STUDY & EVALUATION SCHEME
OF M.E. IN INSTRUMENTATION & CONTROL – REGULAR
PROGRAMME

Semester – I

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**NOTE:**

1. **Requirement for the award of ME in Instrumentation & Control degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.**

2. **No numerical marks are to be assigned to thesis work. It is either “Accepted” or “Rejected”. Quality of work reported in thesis can be graded in term of “Very Good”, “Good” or “Average”.**
## STUDY & EVALUATION SCHEME

**OF M.E. IN INSTRUMENTATION & CONTROL – MODULAR PROGRAMME**

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SCHEME FOR MASTER OF ENGINEERING (INDUSTRY ORIENTED AND PRACTICE BASED) PROGRAMME REGULAR AND MODULAR IN INSTRUMENTATION AND CONTROL

AIM

To offer Master of Engineering (industry oriented and practice based) Regular & Modular Programmes in Instrumentation and Control, for technical teachers and professionals working in industries.

RATIONALE

The rapid pace at which changes and advancements are taking place in technology pose a great challenge to training and supplying the right kind and quality of technical manpower. The training of technical personnel is largely influenced by the nature of curriculum, quality of instructional processes, management of instructional system and the role played by industry in their training.

In order to increase the relevance of technical personnel to the world of work, it has all along been felt that the nature of programmes offered by the technical institutes should be oriented towards technology applications and practices. These programmes should focus on learning of industrial practices, practical and generic skills of problem solving, learning to learn skill and entrepreneurship skill.

As per the latest recommendations of the AICTE regarding pay scales and qualifications for technical teachers, the minimum qualification for lecturers is prescribed as degree in Engineering or Technology or equivalent and they have to acquire Master’s degree or such higher qualifications for promotions to higher grades. Majority of these teachers are fresh graduates and lack the knowledge of industrial practices and related practical skills, which in turn affects, the quality of technician engineers produced by the Polytechnics/ Engineering Colleges. They, therefore, need a strong orientation in technological and field practices in the areas of fabrication, erection, construction, installation, operation, production, testing, maintenance and quality control.
The practice-based M.E. degree programme in Instrumentation and Control will provide the above education and training to the Polytechnic/ Engineering College teachers specially to equip them with the necessary knowledge and skills related to industry and field practices. They will be in a position to transfer such knowledge and training to the students of Polytechnics, so that their effective contribution in the world of work is increased.

In order to meet the above long felt need for higher education of polytechnic/ Engineering College teachers, it is necessary to offer practice based Masters degree programmes specially designed to incorporate credit based system of evaluation. The system will have all the inbuilt flexibility to allow for self pacing, taking up study of courses in the sequence and at the time convenient to in-service graduate personnel and obtaining specialization in the areas specific to their profession and carrier development.

In view of the above, NITTTR (earlier known as TTTI) Chandigarh have started offering a practice based M.E programme (Regular) in Instrumentation and Control for technical teachers having a B.E. degree or an A.M.I.E qualification in Electrical/ Electronics/ Instrumentation & Control Engineering or equivalent, since August, 1998. The course aims to provide an in-depth knowledge of field practices and ability to innovate and conduct research in technology areas. This will not only change the orientation of technician programmes but will also reduce the widening gap between technician courses and field practices and will greatly improve the performance of industries. Limited numbers of seats are also available to professionals working in industries and field organizations.

An acute problem faced by technical institutions both for degree and diploma level is that they are not able to spare their teachers for two long years for higher studies away from their institutes. In order to face the above situation, the institute is also offering another M.E. programme (Modular) in Instrumentation & Control for technical teachers and professionals working in Industries. This programme has been structured modular in nature where the teachers could be relieved from their institute to this institute for attending classes during summer and winter vacations. They will however also have to undertake follow up study when they return to their institutions so as to prepare themselves for University examinations before the beginning of subsequent modules. The contact type ME programme which is of two years duration has been made modular without any dilution with respect to rigour of teaching learning practices as also University examinations. However, the duration of the programme has been increased to 3 years. Classes will begin from first week of June and second week of December having a contact period of 5 weeks each where the students will study two subjects simultaneously.
Objectives

The specific objective of this course is Continuing Education and Training and Retraining of:

- in service technical teachers.
- industry personnel
- any other sponsored candidate desirous of pursuing a career in teaching.

Target Population

The envisaged target group includes:

- teachers with a B.E degree or an equivalent qualification such as A.M.I.E. etc, in Electrical/Electronics/Instrumentation and Control Engineering.
- working professionals from Industries and other organizations having a B.E degree in Electrical/Electronics/Instrumentation and Control Engineering or an equivalent qualification such as A.M.I.E. etc. in Electrical/ Electronics/ Instrumentation and Control Engineering.

SPECIAL FEATURES OF THE PROGRAMMES

i) Both the programmes are flexible, and allow self- pacing and taking up course of study in the sequence and at times convenient to the students:

ii) The courses focus on the mastery of minimum essential competencies and development of capabilities such as learning to learn, problem solving, human relations and management skills in addition to learning of Instrumentation Control Engineering subjects.

iii) These make use of a combination of instructional techniques such as group discussions, home assignments, individual and group projects, independent study, seminars etc.

iv) Assessment of student's performance will be based on both continuous evaluation using variety of assessment techniques matching the learning objectives of the different courses of study and end of term University evaluation.

v) Completion of the course work is followed by Thesis work
MIC 6101 MEASUREMENT SCIENCES

CONTENTS

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**Introduction**


**Generalized Performance Characteristics**

Static and Dynamic performance characteristics. Characteristic of periodic and transient inputs and the response of measuring system to these inputs. Response of measuring system to random inputs. Frequency spectra, auto correlation, cross correlation spectral density. Experimental determination of system parameters, requirement of instrument transfer function to ensure accurate measurement.

**Measurement System**

Classification of various types of transducers, fiber optic sensors, AC/DC signal conditioning, Analog to Digital and Digital to Analog converters, modulation – types, filters – active, passive, digital, Data transmission and telemetry-classification, Recorders – Types of recorders, XY-Plotters, Ultraviolet, magnetic and digital recording.

**LABORATORY/FIELD EXPERIENCES**

1. Experimental determination of system parameters.
2. Study and verification of transducer characteristics.
3. Study of signal conditioning techniques.
4. Verification of dynamic performance characteristics of a given system.
5. Case study of a real life measuring system in an industry.
6. Various data acquisition software.

**BOOKS RECOMMENDED**


MIC 6102 PROCESS DYNAMICS AND CONTROL
CONTENTS

Review of Process and Control systems

Design aspects of Process Control System

Dynamic Behaviour of Feedback Controlled Process

LABORATORY/FIELD EXPERIENCES
1. Study and analysis of a feedback controller
2. Simulation of control schemes
3. Verification of desired characteristics of P,I,D, and PID controllers
4. Design fabrication and testing of an electronic controller
5. Case study of digital computer controlled system in industry

BOOKS RECOMMENDED
MIC 6103 DIGITAL CONTROL

CONTENTS

Introduction

Control system terminology, control theory history and trends, computer-based control. An overview of classical approach to analog controller design. Basic digital control scheme.

Signal processing in digital control


Models of Digital Control Devices and Systems

Z-domain description of sampled continuous-time plants and systems with dead-time, Digital Controller design using direct synthesis procedures.

Control System Analysis using State Variable Methods for Digital Control Systems

State variable representation, Conversion of state variable models to transfer function and of transfer function to canonical state variable models, Eigen values and Eigen vectors, Solution of state difference equations, controllability and Observability, Multivariable system.

Pole-Placement Design and State Observers


Lyapunov stability analysis

Basic concepts, Stability definitions and theorems, Lyapunov functions for linear and non linear systems, A model reference adaptive system.

Linear Quadratic Optimal Control

Parameter optimization and optimal control, Quadratic performance index, control configurations, State regulator design through the Lyapunov equation, Optimal state regulator through the Matrix Riccati-equation for digital control systems.
TUTORIALS

Various simulation exercises on different digital control using MATLAB.

BOOKS RECOMMENDED

CONTENTS

PC as a platform for Data Acquisition
Origin of PC, Software-Operating systems, programming languages, hardware components – Mother Board – Microprocessors, Chipsets and support circuits, functions, system control, peripheral control, memory control BIOS and its functions.

Buses and Communications
History, Architecture, Bus function, Various buses; ISA, PCI, PCI-X, PCI-Express, PCMCIA, Infiniband, Hyper Transport.

Memory and Mass Storage Devices

Data Transfer –I/O devices
Key board, Mouse, Track ball, Scanners, Display systems, Display adapters, Audio Systems, Printers, Ports-USB, Firewire, IrDA, Bluetooth, RS-232C Serial Port, Parallel Ports.

Interfacing
Local Area Networking - Concepts, Topologies, Standards, Hardware, Telecommunication- Analog and Digital Services, Internet–Addressing, Domain Name Systems, Routing. Design of DAS around PC, different DAQ cards and software. Interfacing of Add-on DAQ cards with PC using various buses.

LABORATORY/FIELD EXPERIENCES
1. Interfacing for measurement of standard physical parameters
2. Experimental set up for LAN in a laboratory
3. Designing and implementation of a real life PC based interfacing system.

BOOKS RECOMMENDED
MIC 6105 INDUSTRIAL INSTRUMENTATION

CONTENTS

Measurement of Industrial parameters
Review of measurement and instrumentation system, Measurement of industrial parameters like: pressure, flow, level, temperature, displacement, velocity, acceleration, torque, Shaft power, humidity, moisture, viscosity, pH value measurement, sound level measurement.

Industrial data management and control
PLCs, Field bus concept, Data acquisition system, Data loggers, Supervisory control, DDC, DCS, SCADA, Instrumentation in hazardous situations, Robotics.

Unit Operation Monitoring
Instrumentation for optimization of unit operation e.g. heat exchanger, compressors, burners, weighing and batching, boilers, chillers, clean room, condenser, cooling towers, vapouriser, air handler etc.

Instrumentation in field
Study of instrumentation schemes for Thermal, Nuclear and Hydro power stations, Cement plant, Fertilizer, Chemical and Steel plant Paper industry etc.

LABORATORY/FIELD EXPERIENCES
1. Study of Instrumentation scheme at Thermal, Hydro, Nuclear Power station.
2. Study of instrumentation scheme at process industries e.g. cement, fertilizer, chemical, steel plant etc.
4. Case study of a PLC based instrumentation scheme in a process industry.
5. Experiments on PLC based instrumentation.

BOOKS RECOMMENDED
MIC 6201 MICRO CONTROLLERS AND THEIR INTERFACING

CONTENTS

Overview of microprocessors

Microprocessor- Introduction, Basic architecture, differences between microprocessors and microcontrollers.

Micro Controllers

AT 89C2051 20 pin Microcontroller- Introduction, Architecture
8051 Microcontroller- Architecture, Memory Organization, Timer/Counters, Serial Ports, Parallel ports, Assembly language programming: Addressing Modes, Instruction set, Assemblers and Compilers, 8051 timer programming, Serial port programming.
Real world interfacing of 8051 with: LCD, keyboard, ADC and DAC .
Introduction to Advanced Microcontrollers: PIC, ARM and AVR- Introduction.

Embedded systems
An introduction to embedded systems, Classification of embedded systems.

LABORAOTRY/FIELD EXPERIENCES
1. Performing experiments on microcontroller universal kits
2. Programming Practices on 8051
3. Design of small embedded system projects

BOOKS RECOMMENDED
CONTENTS

Air pollution measurement
Impact of man on the environment: An overview, Air pollution sources and effects, Meteorological aspects of air pollution dispersion. Air pollution methods and equipment, Air sampling techniques, gas analyzers, gas chromatography. Control of specific gaseous pollutants, measurement of automobile pollution; smoke level meter, orsat gas apparatus, CO/HC analyzer.

Water pollution measurement
Sources and classification of water pollutants; Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO), waste water sampling and analysis, Waste water sampling techniques and analyzers, gravimetric, volumetric, calorimetric, potentiometer, flame photometry, atomic absorption spectroscopy, ion chromatography. Instruments used in wastewater treatment and control, solid waste management techniques.

Measurement of other pollutants
Measurement of radioactive pollutants, ganger counter, Noise level measurement techniques.

LABORATORY / FIELD EXPERIENCES
1. Experimental analysis of air pollution of a given sample
2. Study of air pollution control techniques used in a given industry
3. Sampling and analysis of pollution level of a given water sample
4. Case study of air pollution control in an industry
5. Case study of flue gas handling in a thermal power station
6. Case study of water pollution control.

BOOKS RECOMMENDED
1. Environmental Pollution Control Engineering; C.S. Rao; Wiley Eastern LTD, New Delhi, 1996.
CONTENTS

Analytical Methods of Measurements
Physical methods of chemical analysis, special methods of analysis, basic techniques, terminologies, units, Interaction of electromagnetic radiations with matter, emission, absorption and scattering techniques. Instrumentation related to X-Ray, Ultraviolet and Infrared techniques.

Special Analysis
Various light sources, spectrometer, detectors and data processing, comparison of various spectral analytical techniques, refractometry, nuclear magnetic resonance spectrometry. Analytical techniques based on separation method: Basics of chromatography liquid, gas and HPLC Mass Spectrometry and related instrumentation.

Electrometric Methods of Analysis

LABORAOTRY / FIELD EXPERIENCES
1. Study of operation and maintenance of mass-spectrometry related instruments
2. Study of operation and maintenance of pH and selective potentiometry related instruments.
3. Study of operation and maintenance of voltmetry related instruments
4. Study of operation and maintenance of colometry related instruments
5. Study of operation and maintenance of conductometry
6. Case study of operation and maintenance of an analytical instrumentation laboratory.

BOOKS RECOMMENDED
CONTENTS

Control of Power plants
Instrumentation scheme for monitoring and control of various parameters of power plants through control panels. Instrumentation scheme for operation and maintenance of generating units.

Load Despatch
Automatic load dispatch using computers. Software used for optimum generator allocation. Computer based data acquisition system for power plant operations, maintenance and protection. SCADA in power systems.

Instrumentation for Transmission
Instrumentation schemes used for HVDC & EHVAC transmission systems. Energy management: Electronic instrumentation schemes adopted for energy conservation and energy audit.

LABORATORY/ FIELD EXPERIENCES
1. Preparation of layout of instrumentation and control schemes in a power plant
2. Study of computerized load dispatch system
3. Study of instrumentation scheme for HVDC & EHVAC transmission systems.
4. Study of computer control scheme for data acquisition and supervisory control of a power plant.
5. Case study of an energy audit in a small/medium industry.

BOOK RECOMMENDED
4. Economic scheduling; S. Mukhopadhyay, Wiley Eastern

MIC 6205 INDUSTRIAL ELECTRONICS
CONTENTS

Power Semiconductor diodes and transistors
Characteristics of power diodes, power transistor, power MOSFETS, insulated Gate Bipolar Transistor (IGBT), Mos-controlled thyristor and their comparison.

Thyristors and their characteristics
Review of thyristors such as SCR, TRIAC, GTO, PUT, SUS, SCS, ASCR, RCT. Thyristor Controlled Circuits.

Three phase controlled rectifiers
Single phase half wave and full wave converters, Analysis of three phase rectifier, Effect of source impedance on the performance of converters, Dual Converters.

Choppers
Control strategies, step up choppers, A, B, C, D and E type of choppers, Voltage, Current and Load commutated choppers.

Inverters
Single phase series and parallel inverter, single-phase & three-phase bridge inverters, Pulse width modulated inverters, Reduction of harmonics in the inverter output voltages, Current source inverter.

Cycloconverters
Single phase, Mid-point and bridge type cycloconverters. Three phase half-wave cycloconverters, Output voltage equation, Load commutated cycloconverters.

Electric drives
Single-phase and three-phase dc drives, chopper drives, ac drives, Induction motor drives, Speed control of three-phase induction motors, Synchronous motor drives, Microprocessor controlled ac and dc drives.

FACTS Controllers
SVC, TCSC, STATCOM, SSSC, UPFC

LABORATORY / FIELD EXPERIENCES
1. Basic experiments on thyristor and their applications.
2. Solid state control of drives.
3. Fabrication, testing and trouble shooting of various industrial electronic circuits.
4. Design and testing of thyristor based controllers for electric drives
5. Design and testing of microprocessor based drive controllers.
6. Study of applications of solid state control of industrial drives.
BOOKS RECOMMENDED

Introduction
Optical Electronics, Optical process in semiconductors.

Photo Sensitive Devices
Light emitting diodes, Photo-diodes, Photoconductors, Junction photodiodes, PIN diodes, Avalanche photodiodes, Photo transistors, Optical sensors.

Lasers

Optical fibre
Introduction to fiber communication, Optical fiber materials, their properties, Optical fiber communication schemes, Comparison of optical fiber communication with the conventional communication.

LABORATORY / FIELD EXPERIENCES
1. Study and verification of characteristics of a light emitting diode.
2. Experiments on laser beam production and their control
3. Study and verification of Characteristics of a photo conductor device.
4. Study and verification of characteristics of an avalanche photo diode.
5. Study of an opto-electronic integrating circuit used in industries.

BOOKS RECOMMENDED
CONTENTS

Introduction
Uses of computer networks, Network hardware and software, Reference models, Example network, Example data communication services.

Physical Layer
Theoretical basis of data communication, Transmission media, Wireless transmission, Telephone system, Narrow band and Broadband ISDN and ATM, Communication satellites.

Data Link Layer
Design issues, error detection and correction, elementary data link protocols, sliding window protocols, protocol specification and verification, data link protocols.

Medium Access Sublayer
Channel allocation problem, Multiple access protocols, IEEE standard 802 for LANs and MANs, Design of LAN, Detection and management of collisions, Budges, High Speed LANs, Satellite networks.

Network Layer
Design issues, Routing algorithms, Congestion control algorithms, Internetworking, Network layer in the internet and in ATM networks.

Transport Layer
Transport service, Elements of transport protocols, Internet transport protocols, ATM AAC layer protocols, performance issues.

Application Layer
Network security, Domain name system (DNS), Simple network management protocol, Electronic Mail, Usenet, World wide web, Multimedia.

LABORATORY / FIELD EXPERIENCES

1. Testing x 2.5 and TCP/IP protocols.
2. Setting up LAN connection
3. Installing a bridge between networks.
4. Setting up a link through Async/ Sync modems

BOOKS RECOMMENDED

CONTENTS

Artificial Neural Networks
Biological Neural Network-structure of human brain, Characteristics of ANN, Artificial neurons, Types of ANN-single layer and multilayer, Hopkinsons, counter propagation, back propagation, feedforward etc., Non Linear activation functions, Training of ANN and different training algorithms, bidirectional associative memories, various applications of ANN in the field of engineering in general and electrical engineering in particular, programming methods using ANN Techniques.

Fuzzy Logic

LABORATORY / FIELD EXPERIENCES

1. Simulation of ANN for digit recognition
2. Application of fuzzy logic for language translation
3. Programming exercises in ANN, FL & GA using MATLAB and its tool boxes.

BOOKS RECOMMENDED

CONTENTS

1. Practices on Daisy Lab Software.

2. Data Acquisition Practices with the help of various transducers and backup software.


4. Minor Projects based on Application of Transducers

5. SCADA Software Applications.
MIC 6209 DIGITAL SIGNAL PROCESSING

CONTENTS

Introduction
Classification of signals, concept of frequency in continuous-time and discrete-time signals, sampling theorem, Discrete-time signals and systems. Analysis of Discrete-Time Linear-time-invariant systems-convolution sum. Solution of linear constant coefficient difference equations, correlation of discrete-time signals

Z Transform
Review of direct and inverse z-transforms, solution of linear differential equations, Analysis of linear time-invariant system in the z-domain

Discrete Fourier Transform
Review of Fourier Series and Fourier transform of continuous time and discrete-time signals, DFT and its properties, Fast Fourier Transforms, various algorithms.

Structures for the Realization of Discrete-time System
Structures for FIR systems-Direct from I and II, cascade and parallel form, structures for IIR systems.

Design of Digital Filters

DSP Chips and their Application
TMS C3X series: Architectural overview, CPU, Memory types of Addressing, Applications.

LABORATORY / FIELD EXPERIENCES
2. Implementation of various filters
3. Use of DSP chips

BOOKS RECOMMENDED
MIC 7101 VIRTUAL INSTRUMENTATION

CONTENTS

Introduction to Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, conventional vs virtual instrumentation.

Learning LabVIEW: Introduction to LabVIEW, Front panel, Block diagram, Menus, Palettes, VI and Sub VI, Editing and Debugging VI, Structures, Arrays, Clusters, Charts and Graphs, Data acquisition, Instrument Control, Signal Generation and Signal Processing Examples

Active Interaction Devices: Gloves, Data glove, Power glove, Dexterous hard master, Mice and joysticks, Wands, Force balls, Biological input sensors, Voice recognition, Data suit

Displays: Sequential Scan Converter for VR displays, Interlace/Non-interlace modes, Parallel-in/Serial-out mode; Serial-in/Parallel-out mode. Multi-display Systems, Helmet-mounted displays, monochrome CRTs with shutters.

Application of Virtual Instrumentation in various fields: Aviation, Automotive, High voltage, Defence, Chemical, Industrial, Marine, Medical, Mining, Nuclear Energy, Virtual landscapes.

LABORATORY / FIELD EXPERIENCES

1. Geographical programming using LabVIEW
2. Applications of LabVIEW

BOOKS RECOMMENDED

2. LabVIEW Basic 1 Course Manual, National Instruments
3. www.natinst.com
4. www.ni.com
CONTENTS

Data Communication
General communication system, ASK, FSK, PSK, DPSK, Modulation and demodulation techniques, Baseband signal receiver, Probability of error, Optimum filter, Matched filter correlator examples.

Pulse Modulation
Sampling, Nyquist theorem, Calculation of percentage distortion due to undersampling, Spectrum of sampled signal, sampling with narrow pulses, Pulse amplitude modulation, pulse width modulation, pulse position modulation, digital modulation principles, Pulse code modulation, intersymbol interference, eye patterns, equalization, companding, Bandwidth and noise of PCM systems, Delta modulation, Adaptive DM, Comparison between various techniques.

Information and Theory
Information, Entropy, Mutual information, Redundancy and channel capacity, Shannon – Hartley theorem, Bandwidth S/N Trade off

Coding Theory
Shannon’s Theorem, Coding of η, Shannon-fano coding, Huffman coding, Hamming coding, bit error detection and correction, Error detection using parity bits, Block codes, CRC, convolution codes, Line and interface coding, NRZ codes, Manchester codes, Miller code.

Modern Equipment
Modern Technology, Modem classification, Modem Modulation Methods, Modem Interface specifications, Modem Transmission characteristics, Modem features, compatibility, selection criteria.

Applications of Digital Communication
E-mail, voice managing, teletext, View Data, Digital satellite communication, Mobile Modulation System.

LABORATORY / FIELD EXPERIENCES
1. Implementation of ASK.
2. Practice on A/D cards.
3. Implementation of PCM
4. Familiarization and Application of modems.
BOOKS RECOMMENDED

CONTENTS

Introduction of Technology Management

Technology Forecasting:  Techniques of Forecasting, Technology Forecasting – Relevance Strategic alliance and Practicality, Technology transfer.

Management of Research, Development and Innovation:  Technology mapping, Comparison of types of R & D projects and development approaches – radical platform and incremental projects, innovation process.


Managing Scientist and Technologists:  Identification, Recruitment, Retention, Team work and Result orientation.


Investment in Technology:  Venture Capital & Technology Development.

LABORATORY / FIELD EXPERIENCES
- Technology forecasting and Technology mapping
- Technology Strategy Development
- Exercise on Just-in-Time
- Cases on Venture Capital

BOOKS RECOMMENDED
CONTENTS

Introduction
Energy scenario-in context of Indian and global, conventional and non-conventional sources of energy, Renewable versus non-renewable sources of energy, Generation of electrical energy using non-conventional sources- Solar, Wind, Magnetohydro, Tidal, Geo-thermal, Ocean etc.

Energy Conservation
Various methods of energy conservation, Energy management techniques, case studies

Energy Efficient Technology
Technology for efficient utilization of electrical energy, Energy efficient devices, Instrumentation schemes for measuring and controlling electrical energy for implementation of energy efficient systems.

Energy Audit
Methods for doing preliminary, secondary and final energy audit, impact of power factor on electrical power systems, Improvement of power factor.

LABORATORY / FIELD EXPERENCES
Various Case Studies, Mini projects on energy audit.

BOOKS RECOMMENDED
Relevant journals and Reports
MIC 7105 BIO-MEDICAL INSTRUMENTATION

CONTENTS

Sensors and Transducers for biological applications
Types, properties, characteristics and selection of transducers for biological instrumentation.

Measurement of electrical parameters
Leads and electrodes, electrocardiography, electrical activity of the heart, equivalent cardiac generator. Einthoven lead system, standardization of recording and display of ECT (Electrocardiogram), EEG (Electroencephalogram), EMG (Electromyogram), EOG (Electroocculologram), ERG (Electroretinogram), EGG (Electrogastogram).

Measurement of non-electrical parameters
Bloodflow, droprecorder, electromagnetic flow meter, measurement of systolic and distollic pressures, blood pressure instruments, intraocular pressure, lung air pressure, audiometers. Measurement of body temperature, thermography. Cardiac tachometer, respiration rate phonocardiogram, heart sounds electrical stethoscope pulmonary function analysers. CO₂ - O₂ - Concentration in exhaled air, blood and lungs, pH value of blood, impedance pletnysmography blood gas analysers, blood cell counters.

Medical Imaging Systems
Medical display systems, medical thermography X-Ray, diathermy equipment. Ultrasonics in biomedical application for diagnostic and therapeutic, CAT, MRI, Laser applications in biomedical field.

Patient safety
Electrical Safety of Medical Equipments, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, Test Instruments for checking Safety parameters of biomedical equipments.

LABORATORY / FIELD EXPERIENCES
1. Study of sensors and transducers used in Bio-medical applications
2. Study of Bio Medical instruments used in Heart-care system
3. Study of operation and maintenance of ECG instrument
4. Study of operation and maintenance of instruments used for thermography
5. Study of operation and maintenance of instruments used for blood analysis
6. Case study of operation and maintenance of an ultrasonic machine

BOOKS RECOMMENDED
INSTRUCTION TO PAPER SETTERS

The instructions for the paper setters for all the subjects of M.E. (Instrumentation. & Control) are as follows:

1. The paper must be set by taking into consideration the total syllabus.
2. There should be in all 8 questions covering the total syllabus.
3. The examinees are supposed to attempt any five out of the 8 questions.
4. The paper should be set by following the principle of simple to complex approach.
5. The paper must be set in such a pattern that it examines knowledge, analytical power and the reasoning power of the examinee.
6. Wherever appropriate, proper numerical problems should be included.
7. Maximum marks for the paper should be 100 and time allotted should be three hours.