Dr. Babasaheb Ambedkar Technological University Lonere.

ELECTRICAL ENGINEERING DEPARTMENT

Structure and syllabus

Of

Third Year B. Tech.

(Instrumentation Engineering)

With effect from June 2019

Teaching & Evaluation scheme of Third year B. Tech. Instrumentation engineering

V Semester

Course Code	Course Name	Teaching Scheme			Evaluation Scheme				
		L	P	T	Int	MSE	ESE	Total	Credits
BTINC501	Process loop components	3	0	1	20	20	60	100	4
BTINC502	Microprocessor and Micro Controller	3	0	0	20	20	60	100	3
BTINC503	Digital Signal Processing	3	0	1	20	20	60	100	4
BTHM501	Value Education, Human Rights and Legislative Procedures[MOOC/ Swayam/ NPTEL]	2	0	0	-	-	-	Audit course	0
BTINE504	Elective-IV-A. Multi sensor and data fusion Elective-IV-B Engineering Instrumentation	3	0	0	20	20	60	100	**3**
BTINE505	Elective-V-A Control System Elective-V-B Artificial neural network.	3	0	0	20	20	60	100	**3**
BTINL506	Computational Technics Lab	0	2	0	**30**	-	**20**	50	**1**
BTINL507	Process loop components Lab	0	4	0	**60**	-	**40**	100	**2**
BTINL508	Microprocessor and micro Controller Lab	0	2	0	**30**	-	**20**	50	**1**
BTINF509	Industrial Training	-	-	-	**50**	-	-	50	**1**
	Total	17	08	02	**270**	**100**	**380**	750	**22**

VI semester

Course Code	Course Name	Teaching Scheme			Evaluation Scheme				
		L	P	T	Int	MSE	ESE	Total	Credits
BTINC601	Digital System	3	0	1	20	20	60	100	4
BTINC602	Industrial automation and Control	3	0	1	20	20	60	100	4
BTINC603	Power Electronics and Drives	3	0	0	20	20	60	100	3
BTINOE604	Elective-VI [MOOC/Swayam/NPTEL] Elective-VI-A Project engineering and management Elective-VI-B Design of Experiments.	3	0	0	20	20	60	100	3
BTINE605	Elective-VII-A Embedded system Elective-VII-B Design of sensor and transducer.	3	0	0	20	20	60	100	3
BTINE606	~~Elective-VIII-A Industrial data communication.~~ ~~Elective-VIII-B Fiber optics and laser instruments~~	3	0	0	20	20	60	100	**3**
BTINL607	Digital system Lab	0	2	0	30	-	20	50	**1**
BTINL608	Industrial automation and Control Lab	0	2	0	30	-	20	50	**1**
BTINL609	Power Electronics and Drives Lab	0	4	0	60	-	40	100	**2**
	Industrial Training*								
	Total	18	08	02	**240**	**120**	**440**	800	**24**

*Industrial Training of 30 days to be assessed in 7 semester

SEMESTER V

BTINC501 Process loop components

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Pre requisite	Basics of Feedback Control System	
Course Objective		
Course Outcome		
Unit		Contact Hrs
1	Fundamentals of process control and Transmitters Elements of process control loop, Concept of Process variables, set point, controlled variable, manipulated variable, load variable. Representation of Process loop components using standard symbols (basics with reference to control loop), and Examples of process loops like temperature, flow, level, pressure etc. Need of transmitter (concept of field area & control room area), Need for standardization of signals, Current, voltage, and pneumatic signal standards, Concept of live & dead zero. Signal conditioning(Analog and digital) for RTD , T/C, magnetic flow meter, DPT , Span & zero adjustment, Types of transmitters: Two and four wire transmitters, Electronic and Pneumatic transmitters Electronic Capacitive Differential Pressure Transmitter: Types, Mounting (Installation), Manifold, Calibration setup, Application of DPT for Level measurement, Zero elevation, suppression, Square root extractor. SMART: Comparison with conventional transmitter, Block schematic, Converters: Difference between converter & Transmitter, Pneumatic to current converter, Current to pneumatic converter.	8
2	Types of Control Actions Discontinuous: Proportional (offset), Integral (Reset windup), Derivative, Proportional- Integral, Proportional- Derivative, Proportional- Integral-derivative, Antireset windup, Rate before Reset, Concept of Bump less transfers in PID controller, Effect of process characteristics on PID combination, Selection & application of controller actions.	6
3	Tuning of controller: Different Criteria like Quarter Amplitude Decay Ratio, Loop disturbance, Optimum Control, Measure of Quality, Stability Criteria. Tuning Methods: Process Reaction Curve (open loop), Ziegler Nichols (closed loop), &Frequency Response Method. Digital PID controllers: Velocity & Position algorithm, Block Schematic, Faceplate of Digital controller, Introduction to Direct Digital Control. Current to pneumatic converter & Pressure to Current converter	7
4	Programmable Logic Controller (PLC) Continuous versus Discrete Process Control, Relay based ladder diagram using standard symbols, Limitations of relay based system. Architecture of PLC, Types of Input & Output modules (AI, DI, DO, AO), Wiring diagram, Interfacing pneumatic & Hydraulic systems to PLC, Fixed & Modular PLC (Rack, slot, grouping), PLC specifications, PLC manufacturers, PLC Basic instructions, Timers (ON delay, OFF delay & Retentive) & Counters with timing diagrams, PLC ladder diagram, PLC programming for process applications, Introduction to analog programming.	8
5	Control valve Necessity, comparison with other final control elements, Control valve Characteristics: (Inherent & Installed) Control valve terminology: Rangeability, Turndown, valve capacity, viscosity index, AO, AC (Fail Safe Action) etc. Classification of control valve based on: valve body. Construction, type of actuation, application etc. Construction, Advantages, Disadvantages & applications of Globe: Single, double, 3way, angle, Gate,	8

	Needle, Diaphragm, Rotary valves, Ball, Butterfly. Types of actuators: Construction, Advantages, Disadvantages & applications: Spring Diaphragm & Smart actuators. Control valve accessories: Positioners: Applications/Need, Types, Effect on performance of Control valves. Solenoid valves, Hand wheel.	
6	Explosion proof housing, Encapsulation, Sealing & Immersion, Purging systems Hazardous area classification& intrinsic safety, Concept of safety cycle, HAZOP fault tolerance and safety integrity level	7
	Reference books: 1. Process control and Instrument technology, C.D.Johnson, TMH 2. Introduction to Programmable Logic Controller, Gary Dunning 3. Process Control, Instrument Engineering Hand book, B.G. Liptak	

BTINC502 Microprocessor and Microcontroller

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Digital electronics, electronics devices and circuits	
Course outcome	To know the architecture of 8085 and 8051. To understand interfacing and interrupt features of 8085 and 8051. To develop program for basic applications.	
Unit	Contents	Contact Hrs.
1	Architecture of 8085 Microprocessor and Programming: Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals, Machine cycles and timing diagrams. Instruction formats, Addressing modes, Instruction set, Need for Assembly language, Development of Assembly language programs.	8
2	Interfacing: Memory Interfacing: Interface requirements, Address space partitioning, Buffering of Buses, timing constraints, Memory control signals, Read and write cycles, interfacing SRAM, EPROM and DRAM sections. I/O Interfacing: Memory mapped I/O Scheme, I/O mapped I/O scheme, Input and Output cycles, Simple I/O ports, Programmable peripheral interface (8255). Data transfer schemes: Programmable data transfer, DMA data transfer, Synchronous, Asynchronous and interrupt driven data transfer schemes, Interfacing, Simple keyboards and LED displays.	6
3	Interrupts and DMA: Interrupt feature, Need for interrupts, Characteristics of Interrupts, Types of Interrupts, Interrupt structure, Methods of servicing interrupts, Development of Interrupt service subroutines, Multiple interrupt request and their handling, need for direct memory access, Devices for Handling DMA, Programmable DMA controller 8237.	6
4	Applications: Interfacing of A/D converters (ADC 0800/ADC 0808/ADC 0809), Interfacing of D/A converters (DAC 0800), Waveform generators, Multiplexed seven segment LED display systems, Measurement of frequency, phase angle and power factor-Traffic light controller, Stepper motor control	6
5	Intel 8051 Microcontroller : Architecture of 8051, Memory Organization, Addressing modes, Instruction set, Boolean processing, Simple programs	6
6	8051 Peripheral Functions : 8051 interrupt structures, Timer and serial functions, parallel port features : Modes of operation, Power control, features, Interfacing of 8051, Typical applications, MCS 51 family features	7
	Ref Books: 1. Goankar, R.S., “Microprocessor Architecture Programming and Applications with the 8085/8080A“, 3rd Edition, Penram International Publishing House, 1997. 2. Singh. I.P., “Microprocessor Systems”, Module 9: Microcontrollers and their Applications”, IMPACT Learning Material Series IIT, New Delhi, 1997. 3. Douglas, V.Hall. “Microprocessor and Interfacing Programming and Hardware”, 2ndEdition, McGraw Hill Inc., 1992. 4. Kenneth, L.Short., “Microprocessors and Programmed Logic”, Prentice Hall of India, 2nd Edition, 1987	

BTINC 503 Digital Signal Processing

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Pre requisite	Signals and systems network analysis and synthesis.	
Course Outcome	To study different signals, systems, design procedure for filters. To understand time domain and frequency domain of systems. To analyses system signals and digital filter structure. To design digital filter for engineering application.	
Unit	Contents	Contact Hrs
1	Introduction to signals and systems Discrete time signals and systems, Z-transforms, structures for digital filters, design procedures for FIR and IIR filters. Frequency transformations: linear phase design; DFT. Methods for computing FFT. Noise analysis of digital filters, power spectrum estimation. Signals and signal Processing: characterization & classification of signals, typical Signal Processing operations, example of typical Signals, typical Signal Processing applications.	8
2	Time Domain Representation of Signals & Systems- Discrete Time Signals, Operations on Sequences, the sampling process, Discrete-Time systems, Time-Domain characterization of LTI Discrete-Time systems, state-space representation of LTI Discrete-Time systems, random signals	6
3	Transform-Domain Representation of Signals-The Discrete-Time Fourier Transform, Discrete Fourier Transform, DFT properties, computation of the DFT of real sequences, Linear Convolution using the DFT. Z-transforms, Inverse z transform, properties of z-transform, transform domain r epresentations of random signals. Transform-Domain Representation of LTI Systems: the frequency response, the transfer function, types of transfer function, minimum-phase and maximum-Phase transfer functions, complementary transfer functions, Discrete-Time processing of random signals	6
4	Digital Processing of Continuous-Time Signals - sampling of Continuous Signals, Analog Filter Design, Anti-aliasing Filter Design, Sample-and Hold circuits, A/D & D/A converter, Reconstruction Filter Design.	6
5	Digital Filter Structure - Block Diagram representation, Signal Flow Graph Representation, Equivalent Structures, bone FIR Digital Filter Structures, IIR Filter Structures, State-space structure, all pass filters, tunable IIR Digital filters. cascaded Lattice realization of IIR and FIR filters, Parallel all pass realization of IIR transfer function, Digital Sine-Cosine generator.	6
6	Digital Filter Design: Impulse invariance method of IIR filter design, Bilinear Transform method of IIR Filter Design, Design of Digital IIR notch filters, FIR filter Design based on truncated fonner sens, FIR filter design based on Frequency Sampling approach	7
	Ref Books: 1. Proakis J.G., and Manolakis, Introduction to DSP, PHI, 2007 2. Sanjit K. Mitra, “Applications DSP a Computer based approach”, TMH, 2006	

BTHM501 Value Education, Human Rights and Legislative Procedures

Teaching scheme:
Theory: 2 hrs
Tutorial: 0 hr
Total credit: 0 Audit course

Examination Scheme:
Mid-term test: NA
Internal Assessment: NA
End semester exam: NA

Prerequisite	Human Values and engineering ethics	
Course outcome	To understand value of education and self-development To develop good values and character To know Human right and legislative procedure	
Unit	Contents	Contact Hrs.
1	Values and Self Development-Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non-moral valuation, Standards and principles, Value judgments.	8
2	Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National unity, Patriotism, Love for nature, Discipline.	6
3	Personality and Behavior Development- Soul and scientific attitude, God and scientific attitude, Positive thinking, Integrity and discipline, Punctuality, Love and kindness, Avoiding fault finding, Free from anger, Dignity of labor, Universal brotherhood and religious tolerance, True friendship, Happiness vs. suffering love for truth, Aware of self-destructive habits, Association and cooperation, Doing best, Saving nature.	6
4	Character and Competence- Science vs. God, Holy books vs. blind faith, Self-management and good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of women, All religions and same message, Mind your mind, Self-control, Honesty, Studying effectively.	6
5	Human Rights- Jurisprudence of human rights nature and definition, Universal protection of human rights, Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups.	6
6	Legislative Procedures- Indian constitution, Philosophy, fundamental rights and duties, Legislature, Executive and Judiciary, Constitution and function of parliament, Composition of council of states and house of people, Speaker, Passing of bills, Vigilance, Lokpal and functionaries	7
	Ref Books: 1. Chakraborty, S.K., Values and Ethics for Organizations Theory and Practice, Oxford University Press, New Delhi, 2001. 2. Kapoor, S.K., Human rights under International Law and Indian Law, Prentice Hall of India, New Delhi, 2002. 3. Basu, D.D., Indian Constitution, Oxford University Press, New Delhi, 2002. 4. Frankena, W.K., Ethics, Prentice Hall of India, New Delhi, 1990. 5. Meron Theodor, Human Rights and International Law Legal Policy Issues, Vol. 1 and 2, Oxford University Press, New Delhi, 2000.	

BTINE504. Elective IV.A. Multi-sensor data fusion

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Pre requisite		
Course Objective	To learn the concepts and techniques used in sensor data fusion	
Course Outcome	To understand the concept of sensor fusion. To apply algorithms for multi-sensor data fusion. Interpret high performance data structures.	
Unit	Contents	Contact Hrs
1	Multi-sensor data fusion: Introduction, sensors and sensor data, Use of multiple sensors, Fusion applications. The interference hierarchy: output data. Data fusion model. Architectural concepts and issues.	3
2	Benefits of data fusion, mathematical tools used: Algorithms, Co-ordinate transformations, rigid body motion. Dependability and Markov chains. Meta – heuristics	5
3	Taxonomy of algorithms for multisensory data fusion. Data association. Identify declaration.	7
4	Estimation: Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision level identify fusion. Knowledge based approaches.	8
5	Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.	7
6	High performance data structures: Tessellated, trees, graphs and function. Representing ranges and uncertainly in data structures. Designing optimal sensor system with in dependability bounds. Implementing data fusion system.	7
	Ref Books: 1. David L. hall, Mathematical techniques in multisensory data fusion, Artech House, Boston. 2. R. R. Brooks and S. S. Iyengar, Multisensor Fusion: Fundamentals and applications with Software, Prentice Hall Inc., New Jersey. 3. Arthur Gelb, Applied Optimal Estimation, M.I.T. press 4. James V. Candy, Signal Processing: The Model Based Approach, Mc Graw Hill	

BTINE504Elective V.B. Engineering Instrumentation

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Pre requisite		
Course Objective		
Course Outcome		
Unit	Contents	Contact Hrs
1	Introduction: Static and Dynamic characteristics of instruments, dead zone, hysteresis, threshold, resolution, input & output impedance, loading effects, fundamentals of measurements, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors , calibration of instruments, Traceability, calibration report & certification.	3
2	Analog Indicating Instrumentation: DC galvanometer, PMMC and Moving Iron instruments, voltmeters, ammeters, ohmmeters, multimeters and extension of range of instruments, AC indicating instruments, Potential and current transformers, wattmeters, energy meters, DC Potentiometers, self-balancing potentiometers, standardization, application	5
3	Bridge Circuits: DC bridges: Wheatstone bridge and Kelvin bridge design, bridge sensitivity, errors in bridge circuits, null type and deflection type bridges, current sensitive and voltage sensitive bridges, applications of DC bridges AC bridges: General equations for bridge balance, Maxwell bridge, Hey bridge, Schering bridge, Wein bridge, phasor diagrams, storage and dissipation factor, applications of AC bridges	7
4	Oscilloscope: Introduction, Oscilloscope Block Diagram, Cathode Ray Tube, CRT Circuits, Vertical Deflection System, Delay Line, Multiple Trace, Horizontal Deflection System, front panel controls, deflection sensitivity, dual trace CRO, Oscilloscope Probes ,measurement of electrical parameters like voltage, current, frequency, phase, Z-modulation, Digital Storage Oscilloscope.	8
5	Digital Instruments: Block diagram, principle of operation, Accuracy of measurement Digital Multimeter, Kilo Watt Hour meter, Phase meter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer	7
6	Recording Instruments and Waveform Generation: Principle and working of strip chart and X-Y recorders, single and multi-channel recorders, driving systems for pen and chart, chart speed and their applications, Waveform generation methods, Function generator, Virtual Instrumentation	7
	Ref Books: 1. Electrical and Electronics Measurements and Instruments ,Sahwaney A K 2. W. D. Cooper & A. D. Helfrick, 'Electronic Instrumentation And Measurement Techniques', PHI,4th e/d, 1987 3. David Bell, 'Electronic Instrumentation and Measurements', PHI, 2e/d, 4. Anand M. M. S., 'Electronic Instruments and Instrumentation Technology',PHI, 2004 5. Kalsi H. S., 'Electronic Instrumentation', TMH, 2nd e/d, 2004 6. R. Subburaj, 'The foundation for ISO 9000 and TQM', 7. Bouwens A. J., 'Digital Instrumentation'	

BTINE 505 Elective VI. A. Control System

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Network analysis and synthesis, numerical methods and C programming	
Course outcome	To know different basic concepts and components of a control system. To derive transfer functions of basic control system components. To perform stability analysis using time domain and frequency domain response on a given system	
Unit	Contents	Contact Hrs.
1	Introduction: Concept of open & closed loop control system, Servomechanism, Multivariable control system, Applications in non-engineering field.	8
2	Physical Systems and Transfer Function: a) Concept of system: physical system, Physical model, Linear and nonlinear systems, Time variant and invariant system. b) Equations of physical systems (Mass-Spring-Dashpot system, R-L-C series & parallel circuit) transfer function, Procedure of obtaining transfer function.	6
3	Block diagrams and Signal flow graphs: a) Block diagram algebra, Diagram reduction, and Numerical examples. b) Signal flow graph; Masons gain formula for deriving overall transfer function of systems. Feedback characteristics of control system: Concept of negative and positive feedback, Sensitivity of the system to parameter variation, using negative and positive feedback	6
4	Control system components: Derivation of transfer functions of following components a)DC servomotors (Armature and field control) b) AC servomotors, c) Synchros d) DC and AC tachogenerators , e) Potentiometer error detectors	6
5	Time domain analysis: Typical test signals, Time domain specifications, Steady state response, Types of system, Steady state error constants and steady state error, (With different input), Numerical examples, transient response, Numericals, Concept of stability, Determination of stability by Routh - Hurwitz criterion.	6
6	Frequency domain analysis: Introduction to frequency response, Advantages of frequency domain analysis, Polar plots, Numericals, Bode plots, Principle of argument, Nyquist criterion, Relative stability from Nyquist criterion, Numericals. Definition of Root Locus, Construction of root locus, and Stability from root locus plots, Root counters, Effect of addition of poles & zeros on root locus plots.	7
	Ref Books: 1 Ogata – Modern Control Engineering (Prentice Hall Of India). 2. Kuo .B. C– Automatic Control System.(Prentice Hall Of India). 3.Nagarath & Gopal – Control System(Willey Earstern) 4. Gopal .M. – Control System.(Prentice Hall Of India).	

BTINE505 Elective V. B. Artificial Neural Network

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To review basic principles of neuron structure. To understand building blocks artificial neural network. To understand different networks of ANN To develop different algorithm for learning. To study and understand Fuzzy neural networks.	
Unit	Contents	Contact Hrs
1	Introduction and ANN Structure: Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures. Mathematical Foundations and Learning mechanisms: Re-visiting vector and matrix algebra. State-space concepts. Concepts of optimization. Error-correction learning. Memory-based learning. Hebbian learning. Competitive learning.	8
2	Single layer perceptron: Structure and learning of perceptron. Pattern classifier - introduction and Bayes' classifiers. Perceptron as a pattern classifier. Perceptron convergence. Limitations of a perceptron.	6
3	Feed forward ANN: Structures of Multi-layer feedforward networks. Back propagation algorithm. Back propagation - training and convergence. Functional approximation with back propagation. Practical and design issues of back propagation learning.	6
4	Radial Basis Function Networks: Pattern reparability and interpolation. Regularization Theory. Regularization and RBF networks. RBF network design and training. Approximation properties of RBF	6
5	Competitive Learning and Self organizing ANN: General clustering procedures. Learning Vector Quantization (LVQ). Competitive learning algorithms and architectures. Self-organizing feature maps. Properties of feature maps.	6
6	Fuzzy Neural Networks: Neuro-fuzzy systems. Background of fuzzy sets and logic. Design of fuzzy stems. Design of fuzzy ANNs	7
	References NPTEL course	

BTINL 507 Computational Techniques Lab

Teaching scheme:
Lab work : 2 hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 30 Marks
Pr/oral: 20 Marks

Any 8-9 experiments from the list

Pre requisite	Basic electrical engineering, control system I	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Study of analog computer components	
2	Simulation of first order differential equation on the analog computer	
3	Simulation of second order differential equations and sine waveform	
4	Simulation of nonlinear equations	
5	Nonlinear system analysis by DF method	
6	Nonlinear system analysis by phase method	
7	Finding transfer function from frequency response plots	
8	Analysis of control system using digital computer MATLAB and basic command	
9	MATLAB programming	
10	MATLAB simulation program	
11	MATLAB and its basic command	
12	Solution of state space equation using MATLAB	

BTINL508. Process loop components Lab

Teaching scheme:
Lab work : 4 hrs
Total credit: 2

Examination Scheme:
Continuous Assessment (T/W): 60 Marks
Pr/oral: 40 Marks

Any 8-9 experiments from the list

Pre requisite	Basic electrical engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Study of D.P. Transmitter and its application for flow or level.	
2	Study of Square Root Extractor	
3	Study and Calibration of I/P converter	
4	Study & verification of different control actions (P, I, D, PI, PD, PID) for step Input	
5	Tuning of PID controller	
6	Study of Control valve & plot the characteristics of Control valve	
7	Control valve design using any software package.	
8	Study of PLC and PLC Programming.	
9	Study & Implementation of cascading of Timers and Counters	
10	Interfacing PLC to hydraulic & pneumatic circuits	
11	Designing of intrinsic safety circuits	
12		
13		

BTINL509. Microprocessor and Microcontroller Lab

Teaching scheme:
Lab work : 2 hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 30 Marks
Pr/oral: 20 Marks

Any 8-9 experiments from the list

Pre requisite	Basic electrical engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Programming exercises to programmable peripheral interface.	
2	Programming exercises using interrupts.	
3	Programming exercises to use the timer.	
4	Familiarization with 8051 micro-controller board and its assembler.	
5	Programming exercises using 8051 micro-controller.	
6	Basic I/O operations and ADC Interfacing using KEIL software.	
7	Counting Pulses using Interrupt and Serial Data Transmission.	
8	Interfacing 8051 with DAC.	
9	Interfacing 8051 with stepper motor.	
10	Real time clock and memory interfacing with 8051.	
11	Programming exercise using ARM processor	
12		

SEMESTER VI

BTINC601. Digital System

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome		
Unit		Contact Hrs
1	Introduction to digital control: Configuration of basic digital control system, discrete transfer function, discrete model sampled data systems using z-transform, transfer function model, signal analysis and dynamic response, zero-order hold equivalent, introduction to first order hold equivalent, transformation between =s, =z, =w plane, z-domain description of sampled continuous time systems	8
2	Controller design using transform techniques: root locus and frequency domain analysis compensator design	6
3	State space theory: Control system analysis using state variable method, vector and matrices, state variable representation, conversion of state variable to transfer function and vice-versa, conversion of transfer function to canonical state variable models, system realization, and solution of state equations	6
4	State space design: Design using state space methods- controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD)	6
5	Observer design: Observer design, Deadbeat controller design, delayed system, controller design for delayed systems	6
6	Stability analysis and Jury's stability criterion, Lyapunov stability analysis to linear systems and discrete systems, Stability improvement by state feedback.	7
	References: 1. K. Ogata, Discrete Control System 2. M. Gopal, Digital Control and state variable methods, Tata McGraw Hill	

BTINC602. INDUSTRIAL AUTOMATION AND CONTROL

Teaching scheme:
Theory: 3 hrs
Tutorial: 1 hr
Total credit: 4

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Control system I, industrial automation	
Course outcome	To understand construction and working principle of different industrial measurement systems. To understand new trends in industrial process control.	
Unit	Contents	Contact Hrs
1	Introduction to Industrial Automation and Control: Architecture of Industrial Automation Systems. Introduction to sensors and measurement systems.	8
2	measurement: Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Measurement of level, humidity, pH etc, Signal Conditioning and Processing, Estimation of errors and Calibration	6
3	Process Control: Introduction to Process Control P I D Control, Controller Tuning. Implementation of PID Controllers. Special Control Structures: Feed forward and Ratio Control. Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control.	6
4	Sequence Control: Introduction to Sequence Control PLCs and Relay Ladder Logic Sequence Control, Scan Cycle, RLL Syntax Sequence Control, Structured Design Approach Sequence Control, Advanced RLL Programming Sequence Control : The Hardware environment	6
5	Control of Machine tools: Introduction to CNC Machines Control of Machine Tools, Analysis of a control loop, Introduction to Actuators, Flow Control Valves. Hydraulic Actuator Systems: Principles, Components and Symbols, Hydraulic Actuator Systems: Pumps and Motors, Proportional and Servo Valves.	6
6	Pneumatic Control Systems: System Components Pneumatic Control Systems, Controllers and Integrated Control Systems. Networking of Sensors, Actuators and Controllers: The Fieldbus, The Fieldbus Communication Protocol, Introduction to Production Control Systems	7
	References NPTEL course	

BTINC603 Power Electronics and Drives.

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Electronic Devices And Circuits	
Course outcome	To review principle of construction, operation and characteristics of basic semiconductor devices. To understand and analyze performance of controlled and uncontrolled converters. To understand and analyze performance of DC to DC converters. Dc to AC converters. To understand and analyze performance of AC voltage controllers.	
Unit	Contents	Contact Hrs
1	Power semiconductor devices & their characteristics : Characteristics and operation of power diodes, Thyristors, power transistors (BJTs, MOSFETs, IGBTs, SITs), Ratings of power semiconductor devices, Turn on and Turn off circuits for power semiconductor devices; BJT base drive requirements and drive circuit, MOSFET & IGBT gate drive circuits, Isolation of gate/base drives: Pulse transformers, optocouplers Thyristor firing schemes, Gate drive ICs	8
2	Basic introduction to electrical drives, Electric drive system – dynamic and steady state stability. Components of electrical drives, electric machine, power converter, controllers, dynamics of electrical drive, torque equation, equivalent values of drive parameters, components of load torques types of load, four quadrant operation of motor, steady state stability, load equalization, classes of motor duty, determination of motor rating	6
3	DC Motor Drives : Review of basic characteristics of DC motors, Single phase drives : Single phase half wave converter drives, semi converter drives, Full converter drives, Dual converter drives. Three phase drives : Three phase half wave drives, semiconverter drives, full converter drives, dual converter drives, DC-DC converter drives : Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives. Introduction to closed loop control of DC drives.	6
4	AC voltage controllers (AC-AC converters) : Principle of on-off control, principle of phase control in single phase and three phase circuits, Cycloconverters: single phase cycloconverter operation, three phase cycloconverter operation	6
5	Induction Motor Drives : Review of starting, braking and speed control of three phase induction motors, Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control, Current control, Closed loop control of Induction motors, Principle of Scalar and Vector control of Induction motor, Multiquadrant operation of induction motor drives fed from Voltage Source Inverters.. Static rotor resistance control method, static slip power recovery control-Static Scherbius drive and Static Kramer drive	6
6	.Synchronous motor drives, speed control of synchronous motors, adjustable frequency operation of synchronous motors, principles of synchronous motor control, voltage source inverter drive with open loop control, self-controlled synchronous motor with electronic communication, self-controlled synchronous motor with electronic communication, self-controlled synchronous motor drive using load commutated thyristor inverter	7
	References: 1.RashidM. H – Power Electronics circuits, devices and applications-(New Delhi Pearson Education). 2.Murthi.V. R- Power Electonics Devices, circuits and Industrial Applications.(Oxford). 3. Bimbhra.P. S- Power Electronics.(Khanna Publication).	

BTINOE604 Elective-VI.A. Project Engineering and Management

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite	Communication skills.	
Course outcome	To understand concepts of project management. To develop a project plan. To understand the project implementation strategy. To analyze post project affects.	
Unit	Contents	Contact Hrs
1	Introduction to Project management: Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization.	8
2	Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management,	6
3	Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks	6
4	Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Levelling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.	6
5	Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management	6
6	Post-Project Analysis	7
	Text/Reference Books: 1. Shtub, Bard and Globerson, Project Management: Engineering, Technology, and Implementation, Prentice Hall, India 2. Lock, Gower, Project Management Handbook. 3. Cleland and King, VNR Project Management Handbook. 4. Wiest and Levy, Management guide to PERT/CPM, Prentice Hall. Ibdia 5. Horald Kerzner, Project Management: A Systemic Approach to Planning, Scheduling and Controlling, CBS Publishers, 2002. 6. S. Choudhury, Project Scheduling and Monitoring in Practice. 7. P. K. Joy, Total Project Management: The Indian Context, Macmillan India Ltd.	

BTINOE Elective-VI.B. DESIGN OF EXPERIMENTS FOR ENGINEERS AND MANAGERS

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To understand experimental design principles. To understand different experimental design used in industry. To deign computer experiments to use with engineering problems.	
Unit	Contents	Contact Hrs
1	Introduction to experimental design principles, simple comparative experiments, introduction to R language and its applications in DOE problems	8
2	Single factor experiments, randomized blocks, Latin square designs and extensions, introduction to R language Introduction to factorial designs, two levels, 2k factorial designs, confounding and blocking in factorial designs, applications to manufacturing problems.	6
3	Fractional factorial designs, two-level, three-level and mixed-level factorials and fractional factorials, applications to quality control problems. Regression models including multiple regression models and its application to transportation scheduling problems	6
4	Response surface methodology, parameter optimization, robust parameter design and its application to control of processes with high variability	6
5	Random and mixed effects models, nested and split plot and strip plot designs and its application to semiconductor manufacturing problem. Repeated measures design, analysis of covariance and its applications in comparing alternatives	6
6	Design of computer experiments and the applications in industrial engineering problems	7
	References NPTEL course	

BTINE605 Elective-VII.A. Embedded Systems

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Ability to understand and analyze, linear and digital electronic circuits	
Unit	Contents	Contact Hrs
1	Introduction to Embedded systems, the build process for embedded systems, Structural units in Embedded processor, selection of processor & memory devices, DMA, Memory management methods, timer and counting devices, watchdog timer, real time clock, in circuit emulator, target hardware debugging.	8
2	Embedded networking: Introduction, I/O Device ports and buses, serial bus communication protocols, RS 232 standard, RS 422, RS 485, CAN Bus, Serial Peripheral Interface (SPI), Inter Integrated Circuits (I^2C), need for device drivers.	6
3	Embedded Product Development Life Cycle: objectives, different phases of ELDC, Modelling of ELDC, issues I Hardware- software co-design Data flow graph, state machine model, sequential program model, concurrent Model, object oriented model.	6
4	OS Concepts and types, tasks & task states, process, threads, inter process communication, task synchronization, semaphores, and role of OS in real time systems, scheduling resource allocation, interrupt handling.	6
5	Introduction to basic concept of RTOS, multiprocessing and multitasking, preemptive and non- preemptive scheduling, task communication shared memory, message passing, inter process communication- synchronization between processes semaphores, mailbox, pipes, priority inversion, priority inheritance, comparisons of real time operating systems: Vx Works, uc/OS-II, RT Linux.	6
6	Case study of washing machine- automotive application- smart card system application.	
	Text/Reference Books: 1. Rajkamal, Embedded system- architecture, programming, design, Mc Graw Hill 2. Peckol, Embedded system design, John Wiley & Sons. 3. Lyla B Das, Embedded Systems-an integrated approach, Pearson.	

BTINE605 Elective-VII..B. Design of sensor & transducer

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	To select and design diaphragm for different sensing applications. To design strain gauge based torque, force, load and pressure measurement systems. To gain knowledge in design of accelerometer and gyroscope. To know about different chemical sensors and their design criteria.	
Unit	Contents	Contact Hrs
1	Introduction to diaphragm: Diaphragm performance and materials, design of flat diaphragms, flat diaphragms with rigid center, design of convex diaphragms, semiconductor diaphragms and rectangular diaphragms, design of corrugated diaphragms.	8
2	Design of strain gauge based load cells, torque sensors, force sensors and pressure sensors.	6
3	Design of capacitance based displacement, pressure and level sensors, Design of self and mutual inductance transducers for measurement of displacement and other parameters	6
4	Design of capacitive and inductive proximity sensors	6
5	Accelerometer and Gyroscopic design and its applications. Design of Hall effect sensors, Electromagnetic sensors, magneto-elastic sensors.	6
6	Introduction to chemical sensors, characteristics. Design of direct and complex chemical sensors.	
	Text/Reference Books: 1. Karl Hoffman, An introduction to stress analysis and transducer design using strain gauges, HBM 2. James W. Dally, William F. Riley, Kenneth G. McConnell, Instrumentation for Engineering measurements, Wiley 3. Di Giovanni, Flat and corrugated Diaphragm Design Handbook, CRC Press	

BTINE606 Elective-VIII.A. Industrial Data Communication

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Upon completing the course, the student should have understand the concepts required for building industrial systems.	
Unit	Contents	Contact Hrs
1	Interface: Introduction, Principle of interface, serial interface and its standards. Parallel interfaces and buses.	8
2	Fieldbus: Use of fieldbuses in industrial plants, functions, international standards, performance, use of Ethernet networks, fieldbus advantages and disadvantages. Fieldbus design, installation, economics and documentation	6
3	Instrumentation network design and upgrade: Instrumentation design goals, cost optimal and accurate sensor networks.	6
4	Global system architectures, advantages and limitations of open networks, HART network and Foundation fieldbus network.	6
5	PROFIBUS-PA: Basics, architecture, model, network design and system configuration	6
6	Designing PROFIBUS-PA and foundation Fieldbus segments: general considerations, network design.	
	Text/Reference Books: 1. Noltingk B.E., Instrumentation Reference Book, Butterworth Heinemann 2. B. G. Liptak, Process software and digital networks, CRC press.	

BTINE606 Elective-VIII.B. Fiber Optics and Laser Instruments

Teaching scheme:
Theory: 3 hrs
Tutorial: 0 hr
Total credit: 3

Examination Scheme:
Mid-term test: 20 Marks
Internal Assessment: 20 Marks
End semester exam: 60 Marks

Prerequisite		
Course outcome	Identify various sensors, Fiber optic and its specifications. Understand principle of working of Fiber Optic used to measure Temperature, Displacement, Level, and various miscellaneous other sensors Understand applications of Fiber Optics in industry.	
Unit	Contents	Contact Hrs
1	Optical Fiber and Their properties: Ray theory, wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, optical fiber mode, single mode fiber, special fiber, fiber materials, fiber fabrication, transmission characteristics of fiber, absorption losses, scattering losses, dispersion, polarization, non-linear phenomena.	8
2	Optical Sources and Detectors, Power Launching and Coupling: Laser theory, Laser diodes, LED, PN diode, Pin diode, avalanche diode, solid, liquid, gas and semiconductor laser their characteristics modulation circuits, optical detection principles, quantum efficiency and detector noise, Source to fiber power launching, fiber alignment and fiber to fiber joints, splices, connectors, coupling losses, lensing schemes for coupling improvement, LED coupling to single mode fiber.	6
3	Optical Fiber Measurements: Measurement of attenuation, dispersion, refractive index profile of fiber and cut off wavelength, numerical aperture, OTDR, Measurement of flow, pressure, Temperature, displacement, acceleration and fluid level vibration measurement.	6
4	Fiber Optic Sensing Principles and Techniques: Classification and principle of fiber optic sensors, fiber grating and fiber Bragg grating technology and distributed optical fiber sensing.	6
5	Optical Amplification and Integrated Optics: Beam splitter, directional coupler, opto isolators, multimode interference coupler(MMIC) optical modulators, fiber modulator optical amplifiers, optical switches, frequency translators, optoelectronic integration	6
6	Holography and Laser instruments in medical application and Remote Sensing: Basic principle, methods, Holographic interferometry. Application of laser in medical application, laser in industrial application. Components of Remote sensing, Active and passive Remote Sensingplatforms, Electro-magnetic radiation(EMR),EMR spectrum	
	Text/Reference Books: 1. "Fiber optics – communication", Gerd Keiser. 2. "Integrated circuits and semiconductor devices theory and application" Deboo Burrous, McGraw Hill Second Edition.	

BTINL 607. Digital System Lab

Teaching scheme:
Lab work : 2 hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 30 Marks
Pr/oral: 20 Marks

Any 8-9n experiments based on course content of BTINC601

Pre requisite	Basic electrical engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1		
2		
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12		

BTINL 608 Industrial Automation & Process Control Lab

Teaching scheme:
Lab work : 2 hrs
Total credit: 1

Examination Scheme:
Continuous Assessment (T/W): 30 Marks
Pr/oral: 20 Marks

Any 8-9 experiments from the list

Pre requisite	Basic electrical engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Identification of FOPDT and SOPDT process using time domain and frequency domain techniques.	
2	Design of different PID controller for FOPDT and SOPDT process using different standard technique and evaluate qualitative & quantitative performance.	
3	Design and Verification of Combinational & Sequential Circuits Using PLC	
4	Design of PID Controller for a Level Process/Temperature/Flow/Pressure process stations and evaluate servo/regulatory responses.	
5	Study the effect of different PID Controller Parameters using real time process trainer.	
6	Pressure to Current & Current to Pressure Convertor using real time process trainer.	
7	Design of Timer and Counter Using PLC.	
8	Design of PLC programming for practical applications.	
9	Design of Cascade and Feed forward-feedback Controller using simulation software.	
10	Verification of Control Valve Characteristics using pneumatic and electronic control value trainer.	
11	Development of P&I design using Distributed control system (DCS)	
12		

BTINL 609 Power Electronics and drives Lab

Teaching scheme:
Lab work : 4 hrs
Total credit: 2

Examination Scheme:
Continuous Assessment (T/W): 60 Marks
Pr/oral: 40 Marks

Any 8-10 experiments covering syllabus of Power Electronics and Drives

Pre requisite	electrical Machines , basic electronics engineering	
Course Objective		
Course Outcome		
Expt No	Title of Expt	
1	Characteristics of MOSFET/IGBT	
2	To study Gate drive circuit	
3	Study of commutation circuits	
4	To study Single phase half wave controlled converter	
5	AC phase control using SCR	
6	Study of semi converter and full converter	
7	Speed control of DC motor using converter	
8	Speed control of IM motor using chopper	
9	Study of industrial drive mechanism. Workshop/ small scale industry	