolation and application – Finite differences – Newton's and Lagrange's Interpolation formulae – Inverse interpolation – Numerical differentiation – Numerical Integration, Trapezoidal and Simpon's rules – Difference equations with constant coefficients, solutions **(08 hrs.)**

Solution of system of Linear equations, Gauss-Jacobi, Gauss-Seidal & relaxation methods Eigen value problems – power method of evaluation of largest Eigen value. **(06 hrs.)**

**TEXT BOOKS:**

1. P.L. Meyer (1979) - Introduction to Probability and statistical applications, Second Edition, American publishing Co.
2. S.S. Sastry (1990) - Introductory methods of Numerical Analysis 2nd Edition, Prentice Hall.
3. Erwin Kreyszig (1985) - Advanced Engineering mathematics, 5th Edition, Wiley Eastern.
4. A.V. Openheim and R.W. Schafer (1975)- Digital Signal processing Edition., Prentice Hall.

**REFERENCES:**

1. Hogg & Craig (1975)- Introduction to Mathematical Statistics, 4th Edition, Macmillan.
2. S.M. Ross (1987) - Introduction to Probability and statistics for Engineers and Scientist, Wiley International.
3. K.S.Trivedi (1982) - Probability and Statistics, Prentice Hall.
4. B.S. Grewal (1989)- Higher Engineering Mathematics, Khanna Publishers.

# ICE 202: INDUSTRIAL INSTRUMENTATION - I [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Standards:** Classification, Mass and length, frequency and time, temperature, luminous intensity, electrical, emf, resistance current. SI Units and Dimensional analysis. **(03 hrs.)**

**Temperature Measurement:** Temperature and heat, Definitions, temperature scales, bimetallic thermometers, filled-bulb and glass stem thermometers. Resistance Temperature Detector (RTD), principle and types, measuring circuits, Linear and Quadratic approximation. Thermistors, principle and sensor types, linearization methods and applications. Thermocouples: Thermoelectric effects, laws of thermocouple, cold junction compensation techniques, thermocouple types, construction. Solid-state temperature sensors, radiation methods, optical pyrometers. **(12 hrs.)**

**Pressure Measurement:** Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement: Mc Leod gauge, Knudsen gauge, Pirani gauge, Thermal conductivity gauges, Ionization gauges. **(12 hrs.)**

**Level Measurement:** Direct methods, Indirect methods, Electrical conductivity, Capacitive, Radioactive, Ultrasonic, Nucleonic methods, Level measurement by capacitance probes, solid-state level measurement. **(07 hrs.)**

**pH Measurement:** Concept and methods of pH Measurement, Electrodes – Hydrogen, Calomel, Quinhydrone, Antimony, Glass, Sensing Devices of pH meter. **(04 hrs.)**

**Moisture and Humidity Measurement:** Moisture content of materials, method of measurement, Humidity measurements. **(04 hrs.)**
**Measurement of Viscocity:** Falling sphere viscometer, falling piston viscometer, rotating cylinder viscometer, capillary tube viscometer, orifice type viscometer. **(04 hrs.)**

**Measurement of Thickness:** Inductive, capacitive and ultrasonic methods. **(02 hrs.)**

**TEXT BOOKS:**

1. Doeblin E.O. (1992)- Measurement Systems: Application and Design, Fourth Edition, McGraw Hill, New York.
2. Patranabis D (1997)- Principles of Industrial Instrumentation, Second Edition, Tata McGraw Hill, New Delhi.

**REFERENCES:**

1. Noltingk B. E. (1996) - Instrumentation Reference Book, Second Edition, Butter worth Heinemann, Oxford.
2. Liptak B. G (1995)- handbook of Process Measurement and Analysis, Third Edition, Chilton Book Company, Radnor, Pennsylvania.
3. Douglas M. Considine (1993)- Process / Industrial Instruments & Controls Handbook, Fourth Edition, McGraw Hill, Singapore.

4. Kerlin T. W. (1999)- Practical Thermocouple Thermometry, ISA Press, New York.
5. Gillum .D. (1995)- Industrial Pressure, Level and Density Measurement, ISA Press, NewYork.
6. Smith.E (1984)- Principles of Industrial Measurement for control Applications, ISA Press, NewYork.
7. A. K . Sawhney (2002)- A course in Mechanical Measurement and Instrumentation , 12/e, Dhanpat Rai and Co, New Delhi.

## ICE 204.1 INDUSTRIAL INSTRUMENTATION [3 0 0 3]

**Hours/ week: 3L**
**Number of credits: 3**

**Measurement System and Transducers:** Block Diagram, functional description of measuring systems, Classification of transducers- Active, Passive, Mechanical, Electrical, Comparison. Selection of Transducers, LVDT, and Strain gauges **(07 hrs)**

**Temperature and Pressure measurement:** Temperature and heat, Definitions, temperature scales, Resistance Temperature Detector (RTD), principle and types, measuring circuits, Thermistors, principle and sensor types, Thermocouples basic principle and construction. Pressure-Manometers-basic principle, Differential Pressure transmitters, Dead weight Pressure gauges **(10hrs)**

**Level and Thickness measurement:** Electrical conductivity, Capacitive, Radioactive, Ultrasonic, Nucleonic methods, Thickness- Inductive, capacitive and ultrasonic methods**. (05 hrs)**

**Flow measurement:** classification of flow meters, orifice meters, venturi meter, variable area flow meters, Laser Doppler Anemometer (LDA), ultrasonic flow meters, Doppler flow meters, V-cone flow meters, purge flow regulators, Measurement of mass flowrate: Radiation, angular momentum **(07 hrs)**

**Miscellaneous measurement:** Measurement of Thermal conductivity, velocity measurement, acceleration, pH measurement, Force measurement, Semiconductor sensors, LDR photoelectric transducers, Brush type optical displacement transducers, optical encoders- photo optic transducers. **(07hrs)**

**REFERENCES:**

1. A.K. Sawhney (2002) - Electrical & Electronic Measurements and Instrumentation, Dhanpat Rai & Co, New Delhi.
2. Doeblin E.O. (1992)- Measurement Systems: Application and Design, Fourth Edition, McGraw Hill, New York.
3. Patranabis D (1997)- Principles of Industrial Instrumentation, Second Edition, Tata McGraw Hill, New Delhi.
4. A. K . Sawhney (2002)- A course in Mechanical Measurement and Instrumentation , 12/e, Dhanpat Rai and Co, New Delhi.
5. Liptak B. G. (1995) - Process Measurement and Analysis, Third Edition, Chilton Book Company, Pennsylvania

## ICE 204.2: CONTROL SYSTEM [3 0 0 3]

**Hours/ week: 3L**
**Number of credits: 3**

**Introduction to feedback control systems:** Concept of transfer function, Mathematical modelling of Electrical Systems, Mechanical and Electromechanical systems, Analogous Systems. Block diagram representation of physical systems- block diagram reduction technique- signal flow graph- Masons gain formula. **(10 hrs.)**

**Time Response Analysis:** Response of systems for different time based inputs, Classification of feedback control system according to type, static error coefficients- generalized steady state errors- steady state errors due to impulse, step, ramp and parabolic inputs. **(08 hrs.)**

**Frequency Domain Analysis:** Frequency domain specifications for second order systems. Correlation between frequency domain and time domain specifications. **(04 hrs.)**

**Stability Analysis:** BIBO stability, Location of roots of the characteristic equation, Routh Hurwitz criteria for absolute / relative stability. Root locus plots – construction of the root locus diagram- Interpretation of system response from these plots. Bode plots- gain margin and phase margin , Polar plots, Nyquist stability criterion, gain margin and phase margin. **(16 hrs.)**

**TEXT BOOKS:**

1. Farid Golnaraghi, Benjamin Kuo, Automatic Control Systems, 9th Edition, John Wiley and Sons, 2010.
2. Norman S. Nise, Control System Engineering, 4th Edition, John Wiley and Sons, 2004.
3. K. Ogata, Modern Control Engineering, 4th Edition, Prentice Hall, 2002

# ICE 206: ELECTRICAL MACHINES [3 1 0 4]

**Hours/ week: 3L+1T**
**Number of credits: 4**

**D.C. Machines:**
D.C. generator – Construction, principle of operation, types of generators-Losses and Efficiency of D.C Generator, O.C.C of D.C Generator. Principles of working of motor, torque equation, characteristics, Speed control, D.C Three point Starter

**(10 hrs**

**Transformers:**
Construction, Types, Principle of Operation, Voltage and Current Transformation ratios effect of voltage and Frequency Variations-Transformer On Load-Resistance and Leakage Reactance-Phasor Diagram of Actual Transformer on Load-Equivalent Resistance and Reactance-Equivalent circuit of a Transformer-Voltage Regulation-Determination of regulation of Transformer From Open-Circuit and Short-Circuit Tests-Transformer Efficiency- Autotransformer- 3-phase Transformer construction- Three Phase Transformer connections. **(07 hrs.)**

**Induction Motor:**
Construction – principle of operation – Equivalent circuit, slip, frequency of rotor current, rotor current and power factor, rotor torque, Effect of change in supply voltage on torque and slip (speed),Full load torque and maximum torque, starting torque and maximum torque, torque, current speed characteristic, –slip characteristics – losses and efficiency – Speed Control by rotor resistance and pole changing – star-delta Starter, Autotransformer starter, direct-on-line starter.

**(12 hrs.)**

**Single Phase Induction Motor:**
Principle of operation by Double Revolving field theory –Equivalent circuit- starting methods and Types of single Phase Induction Motors-Resistance start –Capacitor start, Capacitor start, Capacitor-Run-Permanent Capacitor-Shaded pole, Split phase-Universal motor.

**(06 hrs.)**

**Alternator:**
Construction, - EMF equation – Regulation by EMF method – Synchronization with the mains.
**(06 hrs.**)

**Synchronous Motor:** Construction, principle, Starting methods, V and inverted V curves.
**(03 hrs.)**

**Special Machines:** Stepper motors, Tacho generators, Brushless motors, AC and DC servo motors.
**(04 hrs.)**

**REFERENCES :**

1. Say M.G.,( 1994 ) *Alternating Current Machines (5e),* ELBS.,
2. Langsdorf E.H.( 1994.), *Theory of Alternating Current Machine (2e),* TMH.
3. Nagrath, I.J. & D.P. Kothari,(1997)*Electric Machines (2e),* TMH,.
4. Mukherjee P. K & Chakravorti S(1993), *Electrical Machines*, Dhanpat Rai & Sons.
5. Bimbhra P.S.,(1994) *Electrical Machinery (3e),* Khanna Pub.

6. Mukherjee P. K & Chakravorti S., (1993) *Electrical Machines*, Dhanpat Rai & Sons,.

# ICE 208: LINEAR CONTROL THEORY [3 1 0 4]

**Hours/week: 3L+1T**
**Number of credits: 4**

Introduction: To feedback control systems- concept of transfer function – Derivation of transfer function for typical control system components- block diagram representation of physical systems- block diagram reduction technique- signal flow graph- Masons gain formula. (08 hrs.)

Derivations of time domain specifications for second order systems. Steady - State Errors: Classification of feedback control system according to type, static error coefficients- generalized steady state errors- steady state errors due to impulse, step, ramp and parabolic inputs. (08 hrs.)

Frequency Domain Analysis: Frequency domain specifications for second order systems. Correlation between frequency domain and time domain specifications. (04 hrs.)

Stability Analysis: BIBO stability, Location of roots of the characteristic equation, Routh Hurwitz criteria for absolute / relative stability. Root locus plots – construction of the root locus diagram- Interpretation of system response from these plots. Bode plots- gain margin and phase margin , Polar plots, Nyquist stability criterion, gain margin and phase margin. (16 hrs.)

System Compensation: Using elementary lag, lead and lead- lag compensating networks. Phase lead design using Bode diagram and root locus. Phase lag design using Bode diagram and root locus. Phase lag- lead design using Bode diagram and root locus. Pole Placement using Root locus. (12 hrs.)

**REFERENCES:**

1. John J.D'Azzo and Constantine H. Houpis(2007)- Feedback control system analysis and synthesis, McGraw Hill New-York.
2. Nagrath and Gopal (2001)- Control Systems engineering, 2/e New Age International (P) Limited.
3. R.C Dorf and R.H Bishop (1998) - Modern Control Systems, 8/e Addison- Wesley Longman Inc.
4. K. Ogata (2002) - Modern control engineering 3/e Prentice Hall India.
5. B.C. Kuo, F. Golnaraghi (2003)- Automatic Control Systems, (8/e) Wiley India
6. Distefano, Stubberud, Williams (2007) – Feedback and Control Systems, (2/e) Tata McGraw Hill
7. A. Ramakalyan (2004) Control Engineering- A comprehensive foundation, Vikas Publishing House, New Delhi.
8. Norman S. Nise (2003) – Control Systems Engineering (4/e), Wiley India

# ICE 210: ANALOG SYSTEM DESIGN [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Feedback Amplifiers:** Classification, concepts, feedback amplifier topologies, classification-voltage series, voltage shunt, current series, current shunt, properties of negative feedback amplifier, effect of feedback on $R_i$, $R_o$ and bandwidth, advantages of negative feedback. **(08 hrs)**

**Operational Amplifier:** Architecture, two-stage architecture, gain stage with active load, small signal model, differential stage, difference mode and common mode gains, CMRR, D.C. level shifting, current mirror, offset voltage and current, slew rate limitations. Basic information of Op-amp – Packages, Op-amp Terminals, Power Supply Connections. (**06 hrs**)

**Op-amp Applications:** inverting and non-inverting amplifier, voltage follower, phase shifter, differential amplifier, instrumentation amplifier, summing amplifier, differentiator, integrator, voltage to current converter, current to voltage converter, clippers, clampers, **solving second order differential equations using opamps**, active filters- low pass, high pass, band pass, band rejection, and all pass filters (Butterworth). (**12 hrs**)

**Nonlinear Applications of Op-amps:** Comparator, Schmitt trigger, astable multivibrator, monostable multivibrator, triangular wave generator, precision rectifier, peak detector, zero-crossing detector, square wave generator, ramp generator, V/f and f/V converters. **(08 hrs)**

**Other Linear IC's:** 555 Timer, architecture, applications, (Astable multivibrator, Monostable multivibrator, Schmitt trigger, ramp generator), phase locked loops, voltage controlled oscillators. **(08hrs)**

**Oscillators:** R-C phase shift, Wein-bridge using op-amp, and crystal oscillators. Resonant Oscillators. **(06 hrs)**

**REFERENCES:**


1. Jacob Millman and Arvin Grabel (1982) - Micro Electronics ( Ed.2). MGH
2. Ramakant Gayakwad(1990) - Op Amps and Linear Integrated Circuits (Ed. 2). Pearson education (Singapore) Pvt ltd.
3. Sergio Franko (1989)- Design with Operational Amplifiers and Analog Integrated Circuits.
4. Robert F. Coughlin and Frederick S. Driscoll (2002) - Operational Amplifiers and Linear Integrated Circuits. Pearson education (Singapore) Pvt ltd.
5. Sedra and Smith(2000) - Micro Electronic Circuits.Oxford university press.
6. D Roy Choudhury and Shail Jain (2003)- Linear Integrated Circuits. New age International pvt.Ltd.

# ICE 212: TRANSDUCERS LABORATORY [0 0 3 1]

**Total number of lab. Classes -12**

**List of experiments:**

1. Measurement of strain using strain gauges, Load Cell Characteristics.
2. Measurement of temperature using RTD, Thermocouple.
3. Measurement of angular and linear displacement using Potentiometer.
4. Measurement of displacement using LVDT, Capacitive.
5. Measurement of temperature using semiconductor sensor, Thermister.
6. Study the Characteristics of LDR, Photodiode, Photo Transistor.
7. Secondary Transducer Bridges: Anderson Bridge, Hay's Bridge, De'sautys Bridge.
8. Piezoelectric Transducer Trainer, Force/ weight measurement using Piezo- transducer, Piezoelectric transducer for impact measurement with attenuator and peak detector.
9. Measurement of electrical parameters.
10. Absolute instrumental encoder.
11. Measurement of motor speed using magnetic pick up, Hall effect, Stroboscope.
12. Measurement of distance using Ultrasonic sensor, sound sensing transducer.

**REFERENCES:**

1. A.K Sawhney (2002),A course in Electrical and Electronic Instrumentation Measurements, 7th Edition, Dhanpat Rai & co, New Delhi.
2. D.V.S. Murthy (1995) , Transducers and Instrumentation, PH, New Delhi.
3. Patrananis (1999) , Sensors and Transducers, wheeler Publishing, New Delhi .
4. E.O.Doeblin. (1992 ) Measurement Systems – application and Design, 4th Edition, McGraw Hill, New York.
5. B. S. Sonde (1977), Transducers and Display Systems – TMH.

## ICE 214: ANALOG ELECTRONIC LAB [0 0 3 1]

1. Clipping ,clamping
2. Full wave rectifier with and without filter
3. Regulated power supply using Zener,78XX and 79XX
4. Variable Voltage regulator using 78XX and LM317
5. Frequency Response of RC coupled Amplifier
6. Inverting and Non inverting amplifiers using OPAMP
7. Integrator and differentiator using OPAMP
8. Comparator and Schmitt trigger circuits using OPAMP
9. Astable and Monostable multivibrator using OPAMP
10. Wein Bridge Oscillator using OPAMP
11. Astable multivibrator using 555 timer
12. Monostable Multivibrator using 555 timer

**REFERENCES:**

1. Malvino (1999) –Electronic Principles,TMH
2. Ramakanth Gayakwad (1992) – Opamp and linear Integrated Circuits
3. Adel Sedra and Kenneth Smith Harcourt ((1991)-Microelectronic Circuits

# V SEMESTER INSTRUMENTATION & CONTROL
# ICE 301: MODERN CONTROL THEORY [3 1 0 4]

**Hours/week: 3L+1T**
**Number of credits: 4**

**State Space Analysis:** Introduction to state concept, state equation of linear continuous data systems. Matrix representation of state equations. Phase variable and canonical form of state representation. Derivation of state models from transfer function and ordinary differential equation. Solution of state transition matrix and state equations. Controllability and observability. Pole placement –Ackerman's formula, state feedback and output feedback, Observer design. **(20 hrs.)**

**Non Linear Systems:** Characteristics of non- linear systems, common type of non-linearities, Phase plane analysis of non linear systems- construction of the phase trajectory by Isocline's method, Pell's method and delta method. Singular points on phase plane. **(08 hrs.)**

**Describing Function Analysis:** Determination of describing function for various nonlinearities viz, On-off, dead zone, on-off with dead zone, saturation, saturation with dead zone, Hysteresis, on-off with Hysteresis, Hysteresis with dead zone, Viscous friction, linear transfer through dead zone, square nonlinearity, cubic nonlinearity etc. Application of describing function of stability analysis of systems with single nonlinearity. **(12 hrs.)**

**Lyapunov Stability Analysis:** Definition of stability, instability and asymptotic stability, Sign definiteness, scalar functions. Sylvester's criterion, Lyapunov Theorems of stability, instability and asymptotic stability. Stability in the large. Illustrative examples on the application of Lyapunov's second Method. **(08 hrs.)**

**REFERENCES:**

1. K. Ogata (2002) Modern control engineering, Prentice Hall India.
2. M. Gopal (1984) Modern control system theory, Wiley Eastern Limited.
3. Gibson - Nonlinear control theory, McGraw Hill Kogakusha Co. Ltd.
4. Cunningham W.J. - Nonlinear analysis, McGraw Hill.
5. K. Ogata (1967) State space analysis of control systems. Prentice Hall India.
6. A.Ramakalyan (2004) - Control Engineering- A comprehensive foundation, Vikas Publishing House, New Delhi.

# ICE 303: INDUSTRIAL INSTRUMENTATION – II [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Flow Measurement:** Introduction, definitions and units, classification of flow meters, Pitot tubes, orifice plate, orifice meters, venturi meter, venturi tubes, flow tubes, flow nozzles, positive displacement liquid meters and provers, positive displacement gas flowmeters, variable area flowmeters. **(08 hrs)**

**Anemometers:** Hot wire / hot film anemometer, Laser Doppler Anemometer (LDA), electromagnetic flowmeter, turbine and other rotary element flowmeters, ultrasonic flowmeters, Doppler flowmeters, cross-correlation flowmeters, vortex flowmeters. Measurement of mass flowrate: Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, coriolis, gyroscopic and heat transfer type mass flowmeters. Target flowmeters, V-cone flowmeters, purge flow regulators, flow switches, flowmeter calibration concepts, flowmeter selection and application. **(12 hrs)**

**Measurement of Speed and Acceleration:** Tachometers - Mechanical, Electric, Contact less, Frequency, Ignition, Stroboscopic tachometers. Comparative methods, Elementary accelerometers, Seismic, Practical accelerometers. **(06 hrs)**

**Weight, Force and Torque Measurement:** Weight and weight rate of flow, continuous weighing, force and torque measurements**.** **(04 hrs)**

**Electro Magnetic Coupling:** Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding. Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety. **(09 hrs)**

Measurement of Thermal conductivity of solids, liquids and gases. **(02 hrs)**

**Velocity and Vibration Measurements:** Measurement of linear velocity, digital transducers, Doppler effect, Nature of vibrations, vibrometers. **(03 hrs)**

**Accelerometers:** Potentiometric type, LVDT type, strain gauge, piezo-electric type and variable reluctance type. **(04 hrs)**

**TEXT BOOKS:**

1. Doeblin E. O (1992) - Measurement Systems: Application and Design, Fourth Edition, McGraw Hill, Singapore.
2. R.K. Jain (1996) - Mechanical and Industrial Measurements, Tenth Edition, Tata McGraw Hill, New Delhi.
3. A.K . Sawhney (2002), - A course in mechanical measurements and instrumentation, Dhanpat Rai & Co.
4. John P Bentley (2005), - Principles of Measurement systems, Pearson Education.

**REFERENCES:**

1. Andrew W. G. (1992)- Applied Instrumentation in Process Industries - A Survey, Vol.1 & Vol.2, Gulf Publishing Company, Houston.
2. Liptak B. G. (1995) - Process Measurement and Analysis, Third Edition, Chilton Book Company, Pennsylvania.
3. Considine D. M.(1993) - Process Instruments and Control Handbook, Fourth Edition, McGraw Hill, Singapore

## ICE 305: MICROPROCESSORS AND MICROCONTROLLERS [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**8085 Processor:** Architecture of 8-bit microprocessors, bus configurations, CPU module, introduction to assembly language and machine language programming, instruction set of a typical 8-bit microprocessor, subroutines and stacks, Serial and parallel data transfer schemes, interrupts and interrupt service routines. 8085 interrupts and vector locations, SIM and RIM instructions, RST instructions, programming exercises.

**(12hrs.)**

**Memory Technology:** Timing diagrams , RAM, DRAM and ROM families, memory interfacing, programmable peripheral interface chips, programmable interval timer. Memory map, peripheral I/O and memory- mapped I/O**.** **(04 hrs.)**

**8086 Processor:** Architecture, Addressing Modes, Instruction set and Assembly language programming. Assemblers and advanced programming. Signals of 8086, Min & max mode of operation, Interrupts & Interrupt processing in 8086. (**14 hrs.)**

**Microcontrollers:** Introduction to Microcontrollers, Architecture, RISC and CISC processors.
**(04 hrs.)**

**8051 Microcontrollers:** Architecture and Instruction set of 8051 Microcontrollers. Programming of 8051 microcontrollers. **(09 hrs.)**

**PIC Microcontrollers:** Architecture and Introduction to PIC microcontrollers; Instruction set and programming of 8 bit PIC microcontrollers**.** **(05 hrs.)**

**REFERENCES:**

1. Ramesh S.Gaonkar, (1997), "Microprocessor Architecture, Programming and Applications", Penram Pub. Third edition,.
2. K.Udaya Kumar, Umashankar B.V, (1996), "Advanced microprocessor & IBM PC assembly language programming", Tata McGrawHill.
3. Mazidi M. A. & J. G. Mazidi, (2002) – "The 8051 Microcontroller and embedded systems", Pearson.
4. Kenneth J Ayala, (2002),– "The 8051 Microcontroller architecture programming and applications" 2nd Edition ,Penram International publishing.
5. Barry B. Brey ,(1998) –"Intel Microprocessors: architecture, programming, Interfacing", Prentice Hall India-Fourth Edition.
6. J.B. Peatman, (2001) – "Design with PIC microcontrollers" , Pearson Education Asia,

# ICE 307: SYSTEM MODELING [ 3 1 0 4]

**Hours/week:3L+1T**
**No. of credit: 4**

**Introduction of System Modeling**: Mathematical modeling of Systems by transfer function approach. Mathematical modeling of Electrical Systems, Mechanical and electromechanical systems, Analogous Systems. (08 hrs.)

**Mathematical Modelling**: Liquid level systems, Interacting and non interacting tanks, Pneumatic systems, Hydraulic systems, Thermal systems, Chemical systems, Thermometer bulb, Numerical on models of systems. (08 hrs.)

**Vibration: Rotational mechanical systems**. Vibration isolation. Dynamic Vibration absorbers. Vibrations in multi-degrees of freedoms, Vibration transmissivity. (06 hrs.)

**PID controllers and their characteristics**.Application of PID controllers (04 hrs.)

**Mathematical Modeling**: Dynamics of Aerospace Vehicles, Aircraft longitudinal and lateral dynamics. Longitudinal and lateral autopilots, Missile auto pilot, Missile Guidance system description, Ship Dynamics on three axes. (12 hrs.)

**Mathematical Modeling:** Instrument Servo, Gear train, Inverted Pendulum, Hydraulically actuated gun turret, two axis Gyroscope Distillation Columns, Synchros, Batch reactors. (10 hrs.)

REFERENCES:

1. B. Friedland - An introduction to State Space Methods - Mc.Graw Hill Company, Newyork.
2. K. Ogatta (1998)- Systems Dynamics – 3rd edition - Prentice Hall INC.
3. Umez-Eronini 1999- System Dynamics and Control, Brooks/Cole – Publishing Company
4. R.C. Dorf and R. H. Bishop (1998) - Modern Control systems, 8/e Addition-Wesley Longman,INC.
5. Norman S. Nise (2000) Control System Engineering, John Wiley and sons.

# ICE 309: DATA ACQUISITION AND INTERFACING [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Data Acquisition System:** Introduction to Data acquisition systems, Analog switches, high and low level analog multiplexers, Sample and hold circuits and their specifications, accuracy considerations and applications.

**(10 hrs.)**

**Monolithic ADC 's and DAC's:** Microprocessor compatible ADC's. Discussions on ADC 0816 and ICL 7109 monolithic ADC's. The concepts of Delta-Sigma converters. Selection criteria for ADC and DAC's. Design of multimeter using IC 7109

**(06 hrs)**

**Phase Locked Loop:** Operating principles, lock range, capture range, PLL as frequency multiplier, phase shifter and signal synchronizer.

**(04 hrs.)**

**Interfacing Peripherals with 8085 Microprocessor:** Functional block diagram, control word and modes of operation of:

Programmable I/O - 8212,8155, 8755
Programmable interval timer- 8253
Programmable interrupt controller- 8259
DMA controller- 8257
Programmable display and keyboard interface - 8279
USART- 8251 (**13 hrs.)**

**Interfacing of Keyboard:** Display LEDs, 7-segment, multiplexed (both LEDs and LCDs), DAC and ADC, generation of PWM, communication for the PIC micro controllers, and applications of micro controllers. Ex: RPM meter, event counter, temperature controller . Monolithic timer and its application, voltage regulators.

**(15 hrs.)**

**REFERENCES:**

1. Sergio Franco –( 2001). Design of operational amps and analog IC's, McGraw Hill.
2. Hnatek, (1976).Handbook of A/D & D/A converters, John Wiley.
3. Douglas V. Hall (1992).- Microprocessors and Interfacing , TMH
4. Gilmore(1995) - Microprocessors , TMH,1995.

**FOR FURTHER READING:**

1. Coughlin and Driscoll (2000) - Op.amp and applications,.
2. J.B. Peatman (1972) Design of Digital systems TMH,New York,

# ICE 311: DIGITAL SYSTEM DESIGN [3 1 0 4]

**Hours / week: 4**
**Number of credits: 4**

Review of combinational and sequential logic design **(4hrs)**

**Digital implementation options:** Digital System implementation using MSI/LSI circuits like PLDs, PLAs and PALs; ASICs – Full custom, Semi custom (CBIC & MPGA), Programmable ASICs (PLDs & FPGAs), standard parts, Comparison based on performance & cost, Design flow **(4hrs)**

**Digital system modelling:** Domains – behavioural, structural, physical, levels of abstraction, high level, RTL level and logic synthesis, HDL **(3hrs)**

**VHDL:** Entity and architectures, behavioural, data-flow and structural modelling, sequential and concurrent constructs, packages and libraries, VHDL styles for synthesis, Design case studies – combinational, sequential, FSM, RTL, arithmetic units, Linked state machines, memory. Test bench code. **(18hrs)**

**Programmable ASICs:** Architecture of CPLDs and FPGAs, Antifuse, SRAM, EEPROM based technologies, Xilinx, Altera and Actel logic cells, I/O cells, programmable interconnect, Design flow, P&R, CAD tools for FPGA based design, Reconfigurable computing **(12hrs)**

**Testing & Verification:** Testing combinational circuits: Different fault models, path sensitization algorithm. Testing sequential circuits: sequential test methods; Functional & Timing simulation, delay models, boundary scan, faults, fault simulation, ATPG, BIST, DFT, Verification **(7hrs)**

**REFERENCES:**

1. M.J.S.Smith, ASICs, Pearson Education, 1997
2. C.H. Roth, Digital system design using VHDL,PWS,1998
3. BROWN, Fundamentals of Digital Logic with VHDL Design (With CD), TMH,
4. Peter Ashenden, The Designer's Guide to VHDL, 1996
5. BHASKER J., A VHDL PRIMER, 3RD ED, PHI

# ICE 313: MICROPROCESSORS LABORATORY [0 0 3 1]

**Hours/ week: 3**
**Number of credits: 1**

1. Familiarization of 8085 and 8086 Microprocessor systems.
2. Study of Data Transfer Instructions
3. Study of arithmetic instructions
4. Multiplication and Division programs
5. Logical and branch instructions
6. Array handling
7. Code Conversion
8. Counters and Time delay generation
9. Monitor routines for keyboard and display
10. Interrupts and waveform generation
11. Interfacing peripherals – 8255, ADC, DAC and waveform generation
12. Interfacing -A. Stepper motor interface, B. Elevator interface

Note: The above programming exercises will be conducted using 8085 and 8086 kits.

**REFERENCES:**

1. B. Rama, (2003) – "Fundamentals of Microprocessor and Microcomputer", Dhanpat Rai Publications.
2. Ramesh S.Gaonkar, (1997) – "Microprocessor Architecture, Programming and Applications", Penram Publications.
3. Douglas V Hall, (2006) – "Microprocessors and Interfacing", Tata McGrawhill.
4. K. J Ayala, (2009) – "The 8086 Microprocessor: Programming and interfacing the PC", Cengage Learning.

# ICE 315: INSTRUMENTATION LABORATORY [0 0 3 1]

**Total number of lab. Classes -12**

**List of experiments:**

1. Measurement of Flow using Head type flow meters.
   (Orifice, Venturi, V-Notch, U-tube)
2. Measurement of Flow using Rotameter.
3. Level measurement using Ultrasonic Transducer, Capacitive Transducer, Float level Transducer.
4. Measurement of pressure using pressure transducer.
5. Characteristics of synchros, Thickness measurement.
6. Calibration of pressure using Dead weight tester.
7. Measurement of torque using photo reflector method
8. Measurement of Viscosity using Saybolt and Redwood Viscometer.
9. Study of Accelerometers, Laser Doppler Anemometer.
10. Measurement of Humidity, Measurement of Conductivity.
11. Study of Burglar Alarm, Measurement of Air Flow and Air velocity using Anemometers, Measurement of temperature using Radiation method.
12. Measurement of PH using Combination Electrode.

**REFERENCES:**

1. C S Rangan ,G R Sarma and V S V Mani (2004), Instrumentation Devices & Systems,2nd Edition, Tata McGraw Hill, New Delhi.
2. A..K Sawhney (2002),A course in Electrical and Electronic Instrumentation Measurements, 7th Edition, Dhanpat Rai & co, New Delhi.
3. E.O.Doeblin, (1992) Measurement Systems – application and Design, 4th Edition, McGraw Hill, New York.
4. R.K. Jain (1996) Mechanical and Industrial Measurements, Tenth Edition, Tata McGraw Hill, New Delhi.
5. B.G.Liptak (1995) Process Measurement and Analysis, Third Edition, Chilton Book Company, Pennsylvania.

# VI SEMESTER INSTRUMENTATION & CONTROL

## ICE 302 ANALYTICAL INSTRUMENTATION [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**COLORIMETRY AND SPECTROPHOTOMETRY**
Special methods of analysis, Beer-Lambert law, Deviation from Beer's Law, Colorimeters: UV-Vis spectrophotometers – Single and double beam instruments, sources and detectors, IR spectrophotometers – types, sources and detectors, Attenuated total reflectance flame photometers, Atomic absorption spectrophotometers, FTIR spectrophotometers, Flame emission photometers.
**(10 hrs.)**

**CHROMATOGRAPHY**
Different techniques, Paper chromatography, Gas chromatography - Detectors, Liquid chromatography - Applications, Ion Chromatography, High-pressure (performance) liquid chromatography (HPLC)– Applications, Thin Layer Chromatography, Affinity Chromatography, Paper Electrophoresis, Gel Electrophoresis **(09 hrs.)**

**INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS**
Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide and their estimations, Photochemical Smog: Causes, Behaviour, Effects, Dust and smoke measurements, IR analyzer **(07 hrs.)**

**pH METERS AND DISSOLVED COMPONENT ANALYZERS**
Principle of pH/ pOH measurement, Buffer Solutions, Reference electrodes: Hydrogen electrodes, Metal-Metal ion electrodes, Calomel Electrodes, Quinhydrone electrodes, Ion selective electrodes: Glass Membrane type, Solid state type, Gas sensing type, Bio catalytic membrane electrodes
**(08hrs.)**

**RADIO CHEMICAL AND MAGNETIC RESONANCE TECHNIQUES**
Nuclear radiations: Types, Detectors – GM counter, Proportional counter, Solid state detectors, X-ray spectroscopy (instrumentation), NMR spectrometer: Basic principles, Instrumentation & Applications. ESR Spectrometers: Theory, Instrumentation & Applications, Mass spectrometers: Instrumentation & Applications **(14 hrs.)**

**TEXT BOOKS**

1. Robert D. Braun, (1987)'Introduction to Instrumental Analysis', McGraw Hill, Singapore.
2. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle,(1995) 'Instrumental methods of analysis', CBS publishing & distribution.

**REFERENCE BOOKS**

1. Gurdeep R Chatwal & Sham K Prasad (2009), 'Instrumental Methods of Chemical Analysis', Himalaya Publication House
2. G.W.Ewing, (1992)'Instrumental Methods of Analysis', McGraw Hill.
3. DA Skoog and D.M.West, (1985)'Principles of Instrumental Analysis', Holt,

Saunders Publishing.

4. C.K. Mann, T.J Vickers & W.H. Gullick, (1974)'Instrumental Analysis', Harper and Row publishers.
5. C.S. Rao, 'Environmental Pollution Control Engineering', New Age International Publication
6. R.S. Khandpur, (2003)'Handbook of Analytical Instruments', Tata McGraw Hill publishing Co. Ltd.

# ICE 304: DIGITAL CONTROL SYSTEMS [3 1 0 4]

**Hours/week: 3L + 1T**
**Number of credits: 4**

**Sampled Data Control System:** Introduction, sampling process, system representation in terms of difference equations, Realizations, The z transform and z transfer function, Inverse z transform and response of linear discrete system. z- transforms analysis of sampled data control system. z and s domain relationship. Pulse transfer functions zero order hold, Steady state error analysis. **(14 hrs.)**

**Stability Analysis:** Jury's stability test, bilinear transformation, z domain Nyquist stability, stability analysis using root locus diagram. Correlation between time response and root locus in the z plane and s plane. **(06 hrs.)**

**State Variable Method:** discrete time state equations, similarity transformations, state diagrams, Realization of pulse transfer function, direct, cascade, parallel realizations, solution of discrete state equations, Controllability and absorbability of discrete systems. Pole placement, Lyapunov stability analysis. **(14 hrs.)**

**Design and Compensation:** Design of sampled data control system. Cascade compensation, DIR method, lead, lag, lag- lead compensators, Digital compensator design using root locus plots, Digital compensator design using Frequency response plots. PID controllers. Deadbeat algorithm. **(14 hrs.)**

**REFERENCES:**

1. K. Ogata (1987)- Discrete time control systems PHI.
2. M. Gopal (1997)- Digital control and state variable methods. Tata McGraw Hill New Delhi.
3. C.H Houpis and G.B Lamont (1998) - Digital Control Systems.
4. Krishna Kant (1998)- Computer based Industrial control PHI.
5. Curtis Johnson (1993)- Process control Instrumentation technology, 4/e, PHI.
6. A.Ramakalyan(2004) - Control Engineering- A comprehensive foundation, Vikas Publishing House, New Delhi.

## ICE 306: POWER ELECTRONICS [3 1 0 4]

**Hours/week: 3L + 1T**
**No. of credits: 4**

**Silicon Controlled Rectifiers (SCR):** Basic structure, operation V-I characteristics, turn ON, turn OFF mechanism, Gate drive requirements, di/dt, dv/dt and overload protection. Series and parallel operation of SCR-static & dynamic voltage distribution, string efficiency. **(07 hrs.)**

**Gate Trigger Circuits of SCR:** UJT trigger circuits, Line synchronous trigger circuits triggering of series & parallel connected SCRs. **(02 hrs.)**

**Traic, GTO, BJT, Power MOSFET, IGBT:** Basic structure, equivalent circuit, operation, terminal characteristics, safe operating area (SOA), device ratings, base/gate drive requirements. **(06 hrs.)**

**Commutating Circuits:** Resonant commutation, complimentary commutation, auxiliary commutation. **(03 hrs.)**

**Line Commuted Converters:** Single-phase converters – half wave, half – controlled and fully controlled bridge converters. Operation with R, RL and back-emf loads, performance with freewheeling diode, effect of source inductance. **(10 hrs.)**

**Three-Phase Converters:** Half wave, half – controlled and fully controlled bridge triggering sequence operation, effect of source inductance. **(06 hrs.)**
Dual converters, cyclo-converters. **(02 hrs.)**

**Switching Power Converters:** DC – DC Converters: Basic principle of Time ratio control, constant and variable frequency TRC. Step down and step up choppers. Morgan's Chopper, Jone's Chopper. AC regulators (Three phase and Single Phase). **(06 hrs.)**

**Inverters:** Single Phase series and parallel inverters, Bridge inverters: single phase bridge inverters, principle of operation, commutation circuits, three phase inverters - 120° & 180° modes of operation. Line commuted inverters. **(06 hrs.)**

**REFERENCES:**

1. Bimbhra P.S. (1999) - Power Electronics (3e), Khanna Publication.
2. M. Ramamurthy – Thyristors and their Application (East-West Press).
3. Ned Mohan et. al. - Power Electronics, Converters, Applications & Design (2e), Wiley.
4. Rashid M.H. (1994) - Power Electronics, Circuits, Devices and Applications, PHI.
5. Hart D. W. (1997) - Introduction to Power Electronics, PH.

# ICE 308.1: COMPUTER CONTROL OF PROCESS [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

Computer control – Introduction – Review of Z Transform, Modified Z Transform and Delta Transform. Relation between Discrete and Continuous Transfer function-Poles and Zeros of Sampled Data System (SDS) – Stability Analysis in Z domain. (10 Hrs)

Introduction to Pulse Transfer function- Open loop and closed loop response of SDS- Design and implementation of different digital control algorithm: Dead beat, Dahlin, Smith predictor and Internal Model Control algorithm with examples. (10 Hrs)

Different Models of Discrete System: LTI System:- Family of Discrete Transfer function Models- State Space models- Distributed Parameter Model. Models for Time varying and Non-linear System: Linear Time varying models- Non-linear State space models- Non-linear Black Box Models- Fuzzy Models (10 Hrs)

Parameter Estimation Methods: General Principles- Minimizing Prediction errors- Linear Regression and the Least Square method- Statistical Frame work for Parameter Estimation and the Maximum Likely hood method- Instrument Variable method – Recursive and Weighted Least square method (10 Hrs)

Adaptive Control: Introduction -Deterministic Self Tuning Regulator: Indirect and Direct self tuning regulator-Model reference Adaptive system: Design of MRAS using Lyapnov and MIT Rule- Auto tuning and Gain scheduling adaptive control design with examples. (08 Hrs)

TEXT BOOK

1. Lennart Ljung- System Identification Theory for the user – PTR Printice Hall Information and system sciences Series, NJ, 1999.
2. P. Deshponde and Ash, Computer Controlled System ISA Press, USA
3. Richard H. Middleton and Graham C. Goodwin 'Digital Control and Estimation A Unified Approach'Printice Hall NJ, 1990
4. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp,' Process Dynamics and Control Willey India, 2006.
5. Astrom .K. J, Bjorn Wittenmark, Adaptive Control, Second Edition, Prentice Hall of India, New Delhi, 1994.
6. M. Chidambaram, Computer Control of Processes, Alpha Science International Ltd, 2002.
7. Krishna Kant, Computer-based Industrial Control, Prentice-hall Of India Pvt Ltd, 2008.

# ICE 308.2: BIO-MEDICAL INSTRUMENTATION [4 0 0 4]

**Hours/ week: 3L**
**Number of credits: 3**

**Resting and Action Potentials:** Neuron, Nervous system, Synapse, Propagation of action potential, Reflexes, Electroencephalogram, Epilepsy, EEG recording techniques, Wave types, Brain Tumour. **(08 hrs.)**

**The Heart, its working:** Cardiovascular system, ECG amplifiers, Electrode, Leads- single and three channel ECG recorders, Cardiac arrhythmias, Cardiac pacemakers and defibrillators, Heart lung machine. Function of kidneys and their failures-artificial kidney and dialysis - Haemodialysis and peritoneal dialysis, Respiratory system and skin and its functions. **(14 hrs.)**

**Muscle:** Muscle reaction, Electromyogram, X-ray instrumentation, Computerized axial tomography scanners, Intensive care unit, bedside and central monitoring systems. **(09 hrs.)**

**Respiration Measurements: A**rtificial respirator, oximeter, BP measurement-direct type, indirect type, blood flow measurements, MRI, Colour Doppler systems, ultrasound scanner, nerve stimulator, diathermy. **(08 hrs)**

Endoscopes, Neonatal Instrumentation, Incubators Apnoea monitor, Lithotripsy **(09 hrs)**

**REFERENCES:**

1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer (1991) - Biomedical Instrumentations and Measurements (2e), PHI.
2. Raghbir Singh Khandpur(1975)- Electronic Instrumentation in Medical Practice, Kothari Publications.
3. Bertil Jacobson & John G. Webster (1979)- Medicine and Clinical Engineering, PH.
4. Khandpur R. S. (1987)- Handbook of Biomedical Instrumentation, TMH.
5. Geddes L. A. & L. E. Baker (1989) - Principles of Applied Biomedical Instrumentation, Wiley.

# ICE 308.3 : CHEMICAL PROCESS SYSTEMS [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

Typical products and their and uses, Systematic analysis of chemical processes. Flow sheets and symbols for various operations. Variation in process conditions, raw materials and fuels – effect on end products and economy. **(10 hrs.)**

Overall Balances, Component balances in engineering equipment, combustion reactions, Stoichiometric balances in manufacturing processes. **(08 hrs.)**

Forms of energy, Total balance, Heat balance, Heat effects and combustion reactions, Energy balances in manufacturing processes, optimum utilization of energy, Heat transfer operations in chemical reactors. Equipments- Fundamental concepts in heat exchangers, Evaporators and distillation column, Design and classification of heat exchangers, Evaporators and distillation column. **(14hrs.)**

Fundamental principles and classification of heat exchangers, Evaporators, Distillation columns and equipment for Agitation and mixing of fluids dimensional analysis to estimate power consumption for agitation. **(10 hrs.)**

Energy Conservation in process systems and industries, Optimization principles and pinch analysis to calculate energy consumption. **(06 hrs.)**

**TEXT BOOK:**

1. W.L. McCabe, J.C. Smith and P. Harriott, “Unit Operations of Chemical Engineering”, sixth Edition, McGraw Hill, 2001.
2. Walter L.Badger and Julivst. Banchero “Introduction to Chemical Engineering”, Tata McGraw Hill publishing company, 1997

**REFERENCES:**

1. L.B. Anderson and L.A. Wenzel, “Introduction to Chemical Engineering”, McGraw Hill, 1961.
2. P.Harriot, “Process Control”, McGraw Hill, 1984.
3. D.A. Reay, “Industrial Energy Conservation”, McGraw-Hill, New York, 1979.

# ICE 308.4: OBJECT ORIENTED PROGRAMMING WITH C++ [4 0 0 4]

**Hours/week : 4L**
**Number of credits: 4**

Software evolution, basic concepts of OOP, benefits and applications of OOP. (02 hrs)

Structure of C++ Program: Data Types: Basic, user-defined and derived, operators-assignment, arithmetic, relational, logical, increment/decrement, conditional, precedence of operators, manipulators, decision statements, programming control statements. (05 hrs)

Functions: Main Function, Function Prototyping, Call and return by reference, Inline functions, Default and constant arguments. (04 hrs)

Objects and Classes: Private, public, protected, friend, virtual functions, pointers to members, constructors, destructors, overloaded constructors and destructors. (07 hrs)

Overloading Operators: Unary and binary operators. Multiple overloading: Overloading comparison and assignment operators. (04 hrs)

Data Conversion: Conversions between basic data types, conversions between objects and basic types, conversions between objects of different classes. Function overloading. (04 hrs)

Inheritance: Single inheritance, multilevel inheritance, multiple inheritance: Derived class and base class, derived class constructors, overriding member functions, private and public inheritance. Hierarchical inheritance, abstract base class. Templates: Class templates and function templates. (08 hrs)

Pointers and Virtual Functions: Pointers to Objects, this pointer, pointers to derived classes, virtual function and pure virtual functions. (04 hrs)

Working with files: Classes for file stream operations, opening and closing a file, detecting end of file, file modes, file pointers and manipulations, updating and error handling, command line arguments. (04 hrs)

Linked lists: Operation, Double linked list, circular linked, linked list with pointers. (03 hrs)

Graphics in C++: Text mode graphic functions graphic mode graphic functions, inheritance in graphics. (03 hrs)

**REFERENCES:**

1. Kanetkar Y., (1999), Let Us C++, BPB Pub.
2. Balagurusamy E.,( 2001), Object oriented programming with C++, TMH.
3. Lafore R., (2001), Object oriented programming with turbo C++, Galgotia Pub.
4. Schildt H., (1999), C++ The Complete Reference (3e) TMH.
5. K.R. Venugopal, (2007), Mastering C++., TMH

# ICE 308.5: NEURAL NETWORKS AND FUZZY LOGIC [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Fundamentals:** Artificial Neural Networks, Mc-Culloch – Pitts model, Activation functions, Feedforward and feedback networks, learning rules – Hebbian, Perceptron, delta, Widrow-Hoff, winner take all. **(06 hrs.)**

**Single-layer Feedforward Networks:** Classifiers, Decision regions, Discriminant functions, minimum distance classification, multi category discrete perceptron training algorithm. (**03 hrs.)**

**Multi-layer Feedforward Networks:** Linearly non-separable pattern classification, generalized delta-learning rule, error back propagation training algorithms, Kohenen networks, auto associative networks **(08hrs.)**

**Single-layer Feedback Network:** Hopfield network, Boltzman machine, associative memories, performance analysis of energy function reduction, Bi-directional associative memory. **(06 hrs.)**

**Application of Neural Networks:** Control applications, Character recognition. **(02 hrs.)**

**Fuzzy sets and Membership:** Uncertainty in Information – Fuzzy set operations – Properties of Fuzzy Sets – Fuzzy Relations – Tolearance and Equivalence relations – Composition. **(04 hrs.)**

**Features of Membership functions:** Standard forms and Boundaries – Fuzzification – Membership value assignments. **(03 hrs.)**

**Fuzzy to Crisp Conversions:** Lambda Cuts – Defuzzification methods Extension Principle – Fuzzy Numbers. (**03 hrs.)**

**Fuzzy Rule based Systems:** Linguistic Hedges – Aggregation and Inference rules – Control System design – Assumptions – Fuzzy logic controllers – General models – Industrial applications. (**06 hrs.)**

**Fuzzy Pattern Recognition:** Feature Analysis, Partitions of feature space, single sample identification, multifeature pattern recognition, image processing. **(07 hrs.)**

**REFERENCES:**

1. Jacek M. Zurada (1997)- Introduction to Artificial Neural Networks, Jaico.
2. Yegnanarayana B. (2001)- Artificial Neural Networks, PHI.
3. Timothy J. Ross (1997)- Fuzzy logic with engineering applications, MGH.
4. Yager & Filev (1994)- Essentials of fuzzy modelling and control, Wiley.
5. Chin-Teng (1996)-Lin and C. S. George Lee - Neural Fuzzy Systems, PH.

# ICE 310: DIGITAL SIGNAL PROCESSING [3 1 0 4]

**Hours/ week: 3L +1T**
**Number of credits: 4**

**Overview of Systems:** The properties of systems, the LTI systems, their properties, Analog and discrete signals, Laplace transforms, Transfer function and Impulse response.
**(04 hrs.)**

**Convolution and Correlation of Signals:** Derivation on convolution and related problems, Derivation on correlation and related problems. **(06 hrs.)**

**Discrete Time Signal Analysis:** Exponential periodic sequence, discrete- time Fourier series, discrete frequency spectrum, discrete- time Fourier transform, Fourier transform to discrete- time Fourier transform, Z- transform to discrete- time Fourier transform. **(10 hrs.)**

**Discrete Fourier Transforms:** Periodic and finite duration sequences, odd and even sequences, properties of DFT, linear convolution using DFT, FFT algorithms (decimation in time, decimation in frequency algorithms). **(08 hrs.)**

**IIR Filter Design:** Classical Filter design using Butterworth, Chebyshev and elliptic approximations, Impulse invariant and bilinear transformation methods. Spectral transformation technique for HP, BP and BS filter design. Direct design of IIR filters. Finite word length effects.
**(08 hrs.)**

**Filter Structures:** Direct form I, Direct form II, PSOS and CSOS forms, lattice structures.
**(02 hrs.)**

**FIR Filter Design:** FIR filter design by Fourier approximation, Gibbs's phenomenon, window functions –rectangular, Bartlett, Hamming and Kaiser windows. FIR filter design using frequency-sampling method. Remez exchange algorithm. **(06 hrs.)**

**Applications of DSP:** Applications in image processing, speech processing, biomedical signal processing and communication. **(04 hrs.)**

**REFERENCES:**

1 A.V.Oppenheim and R.W Schafer (1992) - "Discrete time signal processing", PHI.
2 J.G Proakis and D.G Amnolakis - Introduction to digital signal processing, PHI.
3. J.R Johnson - "Introduction to digital signal processing".
4. D.J De Fatta, J.G.Lucas and W.S. Hodgkiss (1988)- "Digital signal processing" John Wiley.
5. Wills J.Tompkins (1993) - "Biomedical digital signal processing" Prentice-Hall.
6. Texas instruments DSP processors (320 family) data handbook.
7. Analog devices DSP Processors data handbook.
8. Rabiner and Gold - (1975) "Theory and Applications of digital signal processing", PHI.

# ICE 312.1: PROGRAMMABLE LOGIC CONTROLLER [3 0 0 3]

**Hours/week: 3L**
**Number of credits: 3**

**Evolution of PLC:** Introduction, Process Control, Evolution of Process Control. Programmable Logic Controllers: History, Types, PLC Vs PC, Advantages and Applications of PLC. (5)

**Architecture of PLC:** Introduction, Components of PLCs: I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply. Working of a PLC, Selection and Operational Safety. (5)

**Programming a PLC:** Scan Cycle, Contacts and Symbols, Program Format and Languages, Dos and Don'ts, PLC Memory. **Bit Logic Operations:** Implementation of AND, OR, NOR, NAND XOR gates, Latching Function with ON/OFF priority, Set & Reset Bits, Flip Flops, Multiplexers and Demultiplexers implementation. (7)

**Timers & Counters:** Characteristics and Classification of Timers, ON Delay, OFF Delay, Retentive and Non-Retentive Timers. Difference between timers and counters, working of a PLC counter, Types – Up, Down, Up-Down, High speed counters. (6)

**Special Instructions:** Arithmetic Instructions, Comparison Instructions, Trigonometric Instructions, Data Handling Instructions, Sequential Functions. (4)

**Analog PLC Operations & Networking of PLC**: Analog PLC operations, special analog modules, PID Instructions. Levels of Industrial control, Types of Networking, Buts Networks, Protocols, PLC and Internet. (6)

**Applications of PLC:** Material handling applications, automatic control applications, Bottling, Spray Painting applications, Conveyor belt, automatic car washing machine, and process control applications. (3)

**Text Books:**

1. John W.Webb and Ronald A.Reis, "Programmable Logic Controllers – Principles and Applications", Fifth Edition, Prentice-Hall India, 2003.
2. W. Bolton, "Programmable Logic Controllers", Fourth Edition, Newnes Publications, 2006.
3. Frank D. Petruzella "Programmable Logic Controllers", McGraw- Hill book, company, 1989.

**References:**

1. Siemens "PLC Handbook"

# ICE 312.2: VIRTUAL INSTRUMENTATION [3 0 0 3]

**Hours/ week: 3L**
**Number of credits: 3**

**Review of virtual Instrumentation:** Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. **(07 hrs)**

**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. **(07 hrs)**

**Data Acquisition Basics:** ADC, DAC, DIO, counters & timers, PC Hardware structure, timing, interrupts, DMA, software and hardware installation. **(07 hrs)**

**Common Instrument Interfaces:** Current loop, RS 232C/ RS485, GPIB, System buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI, etc., networking basics for office & Industrial applications, VISA and IVI, image acquisition and processing. Motion control. **(07 hrs)**

**Use of Analysis Tools:** Fourier transforms, power spectrum, correlation methods, windowing & filtering. VI applications in various fields. **(04 hrs)**

**Input and Output** -Origin of signals, transducers, sensors, actuators, connections **(03 hrs)**

**Instrument Drivers basics** - Interchangeable virtual instruments, Communication standards, Protocols and basic message passing, Analog and Digital DAQ. Process control applications, real time work, single loop controller and multi loop controller. **(03 hrs)**

**TEXT BOOKS:**

1. Gary Johnson (1997) - Labview Graphical Programming, Second edition, McGraw Hill, New York.
2. Lisa K. wells & Jeffrey Travis (1997)- Labview

# ICE 314 CONTROL SYSTEM SIMULATION LABORATORY[0 0 3 1]

1 Familiarization with Matlab Control system tool box.

2 Block diagram reduction Technique

3 Time domain analysis and steady state errors

4 State space analysis

5 Stability analysis

6 Controller design by frequency domain methods

7 Controller design by time domain methods

8 Modeling practice with SIMULINK

9 Root locus design by GUI

10 Discrete time systems

11 Digital system design

12 Non linear system Analysis using matlab

**REFERENCES:**

1. K. Ogata (2002) - Modern Control Engineering, 3/e PHI.
2. R.C. Dorf and R. H. Bishop (1998) - Modern Control systems, 8/e Addition-Wesley Longman,INC.
3. Norman S. Nise –(2000) Control Systems 3/e Wiley.

# ICE 316: MICROCONTROLLER LABORATORY [0 0 3 1]

**Hours/ week: 3**
**Number of credits: 1**

1. Familiarization to 8051 and PIC microcontrollers.
2. Addition and subtraction programs.
3. Multiplication and division programs.
4. Array handling.
5. Code conversion.
6. Generate a PWM waveform whose width can be increased/decreased using switches.
7. Convert the analog voltage to digital using ADC and store the data in memory.
8. Generate the given waveform using DAC.
9. Using display and keys write program to work as a stop clock and counter.
10. Interface a matrix keyboard and display the key pressed.
11. On-OFF temperature controller.
12. RPM meter and Stepper motor control.

**Note**: The above experiments are to be conducted using simulators, ICD/IDE and interfacing cards.

**REFERENCES:**

1. J. B. Peatman - Design with PIC Microcontrollers, PHI.
2. Micro chip, PIC Micro mid range MCU family reference manual.
3. F. P. Volpe and S. Volpe - PIC's in practice, elector, Electronic (Publishing).
4. Mazidi M. A. & J. G. Mazidi, (2002) – "The 8051 Microcontroller and embedded systems", Pearson.
5. Kenneth J Ayala,( 2002),– "The 8051 Microcontroller architecture programming and applications" 2nd Edition , Penram International publishi

# VII SEMESTER INSTRUMENTATION & CONTROL

## ICE 401: PROCESS INSTRUMENTATION AND CONTROL [4 0 0 4]

**Hours/ week**: **4L**
**Number of credits: 4**

**INTRODUCTION:** Need for process control, process control terminology – mathematical model of first order level, pressure and thermal processes – higher order process – interacting and non-interacting systems – continuous and batch process – self-regulation – servo and regulator operation. **(10 hrs)**

**CONTROL ACTIONS AND CONTROLLERS:** Basic control actions – characteristics of on-off, proportional, single-speed floating, integral and derivative control modes – P+I, P+D and P+I+D control modes pneumatic and electronic controllers to realize various control actions. **(09 hrs)**

**OPTIMUM CONTROLLER SETTINGS:** Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio – determination of optimum settings for mathematically described processes using time response and frequency response – tuning – process reaction curve method – Ziegler Nichols method – damped oscillation method. **(09 hrs)**

**MULTILOOP CONTROL:** Feed forward control – ratio control – cascade control – inferential control – split range control – introduction to multivariable control – examples from distillation column and boiler systems, RG Analysis, Internal Model Controller. **(10 hrs)**

**FINAL CONTROL ELEMENT:** I/P converter – pneumatic and electric actuators – valve positioner – control values – characteristics of control valves – inherent and installed characteristics – valve body – commercial valve bodies – control valve sizing – cavitation and flashing – selection criteria. **(10 hrs)**

**TEXT BOOKS:**

1. Stephanopoulis, G, Chemical Process Control, Prentice Hall of India, New Delhi, 1990.
2. Eckman. D.P., Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993.
3. Curtis D. Johnson, Process Control Instrumentation Technology, Eighth Edition PHI, 2009.

**REFERENCES:**

1. Pollard A. Process Control, Heinemann educational books, London, 1971.
2. Harriott. P., Process Control, Tata McGraw-Hill Publishing Co., New Delhi, 1991.
3. Donald Coughanowr, Process Systems Analysis and Control, McGraw-Hill, Inc., 1991.

# HUM 401: ESSENTIALS OF MANAGEMENT [3 0 0 3]

**Hours/week: 3L**
**No. of credits : 3**

**Definition of Management:** Its nature & scope. The functions of managers.
Planning: types of plans, Steps in Planning, Process of MBO, How to set Objectives, Strategies, Policies & Planning Premises.
Strategic Planning Process: Decision Making: Steps in Decision Making, Systems approach.
**(10 hrs.)**

**Organizing:** Nature & Purpose of Organizing, Span of management, factors determining the Span, Basic Departmentation, Line & staff concepts, Functional authority, Art of Delegation, Decentralization of Authority. **(09 hrs.)**

**Human Resource Management:** systems Approach to Staffing, selection Process, Techniques & Instruments, Approaches to Manager Development & Training. **(07 hrs.)**

**Basic Control Process, Critical points & Standards:**
Control techniques: Budget, non – budgetary control devices. Overall & preventive controls: Budget summaries: Profit and Loss control, control through ROI, direct control, preventive control, developing excellent managers. **(10 hrs.)**

**International Management:** Managerial practices in Japan & USA & application of Theory Z. The nature & purpose of International business & multinational corporations, unified global theory of management. **(02 hrs.)**

**TEXT BOOK:**
Koontz - Essentials of management

**REFERENCES:**
1. Peter Drucker - Management, Task & Responsibility.
2. Peter Drucker - The practice of management.

# ICE 403 VIRTUAL INSTRUMENTATION [3 1 0 4]

**Hours/ week: 3L+1T**

**Number of credits: 4**

**Review of virtual Instrumentation:** Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. **(7 hrs.)**

**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. **(7 hrs.)**

**Data Acquisition Basics:** ADC, DAC, DIO, counters & timers, PC Hardware structure, timing, interrupts, DMA, software and hardware installation. **(7 hrs.)**

**Common Instrument Interfaces:** Current loop, RS 232C/ RS485, GPIB, System buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI, etc., networking basics for office & Industrial applications, VISA and IVI, image acquisition and processing. Motion control. **(07 hrs.)**

**Use of Analysis Tools:** Fourier transforms, power spectrum, correlation methods, windowing & filtering. VI applications in various fields. **(04 hrs.)**

**Input and Output** -Origin of signals, transducers, sensors, actuators, connections **(3 hrs)**

**Instrument Drivers basics** - Interchangeable virtual instruments, Communication standards, Protocols and basic message passing, Analog and Digital DAQ. Process control applications, real time work, single loop controller and multi loop controller. **(3 hrs)**

**TEXT BOOKS:**

1. Gary Johnson (1997)- Labview Graphical Programming, Second edition, McGraw Hill, Newyork.
2. Lisa K. wells & Jeffrey Travis (1997)- Labview for every one, National Instruments

# ICE 405.1 : OPTICAL INSTRUMENTATION [4 0 0 4]

**Hours / week: 4L**
**No. of credits : 4**

**Optical Interferometry:** Michelson interferometer – Applications and variations of the Michelson interferometer Multiple beam interference in a parallel plate, Fabry – Perot interferometer, Fringe Profiles – The Airy function.

**(06 hrs.)**

**Elements of Lasers:** A qualitative description, absorption, spontaneous emission and stimulated emission, line broadening, rate equations for lasers with optical pumping, Q switched lasers, mode locking. Laser Instruments: Laser interferometry, velocimetry, pulse echo technique, beam modulation telemetry and holography.

**(12 hrs.)**

**Opto Electronic Devices:** Special Detection Schemes, PIN diodes, solar cells, semiconductor laser – basic operation, steady state analysis and modulation, DBR and DFB lasers, Array lasers, surface emitting lasers.

**(10 hrs.)**

**Optical Communication and Storage:** Optical communication – Light modulation scheme, optical fiber, intermodal dispersion, graded - index fiber, low – dispersion fibers, fiber loses.
Optical detectors, emitters, integrated optics, optical bistability Laser printing, optical disk systems – recording, recording media. Data readout from optical disks, erasable optical disks.

**(12 hrs.)**

**Optical Fiber Sensors:** Multimode passive and active fiber sensors, phase-modulated sensors, fiber optic gyroscope.

**(03 hrs.)**

**Optical Device Fabrication: P**lanar processing, substrate growth and preparation deposition and growth of material, material modification, etching, lithography, optical fiber fabrication.

**(05 hrs.)**

**REFERENCES:**

1. Wilson & Hawkes (1992) - Optoelectronics, Prentice – Hall of Indian Pvt. Ltd.
2. A.Ghatak and K.Thyagarajan (1996) - Optical Electronic, Cambridge University Press.
3. R.Syms and J.Cozens (1993) - Optical guided waves and Devices , McGraw – Hill International.
4. Chin – Lin chen (1996) - Elements of optoelectronics & Fiber optics by, IRWIN group.
5. P. Bhattacharya (1997) - Semiconductor optoelectronic devices by, Pearson Education Asia group.
6. Jasprit Singh (1996) – Semiconductor Optoelectronic – An introduction to Materials and Devices by McGraw – Hill Companies International.

## ICE 405.2: MICROPROCESSOR BASED SYSTEM DESIGN [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

**1. Review of 8086:**
Architecture and Programming – Multiuser/multitasking operating system concepts, Memory management, Architectural features of the advanced processors of the intel family – i286, i386, i486, Pentium processors and Multimedia extensions – Applications. **(16 hrs.)**

**2. Programming Issues:**
Programming aspects of the above processors – IA64 architecture. **(05 hrs.)**

**3. Control Applications:**
Microprocessors for control applications – Micro controller based design of a system – Real time control using micro controllers-microcontroller based temperature monitoring and control. **(09hrs.)**

**4. Interfacing:**
Interfacing with peripheral devices – Peripheral controllers – Bus concepts – Bus standards – Examples – Choosing a bus standard for an application. Digital interfacing- Keyboard interfacing, LED displays interfacing, interfacing to high power devices. **(14 hrs.)**

**5. Special Purpose Processors:** **(04 hrs.)**
Coprocessors, DSP processors, Graphic processors and their applications.

**REFERENCES:**
1. Barrey B. Brey (1998) – The INTEL Microprocessor 8086/8088,8-186,286,386,486, Pentium and Pentium. - Professor – Architecture, Programming and Interfacing, PHI.
2. Barrey B. Brey - Programming the 80286,80386,80486 and Pentium – based Personal Micro Processor. - Manuals (available at Websites).
3. Douglas V Hall (2006)- Microprocessors and Interfacing, Tata McGraw-Hill
4. Dogan Ibrahim (2002), Microcontroller Based Temperature Monitoring and Control , Elsevier Science & Technology Books
5. Micro Processor Manuals (available at Websites).
6. Texas Instruments / Analog Devices Manuals for Graphics Processors and DSP Processors.

## ICE 405.3 Robotic Systems and Control [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

**Introduction:** Introduction to robotics, Components and Structure of Robots, Common Kinematic arrangements, Rotations, Composition of Rotations, Properties, Homogeneous Transformation, Skew symmetric Matrices, Angular Velocity and Acceleration, additional of angular velocities. (10)

**Forward and Velocity Kinematics:** Kinematic Chains, Denavit-Hartenberg Representation, Derivation of the Jacobian, Examples, Singularities, Inverse Velocity and acceleration. (5)

**Dynamics:** Euler-Lagrange Equations, Expressions for kinetic and potential energy, Equation of Motions, Common configuration, Newton Euler Formulation, Planor Elbow Manipulator Revisited. (8)

**Controls:** Introduction, Actuator dynamics, Set-Point Tracking, Drive Train Dynamics, Trajectory Interpolation, Feed forward Control and Computed Torque, PD control revisited, Inverse Dynamics, Implementation and Robustness Issues, Robust outer loop design. (12)

**Force Control:** Natural and artificial constraints, stiffness and compliance, Inverse response in task space, Impedance Control, Hybrid Position/Force Control. (5)

**Feedback Linearization:** The Frobenius theorem, Single-Input Systems, Feedback Linearization for N-Link Robots, Introduction to outer loop design-Lyapunov's Second Method, Methods of Sliding Modes. (8)

**Reference:**

1. Mark W.Spong & M.Vidyasagar. "Robot Dynamics and Control", Willey India Publisher, 2009. ISBN: 978-81-265-1780-0.
2. Lee, K.S. Fu, R.C. Gonzalez & C.S.G - Robotics , McGraw Hill.
3. Bruno Sicilian (1996) - Modelling and controlling of Robot manipulations ,Lorenzo Seivicco, TMH.

**FURTHER READING:**

1. Wolfram Stadler (1995) - Analytical robotics and Mechatronics, TMH.
2. Robert J. Schilling (1996)- Fundamentals of Robotics Analysis and control , PHI.

# ICE 405.4: LOGIC AND DISTRIBUTED CONTROL SYSTEMS [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Review of Computers in Process Control:** Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC).Supervisory Control And Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. Alarms, interrupts. Characteristics of digital data, controller software, linearization. Digital controller Modes: Error, proportional, derivative and composite controller modes. **(08 hrs.)**

**Programmable Logic Controller (PLC) Basics:** Definition, overview of PLC systems, input/output modules, power supplies and isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions, PLC Basic Functions, register basics, timer functions, counter functions. **(10 hrs.)**

**PLC Intermediate Functions:** Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilising digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance. Design of interlocks and alarms using PLC, creating ladder diagrams from process control descriptions. **(10 hrs.)**

**Interface and Backplane Bus Standards for Instrumentation Systems:** Field bus: Introduction, concept. HART protocol: Method of operation, structure, operating conditions and applications. Smart transmitters, smart valves and smart actuators. **(10 hrs.)**

**Distributed Control Systems (DCS):** Definition, Local Control Unit (LCU) architecture, LCU languages, LCU – Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS. **(10 hrs.)**

**TEXT BOOKS:**

1. John. W. Webb Ronald A Reis (1998) - Programmable Logic Controllers - Principles and Applications, Fourth edition, Prentice Hall Inc., New Jersey.
2. Lukcas M.P (1986)- Distributed Control Systems, Van Nostrand Reinhold Co., New York.
3. Frank D. Petruzella (1997)- Programmable Logic Controllers, Second edition, McGraw Hill, New York.

**REFERENCES:**

1. Deshpande P.B and Ash R.H (1995) - Elements of Process Control Applications, ISA Press, New York.
2. Curtis D. Johnson (2002)- Process Control Instrumentation Technology, Seventh edition, Prentice Hall, New Delhi.
3. Krishna Kant (1997)– Computer based Industrial Control, Prentice Hall, New Delhi.

# ICE 405.5: INSTRUMENTATION SYSTEM DESIGN [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

Basic concepts of transducer design: General transducer design consideration, testing of transducer, and selection criteria of transducer; interfacing of primary elements with end devices. Design of reference junction compensation and linearizing circuit for thermocouple and thermistor. Design of temperature measurement system based on RTD. Design of Displacement measurement system based using LVDT, Potentiometer, Ultrasonic transducer, Complete signal conditioning circuits for above temperature and Displacement transducers. (10 Hrs)

Design of orifice, rotameter, venture based flow system and signal conditioning circuits for above system. Design of square root extractor for variable head flowmeters. Orifice meter sizing for flow measurement. Design of control valves; Choice of valve body, materials and flow; lift characteristics; Control valve sizing. (10 Hrs)

Design of level sensors and its signal conditioning circuits, design of pressure gauge, diaphragm based pressure gauge, Load cell and its signal conditioning, Design of P/I and I/P converters, Design of smart transmitters. (10 Hrs)

Design of 2 and 4 wire transmitters with 4-20mA output; Design of pneumatic and electronic controllers; Design of instrumentation servomechanism; Design of annunciators; Low level and high level annunciators. (08 Hrs)

Design of microprocessor and microcontroller based instrumentation system; Design of interfacing circuits. Design of measurement system using object oriented approach. Preparation of instrumentation project; Process flow sheet; Instruments index sheet; Instrument specification; Choice of pressure, temperature, flow, level, analytical instrument and control panels. (10 Hrs)

**REFERENCES:**

1. E.O.Doebline, Measurement Systems, McGraw-Hill, 2003.
2. S. Soclof, Applications of Analog Integrated Circuit, PHI, 1985.
3. B.G.Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume Two: Process Control, CRC Press, 2005.
4. C.D, Johnson, Process control and Instrumentation technology, PHI, 2002.
5. John Bentley, Principles of Measurement Systems, Prentice Hall, 2004.
6. W.G.Andrew, H.B.Williams, Applied Instrumentation in the Process Industries (Vol. 4), Gulf Professional Publishing, 1993.

# ICE 407.1 : ANALOG AND DIGITAL COMMUNICATION SYSTEMS [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Amplitude Modulation: Transmission And Reception**: Principles of amplitude modulation - AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM power distribution, AM modulator circuits – low level AM modulator, medium power AM modulator, AM transmitters – Low level transmitters, high level transmitters, receiver parameters, AM reception – AM receivers – TRF, super heterodyne receiver, double conversion AM receivers. **(10hrs)**

**Angle Modulation: Transmission And Reception:** Angle modulation - FM and PM waveforms, phase deviation and modulation index, frequency deviation, phase and frequency modulators and demodulators, frequency spectrum of Angle – modulated waves. Bandwidth requirements for Angle-modulated waves, commercial Broadcast band FM, Average power of an angle-modulated wave, frequency and phase modulators, A direct FM transmitters, Indirect transmitters, Angle modulation Vs amplitude modulation, FM receivers: FM demodulators, PLL FM demodulators, FM noise suppression, frequency verses phase modulation. **(10hrs)**

**Digital Transmission And Data Communication:** Introduction, pulse modulation, PCM – PCM sampling, sampling rate, signal to quantization noise rate, companding – analog and digital – percentage error, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission – ISI, eye pattern, Data communication history, standards, data communication circuits, data communication codes, Error control, Hardware, serial and parallel interfaces, data modems, - Asynchronous modem, Synchronous modem, low-speed modem, medium and high speed modem, modem control. **(10hrs)**

**Digital Communication:** Introduction, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK bit rate and baud, FSK transmitter, BW consideration of FSK, FSK receiver, phase shift keying – binary phase shift keying – QPSK, Quadrature Amplitude modulation, bandwidth efficiency, carrier recovery – squaring loop, Costas loop, DPSK. **(09hrs)**

**Spread Spectrum And Multiple Access Techniques:** Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques – wireless communication, TDMA and FDMA, wireless communication systems, source coding of speech for wireless communications. **(09hrs)**

**REFERENCES:**

1. Wayne Tomasi, “Electronic Communication Systems: Fundamentals Through Advanced”, Pearson Education, 2001.
2. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons., 2001.

**REFERENCES**

1. Blake, “Electronic Communication Systems”, Thomson Delmar Publications, 2002.
2. Martin S.Roden, “Analog and Digital Communication System”, 3rd Edition, PHI, 2002.

# ICE 407.2: BIO-MEDICAL EQUIPMENTS [4 0 0 4]

**Hours/ week: 4L**
**Number of credits: 4**

**Respiratory Measurements and Aids:** Principles and techniques of impedance Pneumography and Pneumatochograph. Ventilators**:** Parameters, system concepts, flow gauges, valve, humidifiers, body respirators. **(07 hrs.)**

**Acoustic measurements and aids:** Common tests and procedures, air conduction, bone conduction, masking, schematic functional diagram of an audiometer. Hearing Aids**:** Different types, comparison of microphones, receivers and amplifiers.

**(08 hrs.)**

**Electro-surgical Units:** Principles of cutting, coagulation spark gap valve, transistorized generators, safety features.

**(04 hrs.)**

**Laser:** Basic principles, different types of laser, equipments used in surgery, safety.

**(04 hrs.)**

**Ultrasonics:** Basic principles, principles of echo cardiography echo encephalography with block diagrams, display devices for echo imaging, precautions. Endoscopes, neonatal instrumentation, incubators, apnea monitor, anasesthesia equipment. Lithotripsy – principles and applications.

**(10 hrs.)**

**Heart Lung Machine**: Governing principles, Qualitative requirements, functional details of bubble, thin film, membrane type of blood oxygenators.

**(5 hrs)**

**Hemodialysers**: qualitative requirements, General scheme of operations, types of exchangers, block diagram, electronic control and monitoring systems.

**(5 hrs)**

Intensive coronary care concepts, principles and applications of thermograph, infusion pump, blood cell counter

**(5 hrs)**

**REFERENCES:**

1. J.G. Webster–Medical instrumentation application &design, Houghton Miffin Co., Boston USA.
2. R.S. Khandpur - Handbook of Biomedical Instrumentation, McGraw Hill, Edition 2, 2003.
3. Joseph J. Carr & John. M. Brown - Introduction to Biomedical Equipment technology, pearson education, edition 4, 2003.
4. Mohan Murali H. (1985) - Monograph on Biomedical engineering, O.U. Press.
5. J.G. Webster, Encyclopedia of Medical Devices and Instrumentation, John Willey and Sons, 1988.

# ICE 407.3: MULTISENSOR DATA FUSION

**Hours/week: 4L**
**Number of credits: 4**

Multisensor data fusion: Introduction, sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics. (12 Hrs)

Taxonomy of algorithms for multisensor data fusion. Data association, Identity declaration. Estimation: Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches. (12 Hrs)

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion. (12 Hrs)

High performance data structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system. (12 Hrs)

TEXT BOOKS

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998.

REFERENCES

1. Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press, 1982.
2. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company, 1987.

# ICE 407.4: POWER PLANT INSTRUMENTATION AND CONTROL
# [4 0 0 4]

**Hours /week:4L**
**Number of credits:4**

**Boiler and Turbine Units:** Boiler, turbine units and its range systems, ideal steam cycles, feed water systems , steam circuits, combustion process, products of combustion process, fuel systems , treatment of flue gases, steam turbine, condensate systems, alternator, feed water conditioning, turbine bypass valves.

**(10 hrs.)**

**Measurement in Boiler and Turbine:** Metal temperature measurement in boilers, piping system for pressure measuring devices, smoke and dust monitor, flame monitoring. Steam turbine instrumentation: Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement. Installation of non-contracting transducers for speed measurement, rotor and casing movement and expansion measurement.

**(10 hrs.)**

**Controls in Boiler:** Problems associated with control of multiple pulverizers. Draught plant: Introduction, natural draught, forced draught, induced draught, power requirements for draught systems. Fan drives and control, control of airflow. Combustion control: Fuel/Air ratio, oxygen, CO and CO2 trimming, combustion efficiency, excess air, parallel and cross limited combustion control, control of large systems. Boiler drum level measurement methods, feed water control, soot-blowing operation, steam temperature control, super heat and reheat control, boiler following mode operation, turbine following mode operation, sliding pressure mode operation, selection between boiler and turbine following modes.

**(20 hrs.)**

**Nuclear Power Plant Instrumentation:** Piping and instrumentation diagram of different types of nuclear power plant, radiation detection instruments, nuclear reactor control system and allied instrumentation.

**(08 hrs.)**

**TEXT BOOKS:**

1. Sam .G. Dukelow (1991)- The Control of Boilers, second edition, ISA Press, New York.
2. Gill A.B (1984)- Power Plant Performance, Butterworth, London.
3. P.C Martin, I.W Hannah (1992) - Modern Power Station Practice, British Electricity International Vol. 1 & VI, Pergamon Press, London.

**REFERENCES:**

1. David Lindsley (1991)- Boiler Control Systems , McGraw Hill, New York.
2. Jervis M.J (1993)- Power Station Instrumentation, Butterworth Heinemann, Oxford.

# ICE 407.5: ROBUST AND OPTIMAL CONTROL [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

Introduction: Norms for signals and systems, Input- Output Relationships, Internal stability, Asymptotic Tracking, Performance.
Uncertainty and Robustness: Plant Uncertainty, Robust stability, Robust performance.
Stabilization: Controller parameterization for stable plant, Co-prime factorization, controller parameterization for general plant, Asymptotic properties, strong and simultaneous stabilization.

Design Constraints: Algebraic constraints, Analytic constraints.
Design for Performance: $P^{-1}$ stable, $P^{-1}$ unstable, Design example, 2-norm Minimization.
Stability Margin Optimization: Optimal Robust stability, Gain margin Optimization, Phase margin optimisation.
Design for Robust Performance: The modified problem, spectral factorization, solution of the modified problem, design. (24 hrs.)

Optimal Feedback Control: Formulation of optimal control problem, selection of performance criteria for minimum time, minimum energy, Minimum fuel, Principle of optimality, Hamilton – Jacobi- Bellman equation, State regulator, output regulator and tracking problems.

Discrete Linear Regulator Problems: Numerical solution of the Riccati equation. Use of linear state regulator results to solve other linear optimal control problems. Sub optimal linear regulators- continuous and discrete time systems. Minimum time problems, minimum control effort problems.
Calculation of Variations: Fundamental concepts, minimization of functions, minimization of functionals, functional of a single function, functionals involving several independent functions, Piecewise smooth extremals, constrained extremal, Pontryagins minimum principles, control and state variable inequality constraint.
Dynamic Programming: Multi stage decision process in discrete time, principle of causality and optimality, Multi stage decision process in continuous time. Numerical solution of two-point boundary value problem. Minimization of functions. The steepest decent method, The Fletcher-Powell method. (24 hrs.)

REFERENCES:

1. J.C. Doyle, B.A. Francis and A .R. Tannenbaum(1992) - Feedback control Theory Macmillan publishing company, New York.
2. K.Morris (2001)- Introduction to feedback control, Academic press, California.
3. B.A Francis (1987) - A course in $H^{\infty}$ control theory, Lecture notes in control and Information sciences, Spriger-Verlag, Berlin.
4. K. Ogata (1987)- Discrete time control systems PH.
5. M. Gopal (1988)- Digital control engineering. Wiley Eastern Limited, New Delhi.
6. Kirk D.E (1970)- Optimal control theory, an introduction. PH.
7. I .J Nagrath and M. Gopal (1982)- Control system engineering, 2/e Wiley Eastern limited, New Delhi.
8. A. Sinha (2007) – Linear Systems: Optimal and Robust Control, 1/e, CRC Press
   D. S. Naidu (2003) – Optimal Control Systems, 1/e, CRC Press

## ICE 407.6: INSTRUMENTATION AND CONTROL IN PETROCHEMICAL INDUSTRIES [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

**Introduction:** Refining Process: Schematic of a modern refinery, Physical Separation Processes, Chemical Catalytic Conversion Processes, Thermal Chemical Conversion Processes. Refinery Configuration and Type of Products. **(04 Hrs)**

**Instrumentation and Control in Chemical Reactors:** Reaction Rates and Kinetics, Time Constants, Temperature control: General, Cascade control, Pressure compensated temperature control, Model based temperature control, Pressure control. **(06 Hrs)**

**Instrumentation and control in Distillation Columns:** Distillation equipment, variables and degrees of freedom, measurement and control of column pressure, liquid distillate, vapour distillate and inserts, control of feed in reboiler and reflux, cascade and feed forward controls. **(07 Hrs)**

**Instrumentation and Control in Dryers:** Batch dryers and continuous dryers. **(04 Hrs)**

**Instrumentation and Control in Evaporators:** Types of evaporators, measurement and control of absolute pressure, density, conductivity, differential pressure and flow. **(04 Hrs)**

**Boiler Control:** Main inline instruments of a drum type boiler. Role of sensors. Burner management system (BMS), interlock systems and timing diagram. Feed water and Drum-Level Control. **(07 Hrs)**

**Instrumentation and control in Heat Exchangers:** Variables and degrees of freedom, liquid to liquid heat exchangers, steam heaters, condensers, reboilers and vaporisers, use of cascade and feed forward control. **(06 hrs.)**

**Control of Pumps:** Centrifugal pumps, rotary pumps, reciprocating pumps, throttling control, on-off control. **(04 hrs.)**

**Instrumentation and Control in Effluent and Water Treatment:** Chemical oxidation, chemical reduction, neutralization, precipitation and biological control. **(06 hrs.)**

**TEXT BOOKS:**

1. Fundamentals of Petroleum Refining, Elsevier, 2010.
2. Liptak B. G (1995)- Process Control, Third edition, Chilton Book Company, Pennsylvania.
3. Liptak B. G (1995)- Process Measurement and Analysis, Third edition, Chilton Book Company, Pennsylvania.

**REFERENCES:**

1. Luyben W.L (1989) - Simulation and Control for Chemical Engineers, Second edition, McGraw Hill, Singapore.
2. Sarkar G.N (1987)- Petroleum Refining, Khanna Publishers, New Delhi.
3. Considine D.M (1993)- Process / Industrial Instruments and Control Handbook, Fourth edition, McGraw Hill, Singapore.
4. Rao B.K.B (1987)- Petrochemicals, Khanna Publishers, New Delhi.

# ICE 409.1: REAL TIME EMBEDDED SYSTEMS [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

**Introduction to embedded systems:** characteristics of embedded computing applications, concept of real time system, challenges in embedded system design, design process. [6hrs]

**Embedded System Architecture:**Instruction set architecture, Basic embedded processor/microcontroller architecture, Memory system architecture, I/O subsystem, Co-processors and hardware accelerators. Processor performance enhancement. [8hrs]

**Designing Embedded computing platform:**CPU bus, Memory devices and their characteristics, I/O devices, Component interfacing, Designing with processors, development environment, Debugging techniques, Manufacturing and testing. [8hrs]

**Programming Embedded systems:**Program design, Design patterns, Models of program, Programming languages, Desired language characteristics, High level languages, Programing and run time environment, basic compilation techniques. [8hrs]

**Operating System:**Basic features of an operating system, kernel features, processes and threads, context switching, scheduling, Inter-process communication, Real-time memory management, I/O, Real-time OS, Evaluating and Optimising operating system performance, Power optimisation strategies for processes. [8hrs]

**Network Based Embedded Applications:**Network fundamentals, layers and protocols, Distributed Embedded architecture, Elements of protocol design, High level protocol design languages, Network based systems, Internet-Enabled systems, wireless applications. [5hrs]

**Embedded Control Applications:**Introduction, open loop and closed loop control systems, PID controllers, Fuzzy logic controller, Application Examples. [5hrs]

## TEXT BOOKS:

1. Evesham - Developing Real - Time Systems (1996) - A Practical Introduction ,Galgotia Publications, New Delhi.
2. Levi S and AgrawalaA.K (1990) - Real - Time System Design , McGraw Hill, Singapore.

## REFERENCE BOOKS:

1. Ball S.R (1996)- Embedded microprocessor systems - Real World Design, Prentice Hall.
2. HermaK(1997)- Real Time Systems – Design for Distributed Embedded Applications, Kluwer Academic.
3. Gassle J (1992)- Art of Programming Embedded Systems, Academic Press.
4. Gajski D.D, Vahid F, Narayan S(1994) - Specification and Design of Embedded Systems, PRT Prentice Hall.
5. Santa Clara (1991)- Intel manual on 16-bit embedded controllers.
6. Slater M (1989)- Microprocessor based design, a Comprehensive guide to effective hardware design, Prentice Hall, New Jersey.
7. Peatman, J.B (1989)- Design with Micro controllers, McGraw Hill, Singapore.
8. C.M. Krishna, Kang G. Shin (1997)- Real Time Systems, McGraw Hill.
9 Raymond J.A. Buhr, Donald L. Bailey (1999)- An Introduction to Real Time Systems, Prentice Hall,

# ICE 409.2: NONLINEAR CONTROL SYSTEM DESIGN [4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

**Introduction:** Nonlinear feedback control, modern nonlinear control, Linearization by state feedback, Inverse systems and zero dynamics, state feedback for uncertain systems, Nonlinear observers, output feedback, output feedback for uncertain systems, Physical control problems. **(12 hrs.)**

**State Feedback:** Pole placement for linear systems, feedback Linearization, Linearization by change of co-ordinates, partial feedback Linearization, stabilization of triangular systems, Global feedback Linearization, extension to multi-input systems, physical examples.

**(12hrs.)**

**Adaptive and Feedback Linearization:** Matching and triangular conditions, Robust stabilization, self tuning regulator, adaptive feedback Linearization, extension to multi input systems, physical examples. **(10hrs.)**

**Output Tracking:** Inverse systems and tracking dynamics, Input output feedback Linearization, disturbance rejection, disturbance attenuation, Adaptive tracking with transient specifications, extension to multi variable systems, examples. **(08 hrs.)**

**Output Feedback:** Adaptive observers, Observers for linear systems, observers with linear error dynamics, adaptive observers, extension to multi variable systems, examples. (**06 hrs.)**

**REFERENCES:**

1. R. Marino and P. Tomei (1995)- Nonlinear control design - Geometric, Adaptive and Robust,Prentice Hall, UK.
2. J.J.E.Slotine and W.Li (1998)- Applied Nonlinear control, Prentice Hall, Englewood cliffs, New Jersey

# ICE 409.3: MICRO ELECTRO MECHANICAL SYSTEMS [4 0 0 4]

**Hours/week: 4L** **Number of credits: 4**

**Introduction:** MEMS and Microsystems, Evolution of Microfabrication, Microsystems and Microelectronics, Applications of Microsystems in automotive industry and other industries. Microsensors: Acoustic wave, biosensors, chemical, optical, pressure, and thermal sensors. Microactuation: Actuation using thermal forces, shape memory alloys, piezoelectric crystals and electrostatic forces. **(08 hrs)**

**Electronic materials and processing:** Introduction, electronic materials and their deposition, pattern transfer, etching electronic materials, doping semiconductors. **MEMS Materials and Processing:** Overview, metals, semiconductors, ceramic, polymeric and composite materials. Silicon micro machining – bulk: Introduction, etch-stop techniques, dry etching, buried oxide process, silicon fusion bonding, anodic bonding. **(08 hrs)**

**Microsystem Design:** Static Bending of thin plates, mechanical vibration, thermomechanics, fracture mechanics, thinfilm mechanics, overview of Finite element stress analysis. Scaling laws in miniaturization. **(08 hrs)**

**Silicon Micro Machining–Bulk:** Introduction, Isotropic and Orientation-Dependent Wet Etching, Etch-Stop Techniques, Dry Etching, Buried Oxide Process, Silicon Fusion Bonding, Anodic Bonding. **(05 hrs)**

**Silicon Micro Machining–Surface:** Introduction, sacrificial layer technology, material systems in sacrificial layer technology, plasma etching, combined IC technology and anisotropic wet etching. **(06 hrs)**

**Micro Sensors:** Introduction, thermal sensors, radiation sensors, mechanical sensors, magnetic sensors, biochemical sensors and flow sensors. **SAW Devices:** Introduction, saw devices development and history, transducers in SAW devices, acoustic waves. **(06 hrs)**

**Microsterolithography:** Introduction, Scanning method, two photon MSL, Projection MSL, Polymeric MEMS Architecture with silicon, Metal and ceramics, Applications of MSL. **(04 hrs)**

**Packing:** Introduction, Considerations, Interfaces, Essential Technologies, assembly and selection of packaging materials. **(03 hrs)**

**TEXT BOOKS:**

1. Tai-Ran-Hsu (2002), MEMS and Microsystems: Design and Manufacture, Tata McGraw Hill.
2. S.M.Sze (1994). - Semiconductor Sensors, John Wiley & Sons, Inc.,
3. M.Elwenspoek, R.Wiegerink (2001)- Mechanical Microsensors, Springer-Verlag Berlin Heidelberg,.
4. Julian W. Gardner, Vijay K. Varadan (2001) - Microsensors, MEMS, and Smart Devices, John Wiley & Sons Ltd,.

**REFERENCES:**

1. Massood Tabib-Azar (1997) - Microactuators - Electrical, Magnetic, Thermal, Optical, Mechanical, Chemical and Smart structures, Kluwer Academic Publishers, NewYork.
2. Eric Udd (1995)- Fiber Optic Smart Structures, John Wiley & Sons, New York, 1995.

# ICE 409.4: IMAGE PROCESSING [4 0 0 4]

**Hours /week: 4L**
**Number of credits: 4**

**Introduction:** Elements of visual perception, sample image model, sampling and quantization, imaging geometry, discrete image mathematical characterization. **(06 hrs.)**

**Image Representation:** 2-D systems, linearity and space invariance, point spread function and convolution, 2-D Fourier transform and its properties, discrete cosine transform and KL transform. **(08 hrs.)**

**Image Compression & Coding:** Image compression and coding problems, data structures for picture representation. **(08 hrs.)**

**Image Segmentation:** Feature extraction, Point, Line and edge detection, thresholding, region based segmentation, segmentation using morphological waterheads, use of motion in segmentation. **(08hrs.)**

**Image Enhancement and Restoration:** Enhancement, contrast enhancement, histogram modification, Spatial operation, noise cleaning, edge crispening. Digital image restoration: Sources of degradation, characterization. Basic principles of inverse filtering. **(10 hrs.)**

**Dynamic Image Analysis:** Region analysis and scene analysis , statistical and syntactic models for picture classification, image understanding systems. **(08 hrs.)**

**TEXT BOOK:**

1. Gonzalez R. and Woods R. E (2002)- Digital Image Processing, Second edition, Addison Wesley, Singapore.

**REFERENCES:**

1. Rosenfeld A. and Kak A. C (1997) - Digital Picture Processing, Second edition, Academic Press, New York.
2. Pratt W. K (2001) - Digital Image Processing, Third edition, John Wiley & Sons., New York.
3. Andrews A. C and Hunt B. R. (1997) - Digital Image Restoration, Prentice Hall, New Jersey.
4. Jain A.K. (1988) - Fundamentals of Digital Image Processing, Prentice Hall, New Delhi.

## ICE 409.5: DIGITAL NETWORKS AND PROCESS CONTROL [4 0 0 4]

**Hours /week: 4L**
**Number of credits: 4**

**Review of computer networking concepts:**
OSI/ISO Reference Model, TCP/IP reference models, Point to point protocols. ARQ: Retransmission strategies. **(10 hrs)**

**Functional elements:** Multiplexing, Switching, Networks Management & traffic controls. Delay models in Data Networks Switching techniques: Performance measures & architectural issues. **(08 hrs)**

**Internetworking:** TCP/IP Internet architecture, IPV4, IPV6, IP addressing & related issues, IP address resolution techniques (ARP). IP datagram & forwarding, Queuing Models, Routers, routing algorithms. **(08 hrs)**

**Multiple access techniques:** CSMA/CD, CSMA/CA, CDMA, OFDM, Delay throughput characteristics, WLAN-Protocols**,** multiple access Protocols, Ad-hoc networks, WAP, Bluetooth Specifications, 3G Evolution and Architecture. **(08 hrs)**

True time, simulation of networked and embedded control systems, model based predictive networked control systems, stability of networked control systems, control methodologies in networked control systems, control compensation based on upper bound delay in networked control systems, estimation and compensation of processes with time delays. **(14 hrs)**

**Text Books:**
1. Communication Networks – Leon Garcia & Wadeja, Tata McGraw Hill Publication.
2. “Computer Networks and Internetworking”D.E.Comer, Pearson Education

**Reference Books:**
1) “Data Networks” Dimitri Bertisekas & Robert Gallager, PHI
2) “Local Area Networks”, Gerd E Kieser – Mc-Graw-Hill
3) “Cryptography and Network Security: Principles and Practice”, William Stallings, Pearson Education
4) “GSM, CDMA and 3G Systems” , Steele,, Wiely Students Edition

# ICE 409.6: OPERATIONS RESEARCH [ 4 0 0 4]

**Hours/week: 4L**
**Number of credits: 4**

Formulation of Linear Programming, Graphical Method, Simplex Method, Big M Method, 2-phase method. **(8 hrs)**

Duality theory, Transportation problem - Vogel's approximation method, MODI method, Assignment problem- Hungarian method. **(8 hrs)**

Network Analysis – Networks, Minimum - Span problems, Shortest- Route Problems, Maximal – flow problems, Positive – flow path. **(4 hrs)**

Project Management – PERT/CPM, Construction of the network diagram, Critical path computation for CPM, Critical path computations for PERT, Project time Vs Project cost**.** **(8 hrs)**

Decision Theory and Game theory – Decision Trees, Sequential Decisions, Queuing Models, 2 persons zero sum games, Minimax principle, games with mixed strategies, Dominance theory, solution using Linear programming**.** **(10 hrs)**

Dynamic programming - Deterministic Dynamic programming, Search Techniques - Golden mean search, Three point - Intervals search, Fibonacci search, Descent Methods: Steepest Descent method, Conjugate gradient method, Quasi Newton method. **(10 hrs)**

**REFERENCES :**


1. Bronson Richard (2004) – Schaum's Outlines Operations Research, TMH.
2. G. V Shenoy (1998) – Linear Programming, Methods and Applications, New Age International (P) Limited.
3. P.K.Gupta & Man Mohan (1980) - Operations Research (Ed.4) - Sultan Chand & Sons.
4. Hamdy A.Taha (2002) - Operations Research, Pearson Education, Inc.
5. Prem Kumar Gupta and Dr. D. S. Hira (1999) – Problems in Operations Research, Principles and Solutions, S. Chand and Company Ltd.
6. Ravindran, Phillips and Solberg (2006) – Operations Research, Principles and Practice, Wiley- India.

## ICE 411: PROCESS CONTROL LAB [0 0 3 1]

**Hours/ week: 3** **Total No of Classes-12**
**Number of credits: 1**

2. Characteristics of P/I and I/P converters.
3. Study the characteristics of P, PI, PID Controller modes of Level loop
4. Study the characteristics of P, PD, PID Controller modes of Flow loop
5. To study the characteristics of P, PD, PID Controller modes of Pressure loop
6. Calibration of temperature using Microprocessor based temperature calibrator
7. Study the characteristics of ON/OFF, P, PID Controller modes of Temperature loop
8. Study of Characteristics of control valves.
9. Study of various tuning methods for controllers using Matlab.
10. Study of Cascade System using level and flow.
11. Study of Ratio and Feed forward control loops.
12. Real time data acquisition using DAQ cards.
13. Open and closed loop PID controller tuning on process control trainers.
14. Logical and timer operations, Counter, Compare and arithmetic operations of PLC.
15. Control of Bottle filling operation using PLC.
16. Real Time data acquisition using RTD.
17. Design and Implementation of Amplification circuit using strain gauge as a transducer.

**REFERENCES:**


1) Curtis Johnson,(2001), Process control Instrumentation Technology , Prentice Hall of India Pvt. Ltd
2) Donald R. Coughanowr,(1991) "Process Systems Analysis & Control", McGraw-Hill Inc
3) Wayne Bequette ,(2004) Process control, Modelling, simulation & Control, Prentice Hall of India Pvt,Ltd
4) B.G.Liptak ,(2000),Process control ,CRC press
5) Multifunction calibrator manual-Nagman Instruments
6) DCS manual- VI Microsystems Pvt Ltd.
7) John W. Webb, Ronald A. Reis, (2002), 5th Edition, Programmable Logic Controllers: Principles And Applications, Prentice Hall.

# ICE 413- DIGITAL SIGNAL PROCESSING LAB [0 0 3 1]

1. INTRODUCTION TO MATLAB COMMAND WINDOW
2. GENERATION OF BASIC SIGNALS
3. DISCRETE TIME SYSTEMS
4. TRANSFORM DOMAIN REPRESENTATION OF SIGNALS
5. GENERATION OF CROSS CORRELATION SEQUENCE
6. DESIGN OF IIR FILTERS
7. DESIGN OF FIR FILTERS
8. DIGITAL IMAGE PROCESSING
9. DIGITAL SPEECH PROCESSING
10. POWER SPECTRUM ESTIMATION
11. DIFFERENT TYPES OF FILTER COEFFICIENT GENERATION AND DFT COMPUTATION
12. FOURIER TRANSFORM USING DFT

**REFERENCE:**

1. Vinay Ingle (2005) , “Digital signal Processing Using MATLAB” , Thomsan Publications.
2. Sanjay K Mitra (2005) “Digital Signal Processing : A computer Based Approach” , McGraw Hill Publications.

# VIII SEMESTER INSTRUMENTATION & CONTROL

## ICE 497: SEMINAR [0 0 3 1]

**Hours/week: 3**
**Number of credits: 1**

- Each student has to present a seminar, on any technical topic related to any subject not covered in the syllabus. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/question and answers.

- The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance.

- Each student has to submit to the department a seminar report at least three days before the day of seminar.

- Each student has to make the presentation with OHP/multi-media projector.

# ICE 498: INDUSTRIAL TRAINING /VISITS [0 0 0 1 ]

**Number of credits: 1**

- Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester.
- Each student has to submit to the department a training/tour report in proper format before the commencement of eighth semester. The report should include the certificates issued by the industry.
- Students who opt for industrial visit should visit a minimum of ten industries.
- Each student has to make the presentation on the industrial training/visits at the end of eighth semester.

# ICE 499: PROJECT WORK/PRACTICE SCHOOL [0 0 0 20]

**Hours/week 40**
**Number of credits: 20**

- The project work is carried out in the institution/industry/research laboratory or any other competent institutions.

- The duration of project work should be a minimum of four months.

- There will be a mid-semester evaluation of the project work done after about two months. An interim project report is to be submitted to the department during the mid-semester evaluation. The mid-semester evaluation will be done by the department /project guides and will be out of 100 marks.

- Each student has to submit to the department a project report in proper format after completing the work. The final evaluation and viva-voce will be after submission of the report.

- Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation, using OHP/multi-media projectors. The end semester evaluation will be done by the departmental committee including the guides. The final evaluation will be out of 300 marks, the break-up which is as follows:

| | |
|---|---|
| Project work evaluation (end semester evaluation): | 200 marks |
| Project work evaluation (mid semester evaluation): | 100 marks |
| Viva-voce: | 100 marks |
| **Total marks for the project work:** | **400 marks.** |

@@@@ **END** @@@@