TEACHING SCHEDULE & STUDY SCHEME

M. TECH. PROGRAMME

(Instrumentation & Control Engineering)

PUNJAB TECHNICAL UNIVERSITY, JALANDHAR

August, 2004
DETAILED SYLLABUS AND OTHER CONDITIONS FOR THE
PROPOSED COURSE
M.TECH. INSTRUMENTATION & CONTROL ENGINEERING

<table>
<thead>
<tr>
<th>Schedule of Teaching</th>
<th>Schedule of Examination</th>
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<tr>
<td>Lecture (per week)</td>
<td>Time (Hrs.)</td>
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1st Semester
IC-501 Bio-medical instrumentation and Telemedicine
IC-502 Microprocessor based Industrial Control Instrumentation
IC-503 Digital Control Theory
IC-504 Advance Instrumentation
IC-505 Optical Component and Basic Instrumentation
IC-506 Lab-I

2nd Semester
IC-507 Digital Speech and Image Processing
IC-508 Non – Linear Control System
IC-509 Optimal Control systems.
IC- Elective-I
IC Elective-II
IC-516 Lab-II

3rd Semester
IC Elective-III
IC Elective-IV
IC-580 Project
IC-590 Seminar

4th Semester
IC-500 Dissertation

LIST OF ELECTIVES
Elective-I
IC-510 Parameter Estimation & System Identification
IC-511 Computer Aided Instrumentation Design
IC-512 Optical Material & Techniques

Elective-II
IC-513 Random Processes in Control & Estimation
IC-514 Peripheral System Design & Interfacing
IC-515 Advance Microprocessor based systems

Elective-III
IC-517 Geo Physical Instrumentation
IC-518 Micro Controller & embedded systems
IC-519 Laser Techniques and Precision Measurement

Elective-IV
IC-520 Robotic System & Automation
IC-521 Artificial Neural Network & Fuzzy Systems
IC-522 Optimisation Techniques
BIOMEDICAL INSTRUMENTATION AND TELEMEDICINE
(IC – 501)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

1. **Introduction:** Basic transducer principals, The transducers and principals, active transducer, passive transducers, transducers for Biomedical applications.


3. **Cardiovascular System & Measurement:** The head & cardiovascular system, Blood pressure, characteristics of Blood flow, cardiac output, plethysmography. Study of ECG (Electrocardiography), EEG (Electroencephalogram), EMG (Electromyogram), ERG (Electroretinogram), Pacemakers, Sphygmomanometer.

4. **Noninvasive Diagnostic Instrumentation:** Temperature measurements, principles of ultrasonic measurements, ultrasonic diagnosis.

5. **Biotelemetry & Computer In Biomedical Instrumentation:** Introduction to biotelemetry the components of biotelemetry system. Interfacing the computer with medical instrumentation, biomedical computer applications.

**Reference Books:**

1. Biomedical instrumentation & measurement: Leslie Cromwell, Fred J. Weibell & Eric A. Pfeiffer.
2. Handbook of Transducers for Electronic Measuring systems, Norton H. N.
3. Biomedical Electronics, Yanof H.M.
4. Handbook of Biomedical Instrumentation: R. S. Khandpur
MICROPROCESSOR BASED INDUSTRIAL CONTROL
INSTRUMENTATION
(IC – 502)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Process Control Computer Systems: Minis, micros, classification by hardware features and software facilities, performance evaluation techniques.

Characteristics of Digital Processors: Organization, instruction set, characteristics for process control, inputs/output arrangements, addressing techniques, memory systems.

Process Control System Software: Review of availability of process control language, application packages, operating system for real time process control.


Developments Tools: Development systems for micros, software tools, logic analyzer, cross assemblers and compilers, simulators, emulators, in-house vs. turn – key trade off.

Reference Books

1. Intel Series of Microprocessor: Berry B. Bery
2. Microprocessor Principles and Application
3. Microprocessors with application in Process Control: S. I. Ahson
DIGITAL CONTROL THEORY
(IC – 503)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Signal Processing in Digital Control: Principles of Signal Conversion, discrete time signals, various models for discrete time systems, stability criterion, sampling as a impulse modulation.


State Variable Analysis: State description of digital processor, solution of digital state difference equation controllability and observability, stability improvement by state feedbacks, state feedback with integral control, digital control system with state feedback.


Reference Books

1. Modern Control Systems: Dorf Bishop
2. Digital Control & State Variable Methods: M. Gopal
ADVANCE INSTRUMENTATION
(IC – 504)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Basic of Physical Method of Chemical Analysis:
Spectral methods of analysis, basic techniques, terminology, units. Interaction of e.m. radiations with matter, emission, absorption & scattering techniques.

Absorption & Emission Spectroscopy:
Ultra violet visible spectrophotometry, Fluorescence and phosphorescence spectrophotometry.

Chromatography:
General Principles, Gas Chromatography, Liquid Chromatography, Column Chromatography, High performance liquid Chromatography

Atomic emission-spectroscopy, Infrared spectroscopy, X-Ray spectroscopy, Raman spectroscopy.

Radiochemical methods: Nuclear magnetic resonance spectroscopy, Electron spin resonance spectroscopy.

Reference Books

1. Instrumental Methods of Chemical Analysis: Galen W. Ewing
3. Introduction to Instrumentation Analysis: Robert D. Braw
4. Analytical Instrumentation Hand Book: Galan W. Ewing
**OPTICAL COMPONENTS AND BASIC INSTRUMENTS**

*(IC – 505)*

Max. Marks: 100
Time Allowed: 3 Hrs

*Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.*

**Design analysis and testing techniques:**
Design analysis and testing techniques of different optical elements (lens, prism, beam divider, mirror, flat, filter, slit, aperture, fresne, polarizer, holoelement), their functions and their uses.

**Design analysis of lenses and optical system:**
Design analysis of lenses and optical system characteristics and aberrations, performance specifications and applications (achromats, astigmats, apochromats, standard and Zoom lenses) backed with case studies. Tolerancing of optical systems. Light sources, collimators, beam expanders. Optics of semiconductor lasers.

**Optical amplifier:**
Optical amplifier technologies: semiconductor laser amplifiers, erbium-doped fiber amplifiers (EDFAs), planar amplifiers, Raman amplifiers and optical repeaters.

**Optical Measuring Instruments:**
State-of-the-art in various classes of optical measuring instruments such as microscopes, interferometers, imaging systems, linear and angular encoders.

**Reference Books**

1. Optical Fiber Communication – Gerd Keiser (McGraw Hill)
2. Optical Communication System – John Gower (PHI)
At least ten experiments are to be performed related to the subjects related to the subjects taught in 1\textsuperscript{st} semester.
Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.


Weiner’s theory of optimization. Application of Weiner’s theory in compensator design for feedback control system.

Gauss Markov model for vector random process.

Kalman Filtering and Prediction for discrete and continuous time system.

Minimum variance control

Array processing. Multidimensional measurement problems. System identification sinusoidal testing, pulse testing, correlation testing.

Reference Books

NON – LINEAR CONTROL SYSTEM
(IC – 508)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Introduction: Behaviours Non–linear systems. Investigation of Non–linear systems, physical Non-linearities, Point concept of singular point, Nodel point, Saddle point, focus point, Vortex point.


Describing Function Methods: Derivation of Describing functions: Dead zone and saturation, Relay with dead zone and hysteresis, Stability analysis by describing methods, Stability analysis with Gain–Phase plot.


A model reference adaptive system, Review examples.

Reference Books

2. Digital Control Method and State Variable by M. Gopal
OPTIMAL CONTROL SYSTEMS
(IC – 509)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Introduction to Optimal Control System:

Quadratic Performance Index:

Reference Books:
2. Optimum Control Theory: Sage & White
3. Optimal Control System: M. Gopal
PARAMETER ESTIMATION AND SYSTEM IDENTIFICATION  
(IC – 510)

Max. Marks: 100  
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Review of stochastic processes. Models and model classification, the identification problem, some field of application.

Classification methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, properties of i.s.e., generalised and weighted least squares and instrumental variable method.

On-line identification using recursive least squares, minimum variance algorithm, stochastic approximation method and minimum linkeihood method.


Reference Books
2. Modern Control Theory: Dorf
Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.


Computation Techniques For Instruments: Efficient algorithms for scientific computation in instruments. Use of assembly languages. Overview of transcendental function computation, solution of equations, curve fitting, numerical integration; fast Fourier transforms and filter implementations.

Reference Books
1. Computer Aided Design of Electronics Circuits: E. Wolfendale
2. Understanding Computer Aided Design & Drafting: Geotechs
OPTICAL MATERIALS AND TECHNIQUES
(IC – 512)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Optical measurements:
Photometry, measurement of wavelength, radiant intensity and flux, coherence of optical radiation. Application of these measurements to optical systems.

Optical materials:
Optical materials for UV, visible and IR regions. Photosensitive materials for photography, photolithography and photo fabrication.

Optical fibers as optical components:
Elements of an optical fiber transmission link, optical source and photo detector. Otic fiber modes and configurations, fiber types, rays and modes, step index structure, modes in step index fiber, linearity polarized modes single mode fiber – propagation modes in single mode fiber. Design Optimization of single mode fibers, Multimode and single mode fibers.

Fiber coupling and launching techniques.
Source of fiber power launching, lesing scheme for coupling improvement, fiber to fiber joints, led coupling to single mode fiber, fiber splicing, optical fiber connectors.

Introduction to fiber based sensors, imaging systems and communication links.

Reference Books
1. Fiber optics: Theory and Applications: N. S. Kapany
3. Optic Fiber Communication: Gerd Keiser
DIGITAL SPEECH & IMAGE PROCESSING
(IC – 507)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Introduction
History of synthetic audio, speech analysis & synthesis overview, history of automatic speech recognition, digit & speech recognition, pattern matching, digital image processing, origin of digital image processing, fundamental steps & components of digital image processing.

Digital Image Fundamentals:
Elements of visual perception, light electromagnetic spectrum, image sensing & acquisition, image sampling & quantization, relationship b/w pixels.

Digital Signal Processing & Filters:
Introduction, Z - transform, inverse Z transform, convolution, filtering concepts, transformations for digital filter design, bilinear transformation, grey level transformation, histogram processing, image enhancement using arithmatic and logic operation, basics of spatial filtering, smoothing and sharpening of spatial filtering & frequency domain filtering, combining spatial filtering, DFT, DCT (1 dimentional and 2 dimentional) FFT, relation between DFT and Digital filter.

Pattern classification feature extraction, pattern, classification method, statistical pattern classification.

Color image processing wavlets:
Color models, preuho color image processing transformations, color segmentation, image paramid, subband coding, haar transformer, series expansion, scaling function, averasing function, wavlet transform, fast wavlet transform, wavlet packets.

Image compression:
Image compression models, loss less and lossy compression.

Reference Books
PERIPHERAL SYSTEM DESIGN & INTERFACING  
( IC – 514) 

Max. Marks: 100  
Time Allowed: 3 Hrs  

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Bus system
Bus systems in microcomputers ST 100 bus, Multi bus, EISA, PCI Bus, HP IB/GPIB Bus, Bus and their applications. I/O

Interface

Design criterion with PCs
Application of PC buses (ISA, EISA, PCI, VESA-VL) and associated signals, Handshakes, I/O and Interrupt map, Programming methodology for input/output application, GPIB signals and GPIB programming techniques operating system calls.

Peripherals
Peripherals like CRT controller, Communication controllers, DMA controller, Programmable keyboard/Display interfaces and Associated circuitries.

Controllers
PID controllers, Programmable logic controllers, PC based data acquisition system, Interfacing PC to various cards- Stepper motor milli volts, Milliamps.

Development tools
Microprocessor development system, cross compilers, Simulator In circuit emulators, Automated test equipments etc.

Reference Books
1. Intelligent Instrumentation by George C. Barney, PHI.
4. Interfacing A Laboratory Approach by Deonzo, PHI
5. Related IEEE/IEE publications
ADVANCED MICROPROCESSOR BASED SYSTEMS
(IC – 515)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Microprocessor Architectural Concepts

Microprocessor Instructions And Communications
Instruction Set, Mnemonics, Basic Instruction Types, Addressing Modes, Interfacing I/O Microprocessor, Polling And Interrupts, Interrupts And DMA.

Microprocessor I/O

Embedded Controllers & Systems
Architecture of 80186 & 80188 CPU subsystems, Addressing Modes, Instruction set, Basic IO subsystems, Memory Subsystem, Example embedded controllers.

Reference Books
1. Intel Series Of Microprocessors: By Berry B. Bray, TMH.
2. 8086 microprocessor & Architecture by Liu, Gibson; PHI.
3. Embedded Microprocessor System Design by Kenneth L. Short, Pearson Education.
4. Embedded Controllers by Berry B. Bray Pearson Education.
5. Related IEEE/IEE publications
IC-516Lab-II

Max. Marks: 100
Time Allowed: 2hrs

At least ten experiments are to be performed related to the subjects related to the subjects taught in 2nd semester
GEO – PHYSICAL INSTRUMENTATION  
(IC – 517)  

Max. Marks: 100  
Time Allowed: 3 Hrs  

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Geoscience instrumentation characteristics & test systems. Instruments problem definition, external factors, system component interrelationships, design problem, specifications & test important characteristics, definition of characteristics, instruments tests, noise and offset, geophone & seismometer tests.

Geoscience environment, environmental factors, earth science parameters, meteorological parameters, oceanology parameters, lunar and planetary parameters.

Instrument platforms, platform description, ground platforms, airborne platforms, ocean platforms, space platforms, communication and telemetry.

Remote Sensors / Instruments

Design Problems

Reference Books
MICRO – CONTROLLER & EMBEDDED SYSTEMS
( IC – 518 )

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Overview of 8085, 8086 & 9088 microprocessor

Microprocessor I/O: Data communication, parallel I/O Serial communication, serial interface and UART, modem, I/O devices, D/A, A/D interface, Interface, Special I/O Devices.

Micro – Controllers: Introduction 8051 architecture and programming model, Internal RAM and registers, I/O parts, Interrupts system and instructions set, introduction to 8096.

Developing Microprocessor Based Products: Introduction to the design process, preparing the specifications, developing a design, implementing and testing the design, regulatory compliance testing, design tools for microprocessor development.

Pentium Microprocessor: Introduction to pentium microprocessor, addressing modes, flag and data transfer and string instructions, arithmetic, logic, bit manipulation, program transfer and process control instructions.

Reference Books
2. Intel Series of Microprocessors: Berry B. Brey
3. Microprocessor Based System
4. Assembly Language Programming 8086
Characteristics of laser radiation laser systems, Q-switching and mode locking in laser systems. Introduction to the theory and applications of holography and laser speckles, merits and demerits of these techniques in engineering and industrial measurements.

Laser application in flow measurement, vibration analysis, temperature measurement and alignment of machine tools, etc. Laser interferometers with emphasis on engineering measurements theory and practice.

The international SI systems of units, primary standards and their realizations; secondary and tertiary standards and their calibration. Overview of precision measurements of mechanical, electrical and optical parameters. Design considerations and material selection from the point of view of accuracy and reliability.

Study of profile projector, tool markers microscope, talysurf talyoud, floating micrometer, optical and mechanical comparator, interferometer, digital metrological instruments.

Electrical and electronics measurements: precision measurements of electrical parameters, frequency and time. Calibration of laboratory measuring equipment.

Reference Books
1. Optics: Ajoy Ghatak.
2. Principle of Optics: Max Born & Emil Wolf
3. Measurement and Instrumentation: Helfrick Cooper
ROBOTIC SYSTEM AND AUTOMATION
(IC – 520)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Theory and application in robot dynamics and control.

Simulation of roots and manufacturing system, robot language: robotics vision and other sensory interfaces, manipulator design, robot locomotion, management of multi robot systems, geometric modeling.

Other computer aided engineering design technique and manufacturing science as applied to robotics.

Motion planning task planning and expert systems in robotics and automation: hardware and software implementation of robotic system.

Reference Books
1. Robotics – Control, sensing, vision and intelligence, K.S. Fu, R.C. Gonzalez, C.S.G. Lee
2. Robot Manipulators, Richard P. Paul
ARTIFICIAL NEURAL NETWORKS & FUZZY SYSTEMS
(IC – 521)

Max. Marks: 100
Time Allowed: 3 Hrs

Note: Eight questions of equal marks to be set covering the whole syllabus and any five to be attempted.

Review of Neural Networks: models of a neuron, various activation functions: Threshold function, piecewise – linear function, Stochastic model of a neuron, feedback.

Network Architecture: Single layer feed forward network, multiplayer feed forward network, recurrent network, knowledge representation.

Learning Processes: Memory Based Learning Hebbian Learning, Competitive Learning, Boltzmann Learning, Learning with a teacher, learning without a teacher, adaptation, single layer perceptions, multi-layer perceptions.

Introduction to fuzzy logic: membership function, rule generation, fuzzy concept, fuzzification, defuzzification, time dependent fuzzy logic, temporary fuzzy logic, fuzzy artificial neural network, neuro fuzzy control, fuzzy neural nets, application.

Reference Books
1. Neural Networks: Simon Haykin
2. Artificial Intelligence: Eleine Rich, Kevin Knight
3. Understanding Neural Networks and fuzzy logic: Stamatios V. Kartalopoulos.
OPTIMISATION TECHNIQUES
(IC – 521)

Max. Marks: 100
Time Allowed: 3 Hrs