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

Schedule of Teaching				Schedule of Examination				
Lecture	Tutorials (per week)	Total		Time (Hrs.)	Theory Marks	Sessional Marks	Viva	Total
4	0	4	All theory subjects	3	100	50		150
			Project			50	50	100
			Seminar			100		100
			Dissertation			Satisfactory/not Satisfactory		

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.

2 **Bioelectric Potentials and Electrodes:** Resting & Action potentials, propagation of Action potentials, Bioelectric potentials electrode theory, Biopotential electrodes. Biochemical transducer.

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.

System Selection Criteria: Specification, environment, hardware and software requirements. Maintenance, procurement procedures, cost / performance / availability ratios.

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.

Model of Digital Control Devices: Z-Domain description, Implementation of Digital Controller, Z-plain specification of control system design, Z-plain synthesis, Review examples.

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.

Engineering Characteristics of Computer Control Systems, Elements of Hybrid Computer, Digital and Hybrid Simulation of Sampled Data Systems.

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 mthods 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 spetrophotmetry.

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
2. Instrumental Methods of Analysis: H.H. Willard, Lynnel Merriktt, Jr. John, A. Dean F. A. Settle & Jr.
3. Introduction to Instrumentation Analysis: Robert D. Brawn
4. Analytical Instrumentation Hand Book: Galan W. Ewing
5. Hand Book of Analytical Instrumentation: R. S. Khandpur

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 characterstics 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)
3. Geniconductor Optoelectronics Device – Palla (PHI) (IEEE) 1995 Ed.

PTU/BOS/IC/201/28-07-2004

IC-506 Lab-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 1st semester.

RANDOM PROCESS IN CONTROL & ESTIMATION
(IC – 513)

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 of measurements, introduction to probability and random variable. Random process and their characteristics. Correlation functions: autocorrelation, cross correlation.

Estimation of parameters in presence of noise. ML and MAP estimates. Cramer-Rao bounds. Linear estimation and non-linear estimation. Waveform estimation.

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

1. Detection, Estimation & modulation theory: H. L. Vantrees.
2. Analytical Design of linear feedback control Newton G.C., Jr., L.A. Gould and J.F. Kaiser.

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.

Stability of Non–Linear Systems: Phase trajectory by analytical method, Minimum time trajectory, Graphical method: Isocline method, Delta method.

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.

Stability Criterion: Basic concepts, Stability theorems, Lyapunov functions for Nonlinear systems: Kravoskii's method, Variable gradient method, Popov's stability criteria.

A model reference adaptive system, Review examples.

Reference Books

1. Control System Engineering by I. J. Nagrath, M. Gopal
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:
Parameter Optimization: Servomechanism, Optimal Control Problems: Transfer Function Approach, State Variable Approach, State Regulator Problem, Infinite Time Regulator Problem, Output Regulator and The Tracking Problem, Parameter Optimization: Regulators.

Quadratic Performance Index:
State Regulator Design through Lyapunov Equation, Calculation of Variation Based Techniques, Optimal State Regulator through Matrix Riccati Equation, Pontryagin's Principle and Control Problems with Constraints on Control Function, Dynamic Programming, Numerical Techniques, Optimal Control of Distributed Parameter Systems.

Reference Books:

1. Optimal Control Theory: An Introduction: Kirk, D. E.
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.

Simultaneous state and parameter estimation extended kalman filter, two – stage identification methods. Non-linar identification, quasi-linearisation, invariant imbedding, numerical identification methods.

Reference Books

1. Analytical Design of Linear Feedback Control: Newton G. C., Jr. L.A. Gould & J. F. Kaiser
2. Modern Control Theory: Dorf
3. Elements of Engineering Probability & Statistics: Ziemer R.E.

COMPUTER AIDED INSTRUMENT DESIGN
(IC – 511)

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.

Circuit Analysis and Design: Review of signals and systems in time and frequency domain, fourier transforms; Laplace transform, transfer function, response plots. Use of SPICE models for analog circuit analysis. Digital circuit simulation.

Dynamic Analysis of Instrument Systems: Relative merits of analytical and experimental modeling of dynamic behaviour. Use of step response, pulse, harmonic and random test signals. Interpretation of real time dynamic response data. Simulation of dynamic responses.

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

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

Reference Books

1. Fiber optics: Theory and Applications: N. S. Kapany
2. Optical Instrumentation Theory & Design: B. N. Beglanov, N. P. Zakaznov, V. I. Kuzichev & S. L. Kiryushin
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 recogrition, 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 & acquistion, image sampling & quentization, relationship b/w pixels.

Digital Signal Processing & Filters:
Introduction, Z - transform, inverse Z tranform, convalution, filtering concepts, transformations for digital filter design, bilinear transformation, grey level transformation, histogram processing, image enhancement using airth matic 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, classifcation method, statistical pattern classification.

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

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

Reference Books
1. Speech & Audio Signal Processing: Ben Gold & Nelson Morgan
2. Digital Image Processing: Refeal C. Gonzale & Richard E. Woods.

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 S_T 100 bus, Multi bus, EISA, PCI Bus, HP IB/GPIB Bus, Bus and their applications. I/O

Interface
Standard I/O interfaces RS-232 C, RS-232 D Centronics interface, current loop interface, and RS-449 communication 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.
2. Student Reference Manual For Electronics Instrumentation Labs by Stanley wolf and Richard F.M. Smith, PHI.
3. Instrumentation for Engg. Measurement by James W. dally, William F. Riley, John Wilay and Sons
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
Review of 16-bit Microprocessor Architecture, Word Lengths, Addressable Memory, Microprocessor Speed, Architecture Characteristics, Registers, Instructions, Memory Addressing Architecture, ALU, GPR's, Control Logic And Internal Data Bus, Introduction to Pentium Architecture.

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
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.

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 defination, external factors, system component interrelationships, design problem, specifications & test improtant characteristics, definition of characteristics, instruments tests, noise and offset, geophone & seismometer tests.

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

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

Remote Sensors / Instruments

Design Problems

Reference Books

1. Geoscience Instrumentation. Edward A. Wolff: Enrico P. Mercanti, John Wiley
2. Field Instrumentation in Geotechnical Engineering. T. H. Hanna, Trans Tech Pub.
3. Seismic Instrumentation. Maurice Pieuchot, Geophysical Press, London 1984
4. Seismic Exploration. Klaus Helbig & Trieitel, Geophysical Press, London 1984

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 complaiance 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 procss control instructions.

Reference Books

1. Microprocessor principles and application: McGraw Hill 1995
2. Intel Series of Microprocessors: Berry B. Brey
3. Microprocessor Based System
4. Assembly Language Programming 8086

LASER TECHNIQUES & PRECISION MEASUREMENT
(IC – 519)

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.

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, interfero – meter, 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.

Simmulation 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 itelligence, K.S. Fu, R.C. Gonzalez, C.S.G. Lee
2. Robot Manipulators, Richard P. Paul
3. Industrial Robotics – Technology, Programming & Applications. Mikell, P. Groover, Roger N. Nagel, N. G. Odrey, Mitchell Walss.

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.
4. Neural Intelligent System: Hungenahally Jain.

OPTIMISATION TECHNIQUES
(IC – 521)

Max. Marks: 100
Time Allowed: 3 Hrs