SHIVAJI UNIVERSITY, KOLHAPUR

Structure for Instrumentation Engineering Degree Course
Introduced from July 2015
T.E. (Instrumentation Engineering)

Semester - V

Sr. No.	Name of Subject	Teaching scheme(Hrs)				Examination Scheme(Marks)				
--	--	L	T	P	Total	Theory	TW	POE	Oral	Total
1	Power Electronics	4	-	2	6	100	25	50	-	175
2	Process Control	3	1	2	6	100	50	-	25	175
3	Biomedical Instrumentation	4	-	-	4	100	-	-	-	100
4	Automatic Control System	4	-	2	6	100	50	-	-	150
5	Microcontroller & Application	3	1	2	6	100	50	50	-	200
	Total	**[18]**	**[2]**	**[08]**	**[28]**	500	175	100	25	800

Semester - VI

Sr. No.	Name of Subject	Teaching scheme(Hrs)				Examination Scheme(Marks)				
--	--	L	T	P	Total	Theory	TW	POE	Oral	Total
1	Power plant Instrumentation & Unit Operations	3	-	-	3	100	25*	-	-	125
2	Control System Design	4	-	2	6	100	50	-	25	175
3	Chemical & Analytical Instrumentation	3	1	2	6	100	25	-	-	125
4	Industrial Automation	4	-	2	6	100	25	-	25	150
5	Embedded Instrumentation	4	-	2	6	100	25	50	-	175
6	Mini Project	-	-	2	2	-	50	-	-	50
	Total	**[18]**	**[1]**	**[10]**	**[29]**	500	200	50	50	800

*Term-work for Power Plant Instrumentation & Unit Operation will be based on Industrial Visit and report

T.E. INSTRUMENTATION –PART I
POWER ELECTRONICS

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 02 Hrs/Week

Examination Scheme:-
Theory Paper: 100 Marks
TW : 25 Marks
POE : 50 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Electronic Power devices characteristics, specifications and selection
2.Various power electronic circuits operating principle & working
3.Applications of power electronics.

Course Outcomes:
1.Student will able to describe power SCR, MOSFET, IGBT, Diac, Triac.
2.Student will able to explain phase controlled rectifiers.
3.Student will demonstrate Choppers and Inverters.
4.Student will able to design DC motor and AC motor control scheme.
5.Student will able to analyze cycloconverters.

Course Syllabus

Unit	Contents	Hours
1	**Study of Semiconductor Devices :** Power Transistor , Power MOSFET, SCR, GTO, DIAC, DIAC & TRIAC (Principle, construction, working and characteristics)	6
2	**Thyristor Firing & Protection Circuits:** Thyristor Turn-on Methods, Devices Used for Firing Circuits (UJT, PUT,SUS), Gate Characteristic of Thyristor, Firing Circuits (R, R-C), Thyristor Turn-off Methods, Commutating Circuits (class A to class F), Protection of Devices and Ratings.	8
3	**Phase Controlled Rectifiers:** Principle of phase control Single phase controlled rectifiers: Half wave, center tapped Bridge (half controlled and fully controlled) with R and R-L load (calculation of performance parameter) with continuous and discontinuous current mode of operation. Problems based on controlled rectifiers.	6
4	**Inverters:** Principle of operation of single phase Inverters, Series Inverter, Parallel Inverter and Bridge Inverter, Voltage source Inverters and Current source Inverters, Harmonic reduction Techniques.	5
5	**Choppers :** Principle of operation of chopper, Classification, Step up chopper, Step down	4

	chopper, Morgan chopper, Jones chopper, Chopper Control Techniques (TRC & CLC).	
6	**Speed Control of DC Motor:** Scheme for DC motor speed control, Single phase separately excited drives. One quadrant, two quadrant & four quadrant speed control technique of DC motor, single phase separately excited drives.	4
7	**Cyclo Converters :** Single phase to single phase AC conversion, Mid-point Cycloconverters and Bridge type Cycloconverter with R & RL Load.	2
8	**Industrial Applications** : UPS (online, off line), Servo Stabilizer (block diagram), SMPS, Emergency light system, Battery charger using SCR, AC power flasher, DC power flasher, DC timer circuit using UJT and SCR.	6

Suggested books:

1)M. H. Rashid, Power Electronics, PHI India.
2)Alok Jain, Power Electronics & its Applications, PIP India.
3) P. C. Sen, Power Electronics, TMH India.
4M. D. Khandchandani, Power Electronics, MGH
5)Joseph Vithayathil, Power Electronics, Principles & Applications, McGraw Hill Series.

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART I
PROCESS CONTROL

Teaching Scheme:	Examination Scheme:-
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 02 Hrs/Week	TW : 50 Marks
Tutorial: - 01 Hr/Week	PO : 25 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Understand dynamic behavior of process
2. Know analysis of different types control actions
3. Understand various control strategies of process

Course Outcomes:
1.Student will able to describe different process characteristics.
2.Student will able to explain PID controller.
3.Student will able to evaluate PID tuning methods
4.Student will able to illustrate multivariable control system.
5.Student will able to describe control valve.

Course Syllabus

Unit	Contents	Hours
1	**Fundamentals of Process Control :** Elements of process control loop, concept of process variables, set point, controlled variable, manipulated variables, Types of process (dead time, Single and multi capacity, self and non self regulating, Interacting and non interacting, linear and non linear process) Process gains, process reaction curves, process time constant and constant step analysis method for finding time constant, dead time. Dynamic element in control loops. Analysis of flow, pressure, level and temperature loops.	10
2	**Control Actions :** Discontinuous: On / off, multiposition control, floating control. Continuous: proportional, integral, derivative, proportional – integral, proportional – derivative, PID controller, anti-reset windup, bump-less transfer in PID controller. Selection and application of control action	10
3	**Tuning of PID controller :** Process reaction curve (open loop), Z-N method (close loop), set point tuning vs load disturbance tuning, Digital PID controllers: concept of velocity and position algorithm.	6
4	**Multi loop and multi variable process control systems:** Feedback, feed	8

	forward control, cascade control, ratio control, auto selective control, split range control, Predictive control systems and Adaptive control system. (Interaction and de coupling, relative gain analysis, procedure to calculate relative gain and its applications)	
5	**Control valve:** Basics of control valve, definition, types, control valve coefficient, actuator and types, selection of control valve, leakage class, testing of control valve, Effects & remedies of cavitations & Flashing. Anti cavitation trims, Pressure drop across the valve, valve noise, flow characteristics linear, equal percentage, quick opening.	8

References Books :

1) Process Control Systems – F. G. Shinskey (TMH)
2) Process Control – B.G. Liptak (Chitlon)
3) Computer based Industrial Control – Krishna Kant (PHI)
4) Feedback Controller Tuning, Application and Design – F. G. Shinsky (TMH)
5) Instrumentation for Process Measurement and Control By : Nirman Anderson, (Chilton)
6) Tuning PID controller (ISA)
7) Chemical Process control – G. Stephanopoulos. (PHI)
8) Process Instrumentation and Control Hand book – Considine (MGH)
9) Process control instrumentation – C.D. Johnson (PHI)
10) Continuous Process Control (ISA)
11) Statistical Process Control (ISA)
12) Multivariable Process Control (ISA)

Term Work:
It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART I
BIOMEDICAL INSTRUMENTATION

Teaching Scheme: Examination Scheme:-
Lectures: 4 Hrs/Week Theory Paper: 100 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Know human anatomy any physiological system.
2.Understand clinical instruments.

Course Outcomes:
1.Students will able to describe human anatomy & physiological systems.
2.Students will able to distinguish recording and monitoring instruments.
3.Students will able to design of bio potential amplifier.
4.Student will able to illustrate instruments used in clinic.
5.Students will able to collect safety & recent development in biomedical field.

Course Syllabus

Unit	Contents	Hours
1	**Introduction to Human Anatomy** Cell structure, basic cell functions, origin of bio_ potentials, and electrical activity of cells,types of electrodes. Physiological parameters & suitable transducer for its measurement, its operating principle.	5
2	**Physiological Systems** Cardio-vascular system: Structure of heart, cardiac cycle, ECG theory, blood pressure measurement, blood flow measurement. Central nervous system: Structure of neuron, different waveform generation, EEG theory, Evoked response. Respiratory system:-Natural process of breathing, Spiro meters, air flow measurement, Oxygenators, Ventilator, Artificial respiration.	8
3	**Recording & Monitoring Instruments:** Life saving Devices: Pacemaker, Defibrillator, Artificial Heart valves, Heart lung machine. Imaging techniques: Telemetry, C.T, Endoscopy, and Sonography. Cardiac arrhythmias & ambulatory monitoring System.	8
4	**Bio potential Amplifiers:** Designing of Instrumentation Amplifier, CMRR improvement Technique, IC based instrumentation Amplifiers, Isolation Amplifiers, Isolated power Supplies and their applications.	4
5	**Clinical lab Instrumentation:** Blood component & there function Blood cell counter, Glucose measurement	5

	technique, Urine analysis technique- PH electrode, PO2 Electrode, PCO2 electrode. Diathermy Machine. X-ray machine: Introduction, Types, operation, Application.	
6	**Safety Measures:** Electrical Safety: Macro shocks, micro shocks, Significance of Electrical Danger, ground shock hazards, methods of Accident Prevention, line isolation system.	4
7	**Recent Development in Biomedical Instrumentation:** Kidney Instrumentation: Kidney structure, Regulation of water & Electrolyte balance, Artificial Kidney Types, Dialysis system. Laser Instrumentation: Laser Based Surgical Devices, Instrumentation in Cryogenic, Instrumentation in MRI, Wireless biosensors for health monitoring.	7

Reference Books:

1. Carr & Brown,' Introduction To Biomedical Equipment Technology'
2. R. S. Khandpur,' Handbook of Biomedical Instrumentation', TMH.
1. Jacobsons & Webster,' Medicine and Clinical Engineering', PHI
2. Cromwell,' Biomedical Instrumentation and Measurements', PHI
3. Bronzino,' The Biomedical Engineering Handbook', IEEE Press
4. Feenberg,'Applied Chemical Engineering'
5. K. Kirk Shung, Michael B. Smith, Benjamin Tsui 'Principles of Medical Imaging',- Pub:Academic Press.
6. Carruth,' Medical Laser Applications'
7. Sliney & Trokal,'Medical Lasers & their safe Use'
8. Human Physiology: The Mechanism of Body Function by Vander, Sherman, TMH Ed.
9.Biomedical Digital Signal Processing by Tompkins.

T.E. INSTRUMENTATION –PART I
AUTOMATIC CONTROL SYSTEM

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 02 Hrs/Week

Examination Scheme:-
Theory Paper: 100 Marks
TW : 50 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Know basic components of feedback control system.
2.To study the standard inputs and response of first, second order systems.
3.Understand mathematical modeling of system
4.Know frequency domain analysis
5.Student will get concept of stability.

Course Outcomes:
1.Student will able to describe basic components of feedback control system.
2.Student will able to design mathematical model of system.
3.Student will able to evaluate time domain & frequency domain analysis.
4.Student will explain stability criteria of system.

Course Syllabus

Unit	Section –I	Hours
1	**Introduction** Definition. Elements of control systems, examples of control systems, open loop and closed loop control systems, Linear vs Non-Linear control system, SISO and MIMO system, continuous and sampled data control.	2
2	**Mathematical Modeling and system Representation** Differential equations of physical systems such as Mechanical, Electrical, electromechanical , thermal , hydraulic, pneumatic , liquid level etc. Analogous systems, Force voltage analogy, force current analogy and torque current analogy , Transfer function, block diagram representation of control system, rules and reduction techniques .Signal flow graph-elements, definitions, properties, mason's gain formula, application of gain formula to block diagram .	12
3	**Time domain analysis** Standard test signals, transient response, steady state error and error constants. Time response of first order systems to unit and ramp input., second order systems to unit step input, transient response specifications. Effect of adding poles & zeros to transfer function, dominant poles of transfer function. Time domain analysis using MATLAB. Introduction to MATLAB, Control system toolbox.	10

Section –II

4	**Root - Locus Technique** Introduction, Basic properties of the root loci , general rules for construction of root loci . Sensitivity of the roots of the characteristics equation. , Root — locus analysis of control system using MATLAB.	6
5	**Frequency domain analysis** Concept of frequency response, performance specifications, co-relation between time domain and frequency domain responses. Frequency response plots- polar plots, Bode plots, , gain margin , phase margin. Effect of gain variation, adding poles /zero on Bode plot .Frequency response analysis using MATLAB.	10
6	**Stability Analysis** Concept of stability, definition, condition for stability , relative stability, Routh - HURWITZ criterion , . Nyquist stability criterion, Stability analysis using MATLAB	6

Reference Books :-

1) Nise, Control systems Engineering - wse wiley publication
2) Ogatta, Modern Control Engineering - PHI Publication.
3) I.J.Nagrath and M.Gopal - Control systems Engineering.(New Edition)
4) S.C. Goya! and U.A.Bakshi - Principles of control systems
5) Hadi Saadat - Computational aids in control systems using MATLAB.
6) Kuo, Golnaraghi- Automatic Control System- WSE Willey Publication.
7) Rudra pratap -MATLAB

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART I
MICROCONTROLLER & APPLICATIONS

Teaching Scheme:	Examination Scheme:-
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 02 Hrs/Week	TW : 50 Marks
Tutorial: - 01 Hr/Week	POE : 50 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Know fundamentals of microcontrollers.
2.Design microcontroller based applications.

Course Outcomes:
1.Student will able to explain architecture of microcontroller.
2.Student will able to develop assembly language programming.
3.Student will able to function interfacing of hardware with microcontroller.
4.Student will develop interfacing of protocols with microcontroller.

Course Syllabus

Unit	Contents	Hours
1	**Introduction To Microcontrollers:** MCS-51 family architecture, Prog. & data memory organization. SFR and their function. Clock and oscillator, reset organization, power ON reset circuit and its design., external memory and I/P interface like 8255.	4
2	**Programming MCS- 51:** Addressing mode, instruction format, instruction types, instruction sets. Assembling Language Programming.	8
3	**8051 – On Chip Resources:** Interrupts structures, timer / counter operation. Serial port operation (modes of operation) multi processor communication.	8
4	**Introduction PIC (16F877):** RISC & CISC Architecture comparison, PIC architecture. Memory Organisation: Program memory, data memory, ALU / CPU architecture , Addressing modes, conversion of logical to physical address, Instruction set, types, Basic assembly programming .	8
5	**Microcontroller C Programming:** Introduction, Data types, memory types and models, Arrays, structures, pointers, functions.	3
6	**Hardware Interfacing With MCS-51:** LCD interface, key pad interface, ADC, DAC, PWM interface, sensor interfaces like –Temperature, Pressure, Speed, displacement sensors, through to MCS-51	4

7	**Bus Interface To MCS- 51:** RS-232 C interface, EA standards, I2C interface, SPI Interface, USB interface, CAN interface, Ethernet.	4

Suggested Books :

1 The 8051 Microcontroller 4th Edition – Scotmackenzis RCW Phan

2 The 8051 Microcontroller 3th Edition – Ayala

3) The 8051 Microcontroller and Embedded Using assembly and C: Mazidi & Mazidi

4) Intel data sheet : MCS-5

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART II
POWER PLANT INSTRUMENTATION & UNIT OPERATION

Teaching Scheme:	Examination Scheme:-
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 02 Hrs/Week	TW : 25 Marks

Course Objectives: Upon completion of this course, student should be able to:

1.Know overview of all power generation plant.
2.Selection of instrumentation system to power plant.
3.Understand basics of unit processes.
4.Know details of various unit operations.

Course Outcomes:

1.Students will able to identify methods of power generation.
2.Students will able to explain conventional & non conventional energy power plants.
3.Student will able to describe modes of heat transfer.
4.Student will able to discuss basics of distillation columns & gas absorptions.
5.Student will distinguish between extraction, crystallization & drying.

Course Syllabus

Unit	Section - I	Hours
1	**Thermal Power Plant:** Method of power generation, layout and energy conversion process, Material handling system, study of all loops- water, steam, fuel etc	3
2	**Hydroelectric Power Plant**: Site selection, Hydrology, Estimation electric power to be developed, classification of Hydropower plants, Types of Turbines pumped storage plants, storage reservoir plants.	6
3	**Comparison of Thermal and Hydro Power:** Plant – Performance, efficiency, site selection, Economics-capital and running, safety standards, pollution, effluent management and handling.	5
4	**Non conventional Energy Power Plant:** Wind, solar, sea tide, Nuclear, Geothermal, MHD, Biomass cogeneration Problems in Harnessing these energy sources.	6
5	**Pollution monitoring and control**: Sound, Air, smoke, dust, study of Electrostatic precipitator	3
	Section - II	
6	**Introduction:** Basic concepts of unit operations and unit processes, Material Balance –Energy	3

	Balance, Batch and continuous process – operations, endothermic and exothermic reactions	
7	**Heat Transfer : -** Basic modes of heat transfer, Basic Laws Heat transfer Equipments : Double pipe heat exchanger. shell and tube heat exchanger. Types of shell and tube exchanger. Evaporation: Types of evaporators, multiple effect evaporators. Methods of feeding multiple effect evaporation.	4
8	**Distillation:** Concept of distillation , Boiling point diagram, Roult's Law, Vapour liquid equilibrium, Volatility , constant boiling mixtures azeotrope. Methods of distillation, importance of reflux ratio.	4
9	**Absorption:** Concept of absorption and adsorption , concept of equilibrium , Gas absorption Equipments, pressure drop across column,Tower packings	2
10	**Extractions:** General consideration of extraction , equilibrium condition , ternary system , 'basic properties of solvent. Extraction Equipments : mixer settler , spray column	2
11	**Crystallization:** Concept of crystallization , saturation and super saturation , Effects of temperature on solubility , methods of super saturation. Crystallizers : Agitated tank crystallizer, Swenson –walker crystallizer.	2
12	**Drying :** Principles, equilibria, Bound & unbound moisture, Rate of drying. Drying equipments : Tray drier , Rotary drum drier, Vacuum drier ,Fluidized bed drier	2

Recommended Books: -

1. Power Plant Engg.: Domkundwar
2. Process Control: Liptak
3. Energy Management Handbook: W.C. Taeruer
4. Pollution: M.N.Rao and H.V. Rao.
5. Power system control Technology – Torsten Cegrell (PMI)
6. Energy Technology Handbook, considine D.M.(MHR)
7 Solar Energy Technology vol I & II Dickinson & cheremision off.
8 Computer control & modeling- krishnkant.
9.Mccabe and Smith - Unit operations of chemical Engineering .
10.M gopal Rao and Mgrshall Sitting : Dryden's Outline of chemical technology .
11.Georget Austin - Shreve's chemical process industries .

12.Rober E. Trebal - Mass Transfer operations.
13.Richardson and Colsun - Chemical Engineering Vol. I & II
14.Perry's (6th Edn) - Chemical engineering Handbook .
15.Liptak Bela – Process Control Handbook.
16.Peter Harriot – Automatic Process Control
9 Andrew William – Vol I /II.
10 Mass Transfer Operation :- Rober E. Trebal.

Term Work:
It shall consist of a industrial visit and report based on it.

T.E. INSTRUMENTATION –PART II
CONTROL SYSTEM DESIGN

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 02 Hrs/Week

Examination Scheme:-
Theory Paper: 100 Marks
TW : 50 Marks
POE : 25 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Understand state space representation of continuous and discrete time control systems.
2.Analyze continuous and discrete time systems in state space.
3.Knowledge of basic concepts of digital control systems.

Course Outcomes:
1.Student will able to analyze non linear system.
2.Student will able identify state space representation of continuous & discrete system.
3.Student will able to analyze stability of discrete system.
4.Student will able to design discrete time control system.

Course Syllabus

Unit	Contents	Hours
1	**Nonlinear Systems:** Types of non – linearity, analysis by describing functions method , phase plane method, construction of trajectories by isocline method .	5
2	**State Space Representations of Continuous Time System:** Definitions of state variable , state, state vector, state space, state trajectory. Multi input –multi output system state model and block diagram. SISO System State Model & block diagram. Obtaining transfer function from state-space model. Determination of state transition matrix, properties of state transition matrix. Solution of homogeneous and non homogeneous state equations. Concepts of controllability and observability.	10
3	**Design Of Continuous –Time System In State- Space:** Introduction, Pole placement, solving pole-placement problems, Ackerman's formula, state observers, observer design.	6
4	**Discrete –Time Control System:** Introduction of discrete time system. Review of Z-transform, Z- plane analysis of discreet time control system. Pulse transfer function, Impulse sampling, Laplace transform of impulse sampled single starred Laplace transform of signal involving both ordinary and starred Laplace	8

	transforms, Block diagram analysis,	
5	**Stability Of Discrete –Time System:** Introduction, equivalence between 'Z' domain and S- domain. Stability analysis by Jury test and bilinear transformation with Routh criterion	5
6	**State-Space Representation Of Discrete –Time Control System:** Introduction, state space representation of discrete time control system. Solving discrete time- state space equations by recursion method & Z-transform method. State transition matrix by Z-transform and Cayley Hamilton method. Realization of pulse transfer function by direct programming method.	8
7	**Design Of Discrete –Time Control System In State –Space:** Controllability, Observability, Kalman's test for controllability and observability. Design via pole placement and observer.	5

Suggested Books

1) Modern Control Engineering – K . ogata , PHI Publication.
2) Discrete –time control systems - K . ogata , Fourth Edition 2002
3) Control Systems engineering – R. Anandnatarajan / P.Rameshbabu.(Scientech)
4) Modern Control System Theory – M. Gopal
5) Control Systems engineering – I.J.Nagrath and M Gopal.
6) Digital Control & stak variable methods, by M Gopal – McGraw Hill Publication
7) Control Theory – Multivariable & nonlinear methos by Torkel Glad & Lennant Ljund Vikas Publication House.
8) Computational aids in control systems using MATLAB– Hadi Saadat

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART II
CHEMICAL & ANALYTICAL INSTRUMENTATION

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 02 Hrs/Week
Tutorial: - 01 Hr/Week

Examination Scheme:-
Theory Paper: 100 Marks
TW : 25 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.To understand basic principles of various Analytical Instruments.
2.To understand Instrumentation required for different types of Analytical Instruments
3.To know the typical clinical and industrial applications of Analytical Instruments

Course Outcomes:
1.Student will able to discuss chemical analysis.
2.Student will able to describe flame photometry.
3.Student will able to summarize NMR. & mass spectrometer.
4.Student will able to classify chromatography.

Course Syllabus

Unit	Contents	Hours
1	Introduction to Chemical Instrumental Analysis, advantages over classical methods, classification : Spectral, electyroanalytical and seperative methods, Laws of photometry (Beer and Lambart's Law) ,Basic components of Analytical Instruments.	4
2	Colorimeter, Spectrophotometer (UV-Visible), Monochrometer, Filters, Grating, Prism, Dual wave length and Monochrometor system, Rapid scanning spectrophotometers, IR spectrophotometers,	4
3	Flame photometry: Principle, Construction details, Flue gases, Atomizer, Burner, Optical system, Recording system. Atomic absorption spectrophotometers : Theoretical concepts, Instrumentation : Hollow cathode lamps, Burners and flames, Plasma excitation sources, Optical and electronic system.	6
4	Industrial gas analyzers, pH, conductivity, particle counting, detection on the basis of scattering – Nephalomete, Laboratory Instruments : Centrifuge, oven, water bath, incubators, stirrers, densitometer,	4
5	NMR Nuclear Magnetic Resonance spectroscopy, basic principles, continuous wave NMR spectrometers, pulse FT NMR, spectrometer, spectra and molecular structure.	6
6	Mass spectrometer (MS) : Principle, ionization methods, mass analyzer types –	6

	magnetic deflection type time of flight, quadruple, double focusing, detectors for MS, applications. X-Ray spectrometry : Instrumentation for X-Ray spectrometry, X-Ray diffractometer,	
7	Chromatography : Classification, Gas chromatography: Principle, constructional detail, GC detectors Liquid Chromatography High Performance Liquid Chromatography (HPLC) : Principle, constructional detail, HPLC detectors Dust : Air pollution standards, air pollution sampling measurement. Non destructive testing using metal and non metal.	6

Suggested books:

1) Instrumental Methods of Analysis 7th edition : by Willard , Merrit, Dean Settle, CBS Publishers & distributors, New Delhi .

2) Handbook of Analytical Instrumentation by R.S.Khandpur (TMH)

3) Principles of Instrumental Analysis 5 th edition By: Skoog, Holler, Nieman,Thomson Books Publications.

Reference books :

1) Instrumental Methods of Chemical Analysis 5 TH edition By; Galen W. Ewing (TMH).

2) Introduction to Instrumental Analysis By : Robert D. Braun (TMH)

3) Instrumental Methods of Chemical Analysis By : Chatwal & Anand

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART I
INDUSTRIAL AUTOMATION

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 02 Hrs/Week

Examination Scheme:-
Theory Paper: 100 Mark
TW : 25 Marks
PO : 25 Marks

Course Objectives: Upon completion of this course, student should be able to:
Know fundamentals of PLC.
Programming in PLC
Know Hardware structure of PLC

Course Outcomes:
Student will able to distinguish between DCS, PLC, PC & field bus.
Student will able to explain PLC Hardware in detail.
Student will able to program PLC to solve industrial problems.
Student will able to describe commissioning and maintenance.
Student will identify SCADA and HMI

Course Syllabus

Unit	Contents	Hours
1	**Introduction to Automation:** Evolution & Aims of Industrial Automation. Standard Hierarchical Automation Systems Levels, Functional Levels & Database Organization.Features & requirements of manufacturing automation & process automation. Automation options - DCS, PLC, PC, Fieldbus & hybrid architectures. Comparison & selection from among these systems.	8
2	**PLC Basics :** Introduction: Families, Processors, operation, Programming tools,memory structure, access & programming modes. IEC 61131 standards.Hardware: Physical components, racks, slot, Power, CPU, Discrete & Analog Input/Output modules, RTUs & HMI panels Programming: Numbering systems, Ladder Logic Symbols, basic Instructions, Program Logic Development, testing & debugging. Simple problem solving.	8
3	**Advanced Techniques:** Programming Language Standards IEC 61131-3: IL, ST, SFC, FBD, LLProgramming: Multi Rung Ladders, Sequence, Logic, transfer of control timers & counters.Process Interfacing: Discrete Sensors & Actuators, Analog Sensors &Actuators, Linear & Rotary Encoders.	6

4	**PLC in Manufacturing Automation:** Programming: Logic Development steps, Failsafe Programming,Emergency shutdown, Safety Interlocks Case Studies: AC & DC Motor Controls, Variable speed AC motor drives, conveyers, hoist, robots, CNCs.	4
5	**PLC in Process Automation:** Programming: Logic Development steps Control strategies: Auto/Manual, Open loop, Closed loop, On-Off.Case Studies: Temperature, Level, Pressure & flow control, Continuous & Batch processing.	6
6	**Commissioning & Maintenance:** Project: Planning, Installing & Verifying Project, Project & Program Documentation. PLC Fault Handling & Diagnostics, Redundant configurations, networking.	4
7	**SCADA :** SCADA based plant monitoring & control concepts. Functions of SCADA, PLC/SCADA Communication, Graphics & HMI, Animation,Database configuration, Real-Time & historical trends.	6

Reference Books:

1. Distributed computer control for Industrial Automation, Popovic & Bhatkar
2. Programmable Logic Controllers, Webb & Reis, PHI
3. Programmable Logic Controllers, John & Fredric Hackworth, Pearson
4. Introduction to Programmable Logic Controllers, Gary Dunning, Thomson
5. SCADA : Supervisory Control And Data Acquisition By : Stuart Boyer ISA

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART II
EMBEDDED INSTRUMENTATION

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 02 Hrs/Week

Examination Scheme:-
Theory Paper: 100 Marks
TW : 25 Marks
POE : 50 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Know basics of embedded system.
2.Understand ARM processor

Course Outcomes:
1.Students will able to describe embedded system.
2.Students will able to explain ARM organization & programmer model.
3.Students will able to identify ARM instruction set.
4.Student will able to describe real time operating system.
5.Students will able to demonstrate programming of ARM

Course Syllabus

Unit	Contents	Hours
1	**Introduction to Embedded systems:** Processor in Embedded system, Hardware units, Software embedded into a system, Process of selection for embedded system, memory and I/O devices, interrupt servicing mechanism, interrupt latency, context switching.	6
2	**ARM Processor:** CISC and RISC processors architecture, ARM organization, ARM Programmers model, operating modes, Nomenclature, Core Extensions. ARM Design Philosophy, Embedded System Hardware, Embedded System Software, and ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline Exceptions, Interrupts and the Vector table, ARM 7 families, Introduction to ARM 7/ ARM 9. AMBA Bus architecture.	8
3	**ARM Instruction Set:** Introduction to ARM and Thumb instruction set, Data processing instructions, branch instructions, load-store instructions, software interrupts instructions, program status register instructions, stack instructions and conditional execution. Assembly language programming. ARM (32 bit) and THUMB (16 bit) operating modes. Switching between ARM and THUMB instructions	8
4	**Exception and Interrupt handling :** Exception types in ARM, exception handling, External interrupt, software	4

	interrupts handling, abort handling .Memory management unit (MMU), Virtual memory, multitasking and the MMU, Page tables, Translation Look Aside Buffer, Fast Context Switch Extension	
5	**Real Time Operating System:** Operating system services, Real time and embedded system OS. Types of RTOS hardware & software RTOS. Scheduling policies, priority round robin, effective release time and dead line, clock driven approach. Preemptive Kernel, Non preemptive Kernel, monolithic versus micro kernel, priority inheritance protocol, priority ceiling protocol. Messages, queues, mailboxes and paper, timer function, events, memory management, interrupt basic system design using RTOS, task structures and priority, Ncos basics.	10
6	**Case Studies of Embedded:** Case study of embedded systems like RFID, Level control, flow control, Automatic Vending Machine and Adaptive control system in car.	6

Recommended Books: -

1. Andrew Sloss, Dominic Symes, Charis Wright ,"ARM Developers Guide".
2. Raj Kamal ,"Embedded Systems Architecture Programming, Design".
3. Frank Vajid,"Embedded system design",PHI
4. David Simon, "Embedded Systems software primer", Pearson

Term Work:

It shall consist of at least 8 relevant experiments from the topics in the syllabus.

T.E. INSTRUMENTATION –PART II
MINI PROJECTS

Teaching Scheme: Examination Scheme:-
Practical: 02 Hrs/Week TW : 50 Marks

Course Objectives: Upon completion of this course, student should be able to:
1.Understand the basics of sensors, transducers and control algorithms.
2.Design and develop simple instruments used in process control.
3.Improve technical and communication skill.

Course Outcomes:
1.Students will able to apply knowledge learnt, gain new skills.
2.Student will able to design instrumentation systems.
3.Student will able to improve technical and communication skill.
4.Student will able to organise possible solutions to industrial problems.
5.Student will able to present a proper report, both orally and in writing on their work experience.

Course Syllabus

Contents

The students will implement a mini project in small teams to illustrate acquired knowledge and skills in the subjects studied in previous and present semester.

The project will be in the area of measurement, monitoring, supervision and control of typical industrial processes. The mini project will be implemented with continuous assessment at various stages in the project.

A project report will be submitted based on the activities performed during selection, analysis, design and implementation.

SHIVAJI UNIVERSITY, KOLHAPUR

Equivalence for Instrumentation Engineering Degree Course
Introduced from July 2015

T.E. (Instrumentation Engineering)

Semester - V

Sr. No.	Name of Subject (New)	Equivalent Subject (Old)
1	Power Electronics	Industrial Power Electronics
2	Process Control	Process Control
3	Biomedical Instrumentation	Biomedical Instrumentation (B.E.)
4	Automatic Control System	Automatic Control System
5	Microcontroller & Application	Microcontroller & Application

Semester - VI

Sr. No.	Name of Subject (New)	Equivalent Subject (Old)
1	Power plant Instrumentation & Unit Operations	1. Power plant Instrumentation (B.E.) 2. Unit Operations
2	Control System Design	Advanced Control Systems
3	Chemical & Analytical Instrumentation	Analytical Instrumentation
4	Industrial Automation	Industrial Automation-I
5	Embedded Instrumentation	Embedded System s (B.E.)
6	Mini Project	-