Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

B Tech. (Electronics and Instrumentation)

SUBJECT CODE	Category	SUBJECT NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTEI401		Microprocessor and Microcontroller	60	20	20	30	20	2	1	2	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;

***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To gain knowledge of basics of Microprocessor & microcontroller & Learn development of assembly language programs.
2. To learn the programming skills of 8086 microprocessor & 8051 microcontroller.
3. To learn the interfacing of external devices (LED, LCD, ADC, DAC) with the microcontroller 8051.

Course Outcomes (COs):

The students will be able to

1. Apply the concept of buses, microprocessor & microcontroller architecture and interrupts.
2. Interface memory and I/O devices with 8051 microcontroller
3. Program assembly language / C programming of 8051 & 8086.
4. Design microcontroller based small system
5. Interface 8051 with LED, LCD, ADC, DAC etc.

Syllabus

UNIT I **08hr.**

Introduction to 8086 Microprocessor

Overview of 8086 microprocessor. Architecture of 8086, Signals and pins of 8086 microprocessor, Concept of Memory Segmentation in 8086. Maximum Mode , Minimum Mode, Timing diagram, Comparative study of Salient features of 8086, 80286 & 80386.

UNIT II **10hr.**

Microprocessor 8086 programming

8086 Instructions set . Addressing mode of 8086, Assembly directives. Stack , Interupts of 8086, Assembly language programs of 8086.

Input-Output interfacing: Peripherals I/O. PPI 8255 Architecture and modes of operation, Interfacing to 16-bit microprocessor and programming, DMA controller (8257) Architecture, Programmable interval timer 8254, USART 8251.

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UNIT III **08hr.**

Introduction to 8051 Microcontroller

Introduction, Difference between Microprocessors and Microcontrollers. Overview of 8051 Microcontroller family, Architecture of 8051 Microcontroller, The program counter and ROM space in the 8051, registers, 8051 register banks

UNIT IV **10hr.**

8051 Assembly Language Programming

Introduction to 8051 assembly programming, Structure of Assembly language, Assembling and running an 8051 program, 8051 data types and directives, interrupts

8051 Addressing Modes & Instruction set

Addressing modes, Accessing memory using various Addressing modes, Bit addresses for I/O and RAM, Arithmetic instructions, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction, Jump, Loop, And Call Instructions, Call instructions time delay for various 8051 chips.

UNIT V **10hr.**

8051 Programming in C

Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in8051 C, Data conversion programs in 8051 C, Accessing code ROM space in 8051 C, Interfacing with LEDs, LCDs ADCs, DACs.

Text Books:

1. A.K. Ray & K.M.Bhurchandi, Advanced Microprocessors and peripheral-Architecture, Programmingand Interfacing, Tata McGraw –Hill, 2012(Third Edition)
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2/e by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin , McKinlay,2008(SecondEdition,PearsonEducation)
3. The 8051 Microcontroller & Embedded Systems using Assembly and C By Kenneth J. Ayala, Dhananjay V. Gadre, 2008 (Cengage Learning , India Edition).

Reference Books:

1. Hall Douglas V.,Microprocessor and interfacing, Revised second edition 2006, Macmillan, McGraw Hill.
2. Using the MCS-51 Microcontrollers By Han Way Huang Oxford Uni Press,2000.
3. Programming and Customizing the 8051 Microcontroller by Myke Predko Tata McGraw Hill,1999.
4. Microcontrollers Architecture, programming, interfacing and system design by Rajkamal Pearson education,2009.

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List of Experiment:

1. Introduction to 8086 & 8051 kit, hardware features & modes of operationand Technique of programming & basic commands of kit.

2. Design programs for Arithmetic Operations.
3. Develop a program to find 1's complement and then 2's complement of a 16-bit numbers.
4. Develop a program to find larger of two numbers.
5. Write a program to shift an 8-bit number left by 2-bits.
6. Write a program to generate a square wave of 2 KHz Frequency on input pin.
7. Introduction to IDE and Assembler directives.
8. Develop 8051 Assembly language programs using Arithmetic/ Logical instructions.
9. 8051 Assembly language programming for block data transfer between internal and external memory including overlapping blocks.
10. 8051 Assembly language programming for
    a. code conversions
    b. Timers in different modes.
    c. I/O port programming in embedded C.
    d. Programming of LCD in embedded C.

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B Tech. (Electronics and Instrumentation)

SUBJECT CODE	Category	SUBJECT NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTEI-402		Sensor and Transducer	60	20	20	30	20	3	1	2	**5**

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

- Student will be able to understand the structural and functional principles of sensors and transducers used for various physical and nonelectric quantities.
- Explain the principles of operation of the sensor.
- Interpretation of the measurement results by using transducers.
- Development of measurement schemes for different non electrical quantities
- Assimilating knowledge about the implementation of sensors and transducers into a control system structure.

Course Outcomes (COs):

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

The students will be able to

1. To apply knowledge of sensors and transducer.
2. To identify, formulate, and solve engineering problems
3. Demonstrate various types of force transducer and their analysis.
4. Demonstrate various types of pressure transducer and their analysis.

Syllabus

Unit-I **10 hours**

Motional and Dimensional measurement:

Introduction, Aim of measurement, Roll of sensors in engineering, classification of transducers, Fundamental Standards, units , Resistive Potentiometers, stain gauge, LVDT, Hall Effect sensors, magnetostricitive, magnetoresisitive, Optical displacement sensor fiber optic sensor, Ultrasonic distance Sensor,Piezoresistive, Linear encoder, Proximity sensors RVDT, DC tachometer, AC tachometer , eddy current , drag cup type tachometer, magnetic, gyroscope.

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Unit-II **12 hours**

Force, Torque measurement:
Standards and Calibration, Strain gauge: basic principal, gauge factor, types of strain gauge, materials and their properties, bonding material compensation techniques, bridge configuration, Rosettes, Tactile sensors, Piezoelectric sensors, LVDT as secondary sensor
Torque: Flat Spiral Spring, Magenetostrictive Torsion Transducer, Dynamometers.

Unit-III **12 hours**

Pressure Measurement:
Standards and calibration Units and relations. Positive Pressure Sensors
Pressure and sound measurement: Moderate pressure Bourdon tube, Bellows &diaphragms, High pressure measurement, Piezo electric, Electric resistance, Low pressure measurement, Mcleod gauge, Knudsen gauge, Viscosity gauge, Thermal conductivity, Ionization gauge, Dead weight gauge, sound level measurement using different types of microphone

Unit-IV **12 hour**

Flow measurement: Obstruction meter: Orifice, Nozzle, venturi, Pitot tube, Annubar tubes, Target, rotameter, Turbine, Electromagnetic, Vortex, Positive displacement, Anemometers, Weirs & flumes, Laser Doppler, Anemometer, Ultrasonic flow meter, fluidic oscillator, Mass flow meter, Flow visualization, Level measurement: Visual lev el indicators, Ordinary float type, Purge method, Buoyancy method, resistance, Capacitance and inductive Probes, Ultrasonic, Laser, Optical fiber. Thermal, Radar radiation.

Unit-V **10 hours**

Temperature measurement:

Bimetallic thermometers, Liquid in glass, Pressure thermometer, thermocouples, RTD, Thermistors, Semiconductor sensors, Digital thermometers,Pyrometers, Miscellaneous Measurement: Humidity, Dew point, Viscosity, Thermal and nuclear radiation measurements.

Text Book

1. H.N. Norton "Handbook of transducers".
2. E.O. Doebelin "Measurement systems applications and design"

Reference Book

1. DVS Murthy "Transducers and instrumentation"
2. Nakra and Chaudhry "Instrumentation measurement and analysis *& Co.*

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List of experiments

1. Calibration of pressure gauge using dead weight pressure tester and preparation of report for the same.
2. Characterization of strain gauge indicator and weight measurement using load cell.
3. Measurement of displacement using LVDT.
4. Study of linear and rotary encoder as displacement sensor.
5. Measurement of Pressure using Bellows, Bourdon gauge, Diaphragm.
6. Calibration of vacuum gauge using vacuum gauge tester and preparation of the report.
7. Characterization of Thermocouples (J/T/K/R/S)
8. Characterization of RTD.
9. To study characteristics of thermistor.
10. Calibration of Rotameter.

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B.Tech(Electronics and Instrumention)

SUBJECT CODE	Category	SUBJECT NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		L	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTEC401	EC	Linear Integrated Circuits	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives(CEOs):
This course provides the foundation education in operational amplifier and other linear integrated circuits and also familiarizes students with applications of various ICs.

Course Outcomes(COs):
After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes. The student will be able to:

1. Inculcate the basic principles, configurations and practical limitations of op-amp.
2. Explain and design the linear and non-linear applications of an Op-Amp and special application ICs.
3. To analyze, design and explain the characteristics and applications of active filters.
4. Elucidate and compare the working of Multivibrators, Oscillators.
5. Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

Syllabus

UNIT I **10 Hrs.**

Op Amps: Block diagram of Op-Amp, Basic Differential amplifier using transistors and its operation, characteristics and equivalent circuits of an ideal op-amp, Power supply configurations for OPAMP applications, Voltage Transfer Curve, open loop op-amp configurations: inverting, non-inverting and differential amplifier configurations, Closed loop op-amps or feedback amplifiers.

Linear Applications of Op-Amp: Voltage follower, Summing amplifier, Scaling and averaging amplifier, Integrators and differentiators, Instrumentation amplifier, Differential input and differential output amplifier, Log/ Antilog amplifier, V-I and I-V converter, analog multiplier-MPY634.

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UNIT II **9 Hrs.**

The Practical Op-Amp: Introduction, Input offset voltage, offset current, Bias Current, thermal drift, Effect of variation in power supply voltage, common-mode rejection ratio, Slew rate and its Effect, PSRR and gain –bandwidth product, frequency limitations and compensations, interpretation of TL082 datasheet.

UNIT III **8 Hrs.**

Active Filters: Characteristics of filters, Classification of filters, Magnitude and frequency response, Design of Butterworth 1st and 2nd order Low pass, High pass filters, Band pass and Band reject filters, All pass filters.

UNIT IV **9 Hrs.**

Signal Generators and Waveform Shaping Circuits: Oscillator-Phase-shift oscillators, Wein bridge oscillator, Quadrature Oscillator, Monostable and Astable Multivibrator, Precision rectifiers, Square and Triangular wave generator, VCO. Comparator, Zero Crossing Detector, Schmitt Trigger, Voltage limiters, Clipper and clampers, Absolute value output circuit, Peak detector, Sample and hold Circuit.

UNIT V **9 Hrs.**

Advanced IC applications: Applications as Frequency Divider, PLL, AGC, AVC using op-AMP, simple OP-AMP Voltage regulator, Fixed and Adjustable Voltage Regulators, Dual Power supply, Basic Switching Regulator and characteristics of standard regulator ICs – TPS40200, TPS40210

Text Books:

1. Ramakanth A. Gayakwad, "Op-Amps & Linear ICS", PHI, 4th edition, 1987.
2. D. Roy Chowdhury, " Linear Integrated Circuits", New Age International (P) Ltd, 2nd Edition, 2003.

References:

1. R.F. Coughlin & Fredrick Driscoll, "Operational Amplifiers & Linear Integrated Circuits" , 6thEdition, PHI
2. David A. Bell, "Operational Amplifiers & Linear ICs", Oxford University Press, 2nd edition, 2010.
3. Sergio Franco, "Design with Operational Amplifiers & Analog Integrated Circuits" Mcgraw Hill, 1988.
4. C.G. Clayton , "Operational Amplifiers " , Butterworth & Company Publ. Ltd./Elsevier, 1971.
5. K. Lal Kishore, " Operational Amplifiers and Linear Integrated Circuits", Pearson
6. Education, 2007.
7. L. k. Maheshwari, M M S Anand , Analog Electronics, PHI
8. TL082:Data Sheet:http://www.ti.com/lit/ds/symlink/t1082.pdf
9. Application Note:http://www.ti.com/lit/an/sloa020a/sloa020a.pdf

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10. MYP634: Data Sheet:http://www.ti.com/lit/ds/symlink/mpy634.pdf
11. Application Note:http://www.ticom/lit/an/sbfa006/sbfa006.pdf

List of Experiments:

1. Introduction of ASLKv2010 starter-kit & Simulation software
2. Measurements of Op-Amp parameters- CMRR, slew rate ,open loop gain.
3. To develop an understanding of Inverting and non-inverting Op-Amp.
4. To Learn about AC electrical characteristic of Op-Amp.
5. To Learn about Integrator and Differentiator.
6. To Learn about Instrumentation Amplifier.
7. To learn about Analog low pass and high pass filter.
8. To learn about Astable Multivibrator.
9. To learn and study about frequency generation using VCO.
10. To learn and study ADC/DAC circuits.
11. Design a function generator capable of generating a square wave and a triangular wave of a known frequency f.
12. Perform an experiment to plot the Input Vs Output characteristics for the AGC/AVC.

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B Tech. (Electronics and Instrumentation)

Subject Code	Category	Subject Name	Teaching &Evaluation Scheme								
			Theory			Practical		L	T	P	Credits
			End Sem University Exam	Two Term Exam	Teachers Assessment*	End Sem University	Teachers Assessment*				
BTEC408		Signal and System	60	20	20	30	20	2	1	2	4

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit; Q/A Quiz/Assignment/Attendance, MST Mid Sem Test.

.Course Objectives:

The objective of this course is to have an introduction to approaches of signals & systems analysis with an increased emphasis on the frequency response and Analysis of system with continuous signal and discrete time signal. To enable the students to understand the fundamentals of Signals, their Time & Frequency characteristics.

Course Outcomes: Upon completion of this course students will be able to

1. Classify both continuous and discrete time signals and systems.
2. Analyze continuous signals in complex plain.
3. Understand Laplace transform
4. Analyze Z transform
5. Understand the random signals and systems.

Syllabus

UNIT-I

Introduction to signal and systems: Continuous and discrete time signals: Classification of Signals Periodic aperiodic even odd energy and power signals Deterministic and random signals complex exponential and sinusoidal signals periodicity unit impulse unit step Transformation of independent variable of signals: time scaling, time shifting. System properties: Linearity, Causality, time invariance and stability, Dirichlet's conditions, Determination of Fourier series coefficients of signal.

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2. Signals & Systems 2nd Edition, 2002 Simon Haykin and Van Veen Wiley
3. Signals & Systems Analysis Using Transformation Methods & MAT Lab 2003 Robert TMH
4. Signals, Systems and Transforms 3rd Edition, 2004. C. L. Philips, J.M.Parr and Eve A.Riskin Pearson education
5. Signals & Systems 2001. I. J. Nagrath, S.N.Sharan, R.Ranjan, S.Kumar

List of Experiments:

1. Introduction to MATLAB.
2. Write a program to generate continuous time signals (i) Sine wave (ii) Cosine Wave (iii) Square wave (iv) Triangular wave
3. Write a program to generate the discrete sequences (i) unit step (ii) unit impulse (iii) ramp (iv) periodic sinusoidal sequences. Plot all the sequences.
4. Find the Fourier transform of a square pulse .Plot its amplitude and phase spectrum.
5. Write a program to convolve two discrete time sequences. Plot all the sequences. Verify the result by analytical calculation.
6. Generate a discrete time sequence by sampling a continuous time signal.
7. Write a program to find the autocorrelation and cross correlation of sequences.
8. Write a program to generate a random sinusoidal signal and plot four possible realizations of the random signal.
9. To develop program modules based on operation on sequences like signal shifting, signal folding, signal addition and signal multiplication.
10. To develop program for computing Z-transform and Inverse Z-transform.

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COURSE CODE	Category	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment *	END SEM University Exam	Teachers Assessment *				
BTMT 501		Applied Hydraulics and Pneumatics	60	20	20	30	20	2	1	2	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Educational Objectives (CEOs):

1. To impart knowledge about Applied Hydraulics & Pneumatics.

Course Outcomes (COs):

after completion of the course, students will be able:

1. To know the advantages and applications of Fluid Power Engineering and Power Transmission System.
2. To learn the Applications of Fluid Power System in automation of Machine Tools and others Equipments.

Syllabus

UNIT I **8hr.**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law- Laminar and Turbulent flow – Reynolds's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II **12hr.**

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

UNIT III **10hr.**

Construction of Control Components : Directional control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow

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control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.

UNIT IV **10hr.**

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V **12hr.**

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

Text Books:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw-Hill, 2001.

Reference Books:

1. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, 2006.
2. Shanmugasundaram. K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
3. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
4. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
5. Harry L. Stevart D.B, "Practical guide to fluid power", Taraoeala sons and Port Ltd. Broadey, 1976.
6. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
7. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

List of Experiments:

1. Design and testing of Pressure Control Hydraulic Circuit.
2. Design and testing of Flow Control Hydraulic Circuit.
3. Implementation and testing of Directional Control Hydraulic Circuit.
4. Implementation and testing of Pressure Control pneumatic Circuit.
5. Design and testing of Flow Control pneumatic Circuit.
6. Development and analysis of Directional Control pneumatic Circuit.
7. Development and analysis of circuits with Logic Control.
8. Implementation and testing of Circuits with Timers.
9. Design of circuits with programmed Logic sequence using an optional PLC in electro hydraulic trainer.
10. Demonstration of P/I and I/P Converter.

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COURSE CODE	Category	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment *	END SEM University Exam	Teachers Assessment *				
BTEI404		PLC Lab	0	0	0	0	50	0	0	4	2

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;

***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course educational objectives

To provide knowledge levels needed for PLC programming and operating.

.Course outcomes:

At the end of the course student will have ability to

1. understand different types of Devices to which PLC input and output modules are connected
2. create ladder diagrams from process control descriptions.
3. apply PLC timers and counters for the control of industrial processes
4. use different types PLC functions, Data Handling Function

Laboratory Experiment List:

1. Introduction of mechatronics and study of elements of mechatronics systems.
2. To study and analysis of Mechatronics products and systems in manufacturing.
3. To simulate the PLC Ladder logics through Siemens PLC kit and Step-7 Micro/ Win software.
4. To perform and verify given Boolean expressions using ladder logic on PLC simulation software kit.
5. To perform and verify half adder and full adder using ladder logic on PLC simulation software kit.
6. To perform and verify half subtractor and full subtractor using ladder logic on PLC simulation software kit.
7. Design ladder logic for MUX (4x1) on PLC simulation software kit.
8. Design a ladder logic for DEMUX (1x4) on PLC simulation software kit.
9. Design ladder logic for Encoder on PLC simulation software kit.
10. Design ladder logic for Decoder on PLC simulation software kit.

Text Books:

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann
3. G.K.Dubey.Fundamentals of electrical drives
4. Programmable Logic Controllers by W.Bolton

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References:

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student Edition.
4. S.K.Pillai. A First course on electric drives –Wiley Eastern 1990
5. Programmable Logic Controllers by Hugh Jack.
6. Programmable Logic Controllers Principles & applications, John Webb,PHI-2001

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