### Course Structure and Scheme of Evaluation

<table>
<thead>
<tr>
<th>Semester</th>
<th>Name of the Subjects</th>
<th>Hrs/Week</th>
<th>Credits</th>
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<tr>
<td></td>
<td></td>
<td>Lecturer</td>
<td>Tutorial</td>
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<tr>
<td>1st Semester</td>
<td><strong>1. Advanced Mathematical Techniques</strong></td>
<td>3</td>
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<td></td>
<td><strong>2. Linear Control Theory</strong></td>
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<td></td>
<td><strong>3. Modelling &amp; Simulation of dynamic systems</strong></td>
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<td><strong>4. Transducer Technology</strong></td>
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<td><strong>5. Elective I (Any one)</strong></td>
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<tr>
<td></td>
<td>• Advanced Microprocessors &amp; Micro controllers.</td>
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<td></td>
<td>• Electronic Devices and Systems</td>
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<td>• Modern Power Converters</td>
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<td><strong>Sessionals :-</strong></td>
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<td></td>
<td>1. Control System Laboratory I</td>
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<td>2. Instrumentation Laboratory I</td>
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<td><strong>Total :-</strong></td>
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<tr>
<td>2nd Semester</td>
<td><strong>1. Advanced Control Theory</strong></td>
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<td><strong>2. Process Control and Instrumentation</strong></td>
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<td><strong>3. Digital Control Systems</strong></td>
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<td><strong>4. Elective II (Any one)</strong></td>
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<td>• Adaptive &amp; Robust Control Systems</td>
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<td>• Soft Computing Techniques</td>
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<td>• Digital Signal Processing</td>
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<td>• Real Time Systems</td>
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<td><strong>5. Elective III (Any one)</strong></td>
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<td>• Industrial Automation and Control</td>
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<td>• Data Communication</td>
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<td>• Experimental Methods and Analysis</td>
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<td>• Ultrasonic Instrumentation</td>
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<td><strong>Sessionals :-</strong></td>
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<td>1. Control System Laboratory II (CI 2.1 L)</td>
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<td>2. Instrumentation Laboratory II (CI 2.2 L)</td>
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<td>3. Seminar (CI 2.9)</td>
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<td><strong>Total</strong></td>
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<td>Lecturer</td>
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<td>3rd Semester</td>
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<tr>
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<td>• Remote Sensing and Control</td>
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<td>• Robotics</td>
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<td>• Reliability and Safety Engineering</td>
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<td>• Artificial Intelligence</td>
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<td>2. Elective V (Any one)</td>
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<td>• Optical and Laser Instrumentation</td>
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<td>• Biomedical Instrumentation</td>
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<td>• Image Processing</td>
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<td>• Analytical Instrumentation</td>
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<td>Sessionals :-</td>
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<td>1. Project (CI 3.3)</td>
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<td>2. Seminar (CI 3.4)</td>
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<td>Lecturer</td>
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<td>4th Semester</td>
<td>Project &amp; Dissertation (CI 4.8)</td>
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<td>Seminar (CI 4.9)</td>
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SYLLABI FOR THE PROPOSED COURSE

CI 1.1

Advanced Mathematical Techniques

3-1-0 (4 credits)

Full marks: 100 Time: 3 hours

Complex Variables: Elements of set theory, Set notations, Applications of set theory, Open & Closed Sets. Review of Complex variables, Conformal mapping and transformations, Functions of complex variables, Integration with respect to complex argument, Residues and basic theorems on residues.


Optimization Technique: Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus of variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

Probability and Statistics: Definition and postulates of probability, Field of probability, Mutually exclusive events, Bayes' Theorem, Independence, Bernoulli trial, Discrete Distributions, Continuous distributions, Probable errors, Linear regression, Introduction to non-linear regression, Correlation, Analysis of variance.

Ref. Book:
3. Halmos, T. R.-Naïve Set Theory, Van Nostrand
4. Scarborough, J. B.-Numerical Mathematical Analysis, Oxford University Press

CI 1.2

Linear Control Theory

3-1-0 (4 credits)

3-2-0 Full marks: 100 Time: 3 hours

Dynamics and control: An overview, control system configuration, model selection, need for dynamic models, dynamic model by averaging: averaging a variable, averaging a circuit, averaging a switching function, averaging a switch.

Linearized models: Linearization, linearizing a circuit, linearizing the average switch

Feedback control: The classical LTI control configuration, nominal stability, nominal performance, robustness.
State space models: features of state space models, state variables, inputs and outputs, continuous Time models, state space models for Electrical Circuits, properties of solutions, the state property, numerical solution, the continuity property, discrete time or sampled data models. Models for controllers and interconnected systems.

Linear and piecewise models: Linearization, linearizing continuous time models. Analysis of continuous time LTI models: transform domain solution, time domain solution, piecewise LTI models, linearizing discrete time models: time domain solution, transform domain solution, transfer function and frequency response. Eigenvalue & eigenvector analysis for controllability and observability

Feedback control design: classical control design, the Nyquist stability criteria, a design approach. Using Bode plots, designing of Bode plots of the loop gain, multi loop control: State feedback: Pole placement by LTI state feedback, Nonlinear state feedback & Digital control.

Ref. book:
4. Graham C Goodwin, Stefan F Graebe, Mario E Salgado,- Control System Design, PHI.

**CI 1.3**

**Modelling and Simulation of Dynamic Systems**

3-1-0 (4 credits)

Full marks: 100 Time: 3 hours

State variable Modelling of Continuous Dynamic Systems.
Bond Graph Techniques.
Simulation Software.
Skeletal Structure of Simulation software.
Packages and Scripting Techniques.
Real-time simulation systems.
Case studies.
Qualitative Modelling.

Ref. book:

2. Chee-Mun Ong – Dynamic Simulation of Electric Machinery (Using MATLAB / SIMULINK), Prentice Hall PTR.

**CI 1.4**

**Transducer Technology**

3-0-0 (3 credits)

Full marks: 100 Time: 3 hours
Classification of Instrumentation Transducer. Analog/digital, active/passive, force balance.
Variable Resistance transducers. Potentiometers, strain gauges, resistance thermometers, thermistors, hotwire anemometers, ac and dc bridges and half bridges.
Variable Inductance and variable capacitance transducers. Application, ac bridge and other interfacing methods.

Special Transducers. Piezoelectric, Magnetostrictive, Electromagnetic transducers, thermo-electric sensor, semiconductor temperature sensors.
Mechanical Characteristics of transducers: Electrodynaminc transducers, eddy current, damping resonance effects, design considerations.
Force balance transducers.
Power system transducers. Voltage, current, p.f., frequency, power, var.
Analog Signal Conditioning techniques: Bridge amplifier, carrier amplifiers, charge amplifiers and impedance converters, modulation - demodulation, dynamic compensation, linearization, multiplexing and demultiplexing.
Digital Interfacing techniques, Interfaces, processors, code converters, linearizers.
Single transmission. Cable transmission of analog and digital signal, fibre optic signal transmission, radio, telemetry, pneumatic transmission.
Signal Display/Recording systems. Graphic display systems, storage oscilloscope, recorders-ink, thermal, UV.
Smart Sensors.

Ref Book:

**CI 1.5.1**

**Advanced Microprocessors**  
3-0-0  (3 credits)

Full marks: 100  
Time: 3 hours

Internal architecture of 8086 CPU, instruction set and programming, assembly language programming on IBM PC, ROM bios and DOS utilities.
8086 basic system concepts, signals, instruction queue, MIN mode and MAX mode, bus cycle, memory interface, read and write bus cycles, timing parameters.

Input/output interface of 8086, I/O data transfer, I/O bus cycle. Interrupt interface of 8086, types of interrupts, interrupt processing. DMA transfer, interfacing and refreshing DRAM, 8086 based multiprocessing system, 8087 math coprocessor.
Typical 8086 based system configuration, keyboard interface, CRT controller, floppy disk controller, Introduction to higher bit processors, 80286, 80386, 80486, Pentium.

Ref.book : 1. Ray,A. K. and Bhurchandi ,K. M.- Advanced Microprocessor and
Department of Electrical Engineering  
M. Tech. in Control and Instrumentation  
NETAJI SUBHASH ENGINEERING COLLEGE  
peripherals, architecture, programming and interfacing, TMH  
2. Hall, D.V.- Microprocessor & Interfacing –Programming & Hardware –  
8086,80286,80386,80486 , TMH  
3. Rajasree, Y.- Advanced Microprocessor, , New Age International  
Publishers  
4. .Brey,B. B.-The Intel Microprocessor 8086/8088, Pentium , Pentium  
Processor, PHI.  
5. Ayala , K. J.-The 8086 Microprocessor, Thomson Delmar  
Learning.  
6. Ayala, K. J.- The 8051 Microcontroller, Thomson Delmar  
Learning.  
7. Cady ,F. M.- Microcontrollers & Microcomputers Principles of  
Software &Hardware Engineering. Oxford University Press  
8. Tabak ,D. Advanced Microprocessors ,TMH  
9. Deshmukh,-Microcontrollers : Theory and Application.TMH  

CI 1.5.2  

Electronic Devices and Systems  

3-0-0  (3 credits)  

Full marks: 100 Time: 3 hours  

Special operational amplifiers: high voltage/high current, chopper and chopper stabilized amplifiers, instrumentation amplifier, isolation amplifier.  
Nonlinear function circuits: limiter, log/anti-log, multiplier/divider, peak detector, comparator, true RMS/DC converter, square wave oscillators.  
Timing and counting circuits: digital counters, shift register, analog and digital timers, frequency counters, PLA and PLD applications.  
Sinusoidal and relaxation oscillators: phase shift, ring, Wien-bridge, tuned, quadrature oscillator, crystal oscillator and clock circuits, voltage controlled oscillators – sine, square and triangle, frequency synthesizers.  
Frequency-to-voltage converters: diode pump integrator, frequency and RPM transducers. Phase and phase/frequency comparators – analog and digital.  
Phase locked loops: linear model, loop response, applications of PLL.  
Power semiconductor derives: special thyristors (GTO, LASCR, Triacs etc.) BJT power MOS, IGBT, MCT, power semiconductor control circuits, SMPS, UPS, inverters, switching mode amplifier.  
Optoelectronic devices: photo diode/transistor, LDR, LED and LCD displays, opto-coupler, opto-interrupter, high speed detectors – PIN and avalanche photo diodes, fibre optic data link.  
Active filters: types, filter approximations – Butterworth and chebyshev, filter realisations, frequency and impedance scalings, filter transformations, sensitivity, switched capacitor circuit, data conversion and acquisition – A/D and D/A converters, DVM/DMM, quantisation noise in ADCs, selection of ADCs, sample and hold circuit, multiplexer and demultiplexer, programmable gain amplifier, microprocessor interfacing techniques.  

Ref. Books:  
1. Sende, B.S. – Introduction to System design using Integrated Circuits, New Age International (P), New Delhi.  
3. Seymous, -Electronic Devices and Components.
Modern Power Converters

Full marks: 100  
Time: 3 hours

Introduction to switched mode power converters, Generalized comparison between switched mode and linear DC regulators, operation and steady state performance of Buck, Boost, Buck-Boost and Cuk Converters: Continuous conduction mode, discontinuous conduction mode and boundary between continuous and discontinuous mode of operation, output voltage ripple calculation, effect of parasitic elements.

DC-DC converter with isolation: Fly back converters- other fly back converter topologies, forward converter, The forward converter switching transistor- Variation of the basic forward converter, Push pull converter-Push pull converter transistor-Limitation of the Push Pull circuit-circuit variation of the push pull converter-the half bridge and full bridge DC-DC converters. High frequency inductor design and transformer design considerations, magnetic core, current transformers.

Resonant converters: Introduction, Classification: Load resonant, Resonant switch, Resonant DC link, High frequency link integral Half cycle converters: Series and parallel loaded converters in continuous and discontinuous mode of operation, Hybrid resonant DC-DC converter, zero current switch (ZCS), zero voltage switch (ZVS), resonant switch converter, ZCS-clamped voltage converters (ZCS-CV), resonant DC link converters with ZVS.

Control of switched mode DC power supplies: Voltage feed forward PWM control, current mode control, digital pulse width modulation control, isolation techniques of switching regulator systems: soft start in switching power supply designs, current limit circuits, over voltage protection circuit. A typical monolithic PWM control circuit and their application: TL 494. Power factor control in DC-DC converters. Electromagnetic and radio frequency interference, conducted and radiated noise, EMI suppression, EMI reduction at source, EMI filters, EMI screening, EMI measurements and specifications.

Power conditioners and Uninterruptible Power Supplies, Types of UPS-Redundant and Non Redundant UPS.

Ref. Book:
2. A.I. Pressman –Switching mode power supply design-MGH, 1992
3. M. H. Rashid- Power Electronics, PHI, 2004
4. Michel, D. –DC-DC Switching Regulator Analysis
6. Staff, VPEC. – Power Device & their application

Instrumentation Laboratory I

Full marks: 100  
Time: 3 hours

Strain Gauge, LVDT, Thermistor characteristics and linearization, RTD- 3 wire and 4 wire, IC temperature sensor. Capacitive transducer, LDR and photo diodes. Incremental shaft encoder, Cold junction compensation and linearisation thermocouples; Synchro characteristics. Pressure transducers.

List of Equipment
1. Instrumentation tutor comprising of various sensor modules like thermocouple, RTD, Thermistor, Tachogenerator, Inductive pick-up, Capacitive pick-up, strain Gauge, LVDT, Piezoelectric pick-up, Magnetic pick-up, Photo electric pick up, LDR vibrating beam pick up etc with display and calibrating facilities.
2. Sensor modules with input modulation and output display, Recording facilities: Strain gauge, Thermocouple and other temperature sensors, LVDT, Level, Displacements, Acceleration, Load cells, etc.
3. AD 590, Thermocouples.
4. Shaft encoders
6. Pressure transducer.
7. Variable Power supply, CRO.
8. Photodetectors.

CI 1.1L

**Control System Laboratory I**

0-0-3 (2 credits)

Full marks: 100       Time: 3 hours

1. Design and simulation of Linearised models using MATLAB/PSPICE.
2. Simulation and analysis of State space models for continuous time and discrete time systems using MATLAB/PSPICE
3. Design and Simulation of LTI models of Feedback Control System using MATLAB/PSPICE.
4. Simulation and analysis of Digital Control System using MATLAB/PSPICE.
5. Simulation and Stability analysis of control system with common non-linearities using MATLAB/PSPICE.
7. Familiarization and use of PSIM software.

CI 2.1

**Advanced Control Theory**

3-1-0 (4 credits)

Full marks: 100       Time: 3 hours

*Non linear systems*
Modelling Quasi-linearisation, stability of non-linear systems, phase plane methods, describing function methods, deriving describing function from FFT, Popov’s circle criterion, stability analysis using Lyapunov method, parameter plane analysis.
Modal control, Pole allocation by SV and output feed back.
Order reduction of linear system.
Linear Optimal Control with quadratic performance index Formulation, matrix Riccati equation, special cases, Lyapunov’s equation, LQR problem with prescribed degree of stability (Anderson formulation).
4. Anderson and Moore - Optimal Control, PH
6. Thomson and Stevant - Nonlinear and dynamics and control, Wiley.
7. Vidyasagar - Nonlinear system analysis, PH

CI 2.2

Process Control and Instrumentation

3-1-0  (4 credits)

Full marks: 100       Time: 3 hours

Special Characteristics of process systems: Large time constants, Interaction, Multistaging, Pure Lag; Control loops for simple systems: Dynamics and stability.
Generation of control actions in electronic pneumatic controllers.
Tuning of controllers Zeigler Nichols and other techniques. Different control techniques and interaction of process parameters e.g. Feed forward, cascade, ratio, Override controls. Batch and continuous process controls. Multi variable control. Feed forward control schemes.
Control valves, Valve positioners, Relief and safety valves, Relays, Volume boosters, Pneumatic transmitters for process variables.
Various process schemes/ Unit operations and their control schemes e.g. distillation columns, absorbers, Heat exchangers, Furnaces, Reactors, Mineral processing industries pH and blending processes.
Measurement, control and transmission of signals of process parameters like flow, pressure, level and temperature.
Nucleonic instrumentation and its application in industries.
Computer control of processes: Direct Digital Control (DDC), Supervisory Control and advanced control strategies.

Ref Books:
4. Patranabis, D. - Principals of Industrial Instrumentation, TMH New Delhi.

CI 2.3

Digital Control System

3-1-0  (4 credits)

Full marks: 100       Time: 3 hours

Structure of a computer controlled system.
Review of Z-transform.
Computation of time response of Discrete Data system.
Bilinear Transformation.
W-plane, prewarping, inverse transformation.
Design of discrete controllers.
Z-domain compensation, w-plane compensation, state variable feed back
deadbeat controller, sampled data version of PID controllers.
Effect of Data Digitization.
Effect of finite word size, limit cycle determination.
State Variable Analysis of Digital Control Systems.

Ref. books:
3. Kuo, B. C. – Analysis and Synthesis of sampled-data control system, PH

CI 2.4.1

Adaptive and Robust Control

Full marks: 100       Time: 3 hours

System identification. Problem statement, classical stochastic approach, Kalman filters, structure of on line parameter identifiers.
Multivariable Frequency domain approach for linear systems. Characteristics loci, Nyquist arrays, stability criteria, decoupling and compensation.
Robust control. Definition and problem statement, the H(π) norm, H∞ norm, frequency domain formulation, state space formulation robust stabilization H2 optimal control, H∞ control.

Ref. book:
2. Sastry, S. and Bodson,- Adaptive Control (Stabily, Convergence and robustness),
3. Peter Dorato,- Robust Control.
4. Moremi and Zafirious, - Robust Process Control,

CI 2.4.2

Soft Computing Techniques

Full marks: 100       Time: 3 hours
Simulation of control systems, frequency domain versus time domain analysis, issues in numerical solution: numerical integration methods, non-linear differential equations, automatic time step control, treatment of switches, Overview of some widely used simulation programs: PSPICE, EMTP, MATLAB/SIMULINK

The mathematics of Fuzzy logic control, Theory of approximate reasoning, Fuzzy knowledge based controllers, application of fuzzy logic control.

Expert system, fuzzy logic and neural networks in control systems: modeling and estimation and design methodologies.

Introduction to Genetic Algorithm.

Ref. book :
1. Klir, G.J. & Yuan,B.- Fuzzy sets and Fuzzy logic, theory and applications, Prentice Hall of India Private Limited
2. Nie and Linkens,- Fuzzy Neural Control-Principles, Algorithms and Application, PHI
3 Bose, B. K.- Power Electronics and variable frequency drives, by, Standard publishers distributor
4. Kosco, B.-Neural Networks and Fuzzy System.PH
5. Haykin- Neural Network; A Comprehensive Foundation,2/e Pearson .
6. Rajasekaran and Pai – Neural Networks, Fuzzy Logic and Genetic algorithms: Synthesis and Application, PHI.

CI- 2.4.3

Digital Signal Processing

(3-0-0) 3 Credits

Full marks: 100 Time: 3 hours


Introduction to linear Optimal Filtering.

Digital Filter :Definition and anatomy of a digital filter, frequency domain description of signals and systems, typical application of digital filters, replacing analog filters with digital filters, filter categories: recursive and non-recursive.

Digital Filter Structures: The direct form I and II structures, Cascade combination of second order sections, Parallel combination of second order sections, Linear- phase FIR filter structures, Frequency sampling structure for the FIR filter.

Effect of word length: Round off error, truncation error, quantization error, limit cycle.

Design of Digital filters

Introduction to DSP hardware

Application of DSP in control system and instrumentation.

Ref Book:
1. Mitra, S. K.- Digital Signal Processing,
CI 2.4.4

Real Time Systems

3-0-0 (3 credits)

Full marks: 100       Time: 3 hours

Overview of Real time systems.
Definition, evolution, typology, structure and applications. Temporal Modelling and specification of real time systems. State diagram, finite automata model, petri-net, state chart and mode chart, Q-model, formal methods.
Sequential and logic control. Ladder diagram, PLC programming, case studies in interlocking and sequence control.
Hardware Components and Configuration of real time system. Interfacing systems for analog and digital I/O, programmable logic control system architecture, computer control system architecture, flight control systems, hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy.
Real time Operating systems.: Features, primary components.

Ref Book:

CI 2.5.1

Industrial Automation And Control

3-0-0 (3 Credits)

Full marks: 100       Time: 3 hours

Overview: Structure & components Industrial Automation systems. Architectural levels of Industrial controls.
Actuators & sensors: Servomotors, Stepper motors, Process I/O systems. Local & remote I/O systems.
Controllers: Different types of controllers, Single loop and Multiloop controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct controllers and their tuning, Direct Digital Controllers, Software implementation of Multiloop Controllers. Distributed Control Systems.
Department of Electrical Engineering
M. Tech. in Control and Instrumentation
NETAJI SUBHASH ENGINEERING COLLEGE

Sequence Control: Programmable Logic Controllers, Relay Ladder Logic, Programming.
Supervisory Controllers: Functionally of Supervisory Control Level, Process Optimization, Recipe

Process Operation Management Systems: Overview of process operation management systems, order
inventory management, process scheduling, quality management.
Industrial Communication Systems: Characteristic features of industrial networks. Low level networks and
their features, Field bus architecture. Performance aspects of Industrial Automation Systems.

Ref. books:

2.5.2

Data Communication

3-0-0 (3 credits)

Full marks: 100
Time: 3 hours

Modulation techniques, Different kinds of AM and FM. AM and FM modulators and demodulators.
Sensitivity for wire and wireless transmission. Power line carrier communication. Sampling theorem,
Nyquist frequency, sampling techniques and signal reconstruction. Pulse code modulation, PAM, PWM,
Multiplexing, FDM and TDM systems, their relative merits, ASK, FSK, PSK and higher order modulation,
techniques. Local area and public data Networks.

Data transfer techniques- asynchronous and synchronous. Serial and parallel interface
Fiber optic and satellite communication. Remote control, Mechanical, electrical and electronic methods,
special considerations. Typical telemetry and telecontrol schemes related to industry and space application.

Ref. Book:
5. Miller,- Data Network Communication, Vikas.

CI 2.5.3

Experimental Methods and Analysis

3-0-0 (3 credits)

Full marks: 100
Time: 3 hours

Errors of measurement, Classification of errors, Systemic and random errors: Statistical analysis of errors,
Normalized histograms, Probability distribution functions; Gaussian error curves, Chi-squared statistical
test, Regression analysis of data, Best fit curve and estimation of model; Combination of errors, Variance of sum of two sets, Errors of computed results – examples from engineering measurements, Special functional forms; Methods of measurements – Classification and examples; Instrument scales and reading errors; Methods of minimization and elimination of errors due to noise in measured data – Input-output configuration, filtering, averaging and correlation techniques; Errors in digital instruments.

Ref. Books

CI 2.5.4

Ultrasonic Instrumentation

3-0-0 (3 credits)

Full marks: 100       Time: 3 hours


Ref. Books

CI 2.1L

Control System laboratory II

0-0-3 (2 credits)

Full marks: 100       Time: 3 hours


CI 2.2L

Instrumentation laboratory II

0-0-3 (2 credits)

Full marks: 100       Time: 3 hours
Calibration of Bourdon Gauge using dead weight tester; Determination of discharge coefficient using Orifice Meter; Calibration of Rotameter; Determination of time constants of a Thermocouple; Study and calibration of Differential pressure transmitter; Speed measurement using non-contact type sensor; Measurement of very small angles and displacements, Level measurements using air purging, pH meter, Conductivity meter.

**Note 1:** Typical experiments on chemical processes may comprise of –
1. Measurement of velocity distribution for a fluid flowing through a cylindrical tube by a Pilot tube.
2. To find equivalent length of different pipe fittings.
3. To determine the surface area and also the shape factor of particles by permeability method.
4. To study the characteristics of fluid flow through a packed bed.
5. To study the working of different crushers and ball mills.
6. Heat transfer studies in counter current and co-current double pipe heat exchangers.
7. To determine the thermal conditions of different solids.
9. To study the characteristics of batch, plug flow and mixed reactor using homogeneous reactions.
10. RTD study for fluid through a tubular reactor.

**Note 2:** Students will perform 8-10 experiments on processes and process instrumentation (combined)

**List of Equipment:**
1. pH meter setup (electrodes, electrometer set up).
2. Conductivity meter set up.
3. Models of Heat Exchanger, distillation column, Tubular reactor, Mixed reactor along with accessories.
4. Instrumentation tutor for Flow meter calibration.
5. Pilot tube.
6. Function generator, Dual trace CRO, Storage CRO, Audio cassette recorder, Multimeters, Analog/Digital voltmeters, etc.
7. Water level controller.

**CI 3.1.1**

**Remote Sensing and Control**

3-0-0 (3 credits)

Full marks: 100 Time: 3 hours

Nature of electromagnetic radiation - spectral, spatial and temporal characteristics of objects - atmospheric interaction sensors - photographic, thermal, multi-spectral, passive microwave and active microwave sensors - ground data acquisition - photo-interpretation - image processing techniques, remote sensing applications.

Techniques of remote control; remote control in Industry including Oil pipelines, rocket motion and satellite movements.

Ref Book:
C1 3.1.2

Robotics

3-0-0 (3 credits)

Full marks: 100

Time: 3 hours


Ref. Book:

   Vol. 15, No. 12.
6. Mittal and Nagrath, Robotics and Control, Tata Mc. Graw Hill,

C1 3.1.3

Reliability and Safety Engineering

3-0-0 (3 credits)

Full marks: 100

Time: 3 hours


Maintenance: Objectives, Types of maintenance, preventive, condition based and reliability centered maintenance. Terotechnology and total productive maintenance.(TPM).

Maintainability: Definition, basic concepts, Relationship between reliability, maintainability and availability : corrective maintenance time distributions and maintainability demonstration. Design considerations for maintainability. Introduction to life-testing-estimation of parameters for exponential and Weibell distributions, component reliability and MIL standards.

Department of Electrical Engineering
M. Tech. in Control and Instrumentation
NETAJI SUBHASH ENGINEERING COLLEGE

Ref. Books:
2. Blanchard B.S – Maintainability
3. Sinha And Kale – Introduction to Life Testing, Willey Eastern

CI 3.1.4

Artificial Intelligence

3-0-0 (3 credits)

Full marks: 100
Time: 3 hours


AI Languages: Important characteristics of AI languages – PROLOG.
Introduction to expert system – interaction with an expert. Design of an expert system.

Neural Networks: Basic structure of a neuron Perception Feedforward, Back propagation, Hopfield Network.

Ref. Books
6. Kos Ko B – Neural Networks and Fuzzy System, PHI.
7. Russel – Artificial Intelligence, Pearson.
9. Patterson- Introduction to Artificial Intelligence and Expert Systems, PHI.

CI 3.2.1

Optical and Laser Instrumentation

3-0-0 (3 credits)

Full marks: 100
Time: 3 hours

Interferometry: Interference of light Newton’s Interferoscope, Fizeau Interferometer, Twyman Green Interferometer, Mach-Zehnder Interferometer.  
Laser Applications: Distance Measurement, Laser-Doppler Velocimetry, Welding, Cutting, Machining, Holography, Holographic Interferometry.

Ref. Books  
1. Rampal V V – Lasers and Applications.  

Biomedical Instrumentation  

C1 3.2.2

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<th>Biomedical Instrumentation</th>
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Full marks: 100  
Time: 3 hours

Introduction to the physiology of cardiac, nervous and muscular and respiratory systems.

Transducers and Electrodes: Different types of transducers and their selection for Biomedical applications, Electrode theory, Different types of electrode Hydrogen Calomel, Ag-Agcl, Ph, P_{o2} P_{co2} electrodes, selection criteria of electrodes.

Cardiovascular measurement: The heart and other cardio vascular systems, Measurement of Blood pressure, Blood flow, Cardiac output and cardiac rate, Electrocardiography, Phonocardiography, Ballistocardiography, Plethysmography, Magnet-Cardiography, Cardiac pace-maker, Computer applications.


Aspects of patient care monitoring

Ref. Books:
1. Webster J S – Medical instrumentation-Application & Design.  
2. Cromwell L Biomedical instrumentation, PHI  

3.2.3

Image Processing  

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<th>Image Processing</th>
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<th>(3 Credits)</th>
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Full marks: 100  
Time: 3 hours
Underlying principles of image formation and enhancement; Techniques & mechanisms of image capture & display; Low level segmentation; feature detection of 2-D & 3-D images; Dynamic scene analysis; Colour image analysis and occluded scene analysis.

Ref. Books:

1. Jain, A K- Fundamentals of digital image processing, PHI.

Analytical Instrumentation

Full marks: 100
Time: 3 hours


Ref. Books:

1. Patranabis D- Principles of Industrial Instrumentation, TMH publication, New Delhi, 1976.