

## RESTRUCTURED FOUR YEAR BTECH UNDERGRADUATE PROGRAMME IN INSTRUMENTATION

Semester-I (Core Papers)		Semester-II (Core Papers)	
ELI-101	Circuit Analysis	ELI- 201	Transducers
ELI- I02	Engineering Mathematics	ELI- 202	Analog Devices
<b>Foundation Courses</b>			
A1/AGIL Language, Literature & Creativity I (Hindi)/Indian Literature			
A2 Information Technology			
A3 Science & Life			
A4 Applied Course (English/Hindi (AGH) )			
IMBH Integrated Mind Body and Heart			
B1 Language, Literature & Creativity-II (English)			
B2 Building Mathematical Ability			
B3 History Culture & Civilization			
B4 Business Entrepreneurship			
<b>Semester-III</b>		<b>Semester-IV</b>	
ELI-301 (Core)	Industrial Instrumentation	ELI-401 (Core)	Electrical Instruments
ELI-302 (Core)	Digital Electronics	ELI-402 (Core)	Linear Integrated Circuits
ELI-303 (Core)	Quality Control Techniques	ELI-403(Core)	Measurement Science and Techniques
DC-II (Physics) (Basic Science)	Mechanics	DC-II (Chemistry) (Basic Science)	Conceptual Organic Chemistry
<b>Semester-V</b>		<b>Semester-VI</b>	
ELI-501 (Core)	Microprocessor***	ELI-601	Analytical Instrumentation-II
ELI-502 (Core)	Analytical Instrumentation-I**	ELI-602(Core)	Control Systems*
ELI-503 (New Core Paper)	Biomedical Instrumentation-I **	ELI-603 (Core)	Biomedical Instrumentation-II**
ELI-504 (New Allied Eng. Course)	Signals and Systems*	ELI-604 (New Allied Eng. Course)	Programming in C and Data Structures*
<b>Semester-VII</b>		<b>Semester-VIII</b>	
ELI-701	8051 and Advanced Microcontrollers	ELI-801	Artificial Intelligence Control Techniques
ELI-702 (New Core Paper)	Virtual Instrumentation*	ELI-802	Process Control Dynamics
DC-II (Mathematics) (Basic Sciences)	Numerical Methods*	ELI-803 (New Allied Eng. Course)	Communication*
	Project		Project and Dissertation

\* Text highlighted with yellow: New Core / Allied Eng./Basic Science Paper

\*\* Text with red font and highlighted with yellow Color: Syllabus as well as title changed

\*\*\* Text with red font color: Only Title of the paper changed

## **Circuit Analysis**

**48 Periods**

### **UNIT 1**

#### **Circuit Concepts and Circuit Analysis:**

Current and Voltage Sources, KVL, KCL, Mesh and Node Analysis and Star-delta conversions, Difference between Passive and Active components, Current division, Voltage division, Duality.

5 Periods

### **UNIT 2**

#### **Network Theorems:**

Superposition, Maximum Power Transfer, Thevenin's, Norton, Reciprocity, Millman, Compensation, Substitution and Tellegens Theorem.

16 Periods

### **UNIT 3**

#### **Transient Network Analysis:**

Response of RL, RC and RLC networks using differential Equation for unit step, impulse and ramp inputs.

#### **AC circuit Analysis:**

Sinusoidal voltage and current, Definition of instantaneous, peak, peak to peak, root mean square and average values. Voltage-current relationship in resistor, inductor and capacitor. Phasor, complex impedance, power in AC circuits: instantaneous power, average power, reactive power, power factor. Sinusoidal circuit analysis for RL, RC and RLC circuits. Mesh analysis, node analysis and network theorems for AC circuits. Resonance in series and parallel RLC circuits, frequency response of series and parallel RLC, Quality (Q) factor and bandwidth. Passive filters: low pass, high pass, band pass and band stop.

16 Periods

### **UNIT 4**

#### **Two Port Network:**

Impedance (Z), Admittance(Y), Transmission (ABCD) and Hybrid parameters (H).

11 Periods

### **UNIT 1**

Chapter- 3, 4 of M. Nahvi and J. Edminister, Schaum's outline series, Electric circuits, Tata McGraw Hill (2005), 5<sup>th</sup> edition

Chapter-8 of Robert L. Boylestad, Introductory Circuit Analysis, Pearson Education, 12<sup>th</sup> Edition

### **UNIT 2**

Chapter-5 of M. Nahvi and J. Edminister, Schaum's outline series, Electric circuits, Tata McGraw Hill (2005), 5<sup>th</sup> edition

Chapter-9 of Robert L. Boylestad, Introductory Circuit Analysis, Pearson Education, 12<sup>th</sup> Edition

### **UNIT 3**

Chapter-7, 9, 10, 11, 12 of M. Nahvi and J. Edminister, Schaum's outline series, Electric circuits, Tata McGraw Hill (2005), 5<sup>th</sup> edition

Chapter-7 of C. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2009), 4<sup>th</sup> Edition

## UNIT 4

Chapter -13 of M. Nahvi and J. Edminister, Schaum's outline series, Electric circuits, Tata McGraw Hill (2005), 5<sup>th</sup> edition

### Essential Books:

1. M. Nahvi and J. Edminister, Schaum's outline series, Electric circuits, Tata McGraw Hill (2005), 5<sup>th</sup> edition
2. C. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2009), 4<sup>th</sup> Edition
3. Robert L. Boylestad, Introductory Circuit Analysis, Pearson Education (2004), 12<sup>th</sup> Edition

### Suggested Books:

1. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill (2005)
2. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004)
4. John. D. Ryder, Networks, Lines and Fields, Prentice Hall of India (2002)
5. Valkenberg V., 3rd Ed., Network Analysis, Prentice Hall International Edition.
6. A.Sudhakar, Shyamohan S.Pillai ,Circuits and Networks ,3 ed., 2009 TMH T3

### Circuit Analysis (Practicals)

At least any six in hardware and three by simulation software (pspice/multisim)

1. Verify the Thevenin, Norton and Superposition Theorem.
2. Verify the Maximum Power Transfer Theorem.
3. Verify Compensation and Substitution Theorem.
4. RC Circuits: Time constant, differentiator, integrator.
5. Design a Low Pass RC Filter and study its frequency response.
6. Design a High Pass RC Filter and study its frequency response.
7. To Measure the Z-parameters of a two-port network.
8. To study the frequency response of a Series LCR circuit and determine its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

## Engineering Mathematics

48 Periods

### UNIT 1

Introduction to ordinary and partial differential Equation, Scalars and Vectors, Vector Analysis: Gradient, Divergence and Curl. Introductory Complex Theory. 8 Periods

### UNIT 2

Fourier Series: Functions of any period, even and odd Functions, half range expansions, Harmonic Analysis.  
Fourier Transform, Inverse Fourier Transform and their properties. Application to Differential equations 16 Periods

### UNIT 3

Laplace Transform, Inverse Laplace transforms and their properties. Convolution theorem, Impulse Function and Unit Step function, solutions to ordinary differential equations. Initial and Final value theorem. 13 Periods

### UNIT 4

Z-Transform and Inverse Z-Transform and their properties. Region of Convergence (ROC). 11 Periods

### UNIT 1

Chapter-8 of E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8<sup>th</sup> Edition  
Chapter-3, 8 of B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007), 6<sup>th</sup> reprint

### UNIT 2

Chapter-10 of E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8<sup>th</sup> Edition

### UNIT 3

Chapter-5 of E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8<sup>th</sup> Edition

### UNIT 4

Chapter-21 of B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007), 6<sup>th</sup> reprint

### Essential Books:

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8<sup>th</sup> Edition
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007), 6<sup>th</sup> reprint
3. Michel D Greenberg; Advanced Engineering Mathematics, Pearson International

### Suggested Books:

1. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007), 3<sup>rd</sup> edition
2. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
3. A.S.Willsky, Oppenheim, Signals and System, Prentice Hall, 2<sup>nd</sup> edition
4. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers

### Engineering Mathematics (Practicals)

(MATLAB Based)

1. Solve the linear differential equation of second order with variable coefficients.

2. Solve the linear differential equation of second order with constant coefficients.
3. Find curl of a given vector.
4. Find divergence of a given vector.
5. Solve the higher order linear homogeneous differential equation.
6. Computing Fourier of a given signal.
7. Laplace Transform of a given signal.
8. Compute the Z-Transform of a given signal and plot its poles and zeros and determining its ROC's.

## Transducers

48 Periods

### UNIT 1

Basic concepts of instrumentation, generalized instrumentation systems block diagram representation, scope of instrumentation in Industrial organization. 7 Periods

### UNIT 2

**Measurement systems-** static (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), impedance matching and loading, dynamic characteristics (types, fidelity, speed of response, dynamic error). 7 Periods

### UNIT 3

**Definition of errors-** systematic errors, instrumental errors, environmental errors, random errors, loading errors, random errors, source of errors in measuring instruments, Uncertainties types, propagation of uncertainties) 7 Periods

### UNIT 4

**Transducers** - Classification, Active, Passive, Mechanical, Electrical, their comparison. Selection of Transducers, Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge) Capacitive (diaphragm), Inductive (LVDT-Principle and characteristics, Hall effect sensors, magneto-strictive transducers), Piezoelectric (Element and their properties, Piezo Electric coefficients. Equivalent circuit and frequency response of P.E. Transducers), light (photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical). Pressure (force summing devices, load cell) 27 Periods

### UNIT 1

Chapter 1 – Nakra & Choudhary, Instrumentation Measurements and Analysis , Tata McGraw-Hill ,2nd edition

Chapter 2- Doebelin & Manek, Measurement Systems, 4/e, McGraw Hill, New York, 1992, 5th edition

### UNIT 2

Chapter 2 – Nakra & Choudhary, Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition

### UNIT 3

Chapter 2 – Nakra & Choudhary, Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition

Chapter 3 – Doebelin & Manek, Measurement Systems, 4/e, McGraw Hill, New York, 1992, 5th edition

### UNIT 4

Chapter 25 - A.K. Sawhney , Electrical & Electronic Measurements & Instrumentation, 19th revised edition

Chapter 4, 12 - Nakra & Choudhary, Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition

### Essential Books:

1. Doebelin & Manek, Measurement Systems, 4/e, McGraw Hill, New York, 1992, 5th edition
2. Nakra & Choudhary , Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition

3. A.K. Sawhney , Electrical & Electronic Measurements & Instrumentation, 19<sup>th</sup> revised edition

**Suggested Books:**

1. Rangan, Sarma, and Mani, Instrumentation- Devices and Systems ,Tata-McGrawHill 2<sup>nd</sup> edition
2. H.S Kalsi, Electronic Instrumentation ,McGrawHill, 4<sup>th</sup> edition
3. DVS Murthy, Measurement & Instrumentation, PHI
4. D. Patranabis, Sensors and Transducers, PHI, 2<sup>nd</sup> edition
5. Arun K. Ghosh, Introduction to Measurements and Instrumentation, PHI, 4<sup>th</sup> edition

**Transducers (Practicals)**

(Any Eight)

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of speed using Electromagnetic transducer.
3. Measurement of speed using photoelectric transducers
4. Measurement of angular displacement using Potentiometer.
5. Measurement of displacement using LVDT.
6. Measurement using load cells.
7. Measurement using capacitive transducer.
8. Measurement using inductive transducer.
9. Measurement of Temperature using Temperature Sensors/RTD.
10. Characteristics of Hall effect sensor.
11. Measuring change in resistance using LDR.

## **Analog devices**

**48 Periods**

### **UNIT 1**

**Semiconductor Basics:** Introduction to semiconductor materials, intrinsic & extrinsic semiconductors. p-n junction diode: Ideal diode, Formation of depletion layer, space charge at a junction, Diode Circuits: clipper circuits, clamping circuits. Half wave rectifier, center tapped and bridge full wave rectifiers, calculation of efficiency and ripple factor.

**DC power supply:** Block diagram of a power supply, Zener diode as voltage regulator, temperature coefficient of Zener diode. 12 Periods

### **UNIT 2**

**The BJT:** basic transistor action, Transistor current components and amplification. Transistor configurations: Common Base (CB), Common Emitter (CE) and Common Collector (CC) configuration, I-V characteristics and hybrid parameters, regions of operation, dc load line, Q point. CE amplifier: Self bias arrangement of CE, dc and ac load line analysis, Hybrid equivalent of CE, frequency response of CE amplifier. 10 Periods

### **UNIT 3**

**Feedback Amplifiers:** Concept of feedback, negative and positive feedback, Negative feedback: advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, derivation of gain, input and output impedances for feedback amplifiers.

**Power Amplifiers:** A, B, C and AB power amplifiers, Class B push pull amplifiers.

**Positive feedback:** Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Crystal oscillator. 13 Periods

### **UNIT 4**

**Junction Field Effect Transistor (JFET):** Construction of JFET, idea of channel formation, pinch-off and saturation voltage, current-voltage output characteristics.

**Metal Oxide Field Effect Transistor (MOSFET):** The ideal MOS diode, accumulation, depletion and inversion, Basic Construction of MOSFET and working, I-V characteristics, enhancement and depletion modes. Complimentary MOS (CMOS).

**UJT:** construction, working and applications. 13 Periods

### **UNIT 1**

Chapter 1,2 - R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).

Chapter 3, 4 - N N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007)

Chapter 1, 2- J. Millman and C. Halkias , Integrated Electronics, Tata McGraw Hill (2001).



## **UNIT 2**

Chapter 3,4,7,11- R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).

Chapter 5,7- N N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007).

Chapter3-J. Millman and C. Halkias , Integrated Electronics, Tata McGraw Hill (2001).

## **UNIT 3**

Chapter 16, 18- R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).

Chapter 10- N NBhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007)

## **UNIT 4**

Chapter 5- R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).

Chapter 5 - N NBhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007).

Chapter 4-J. Millman and C. Halkias , Integrated Electronics, Tata McGraw Hill (2001).

Chapter 20- David A. Bell, Electronic Devices & Circuits,Oxford University Press, Fifth edition

### **Essential Books:**

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006), 5<sup>th</sup> edition
2. N NBhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007), 1<sup>st</sup> edition
3. J. Millman and C. Halkias, Integrated Electronics: Analog Digital Circuit & Systems, Tata McGraw Hill (2001), 48<sup>th</sup> edition.

### **Suggested Books:**

1. Mottershed, Electronic Devices, PHI Publication, 1st Edition.
2. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002).
3. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010).
4. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002).
5. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991).

### **Analog Devices ( Practicals)**

At least any six in hardware and three by simulation software (pspice/multisim)

1. To study the Half wave rectifier and Full wave rectifier.
2. To study power supply using C filter and zener diode.
3. To study Fixed Bias and Voltage divide Feedback configuration for transistor.
4. To design a Single Stage CE amplifier.
5. To study Class A, B and C Power Amplifier.
6. To study clipping circuits
7. To study clamping circuits
8. To study the Colpitt's Oscillator.

9. To study the Phase Shift Oscillator.
10. To study the frequency response of Common Source FET amplifier.

## **Industrial Instrumentation**

**48 Periods**

### **UNIT 1**

Introduction, definitions and units, classification of flow meters, Mechanical type flowmeters - Theory of variable head type flow meters – orifice plate, venture tube, flow nozzle, Positive displacement flow meters – constructional details and theory of operation of nutating disc, reciprocation piston, oval gear– inferential meter – turbine flow meter – rotameter – thermal mass flow meter ,Principle and constructional details of electromagnetic flow meter, different types of ultrasonic flow meters, laser Doppler anemometer systems – vortex shedding flow meter

11 Periods

### **UNIT 2**

Measurement of Speed and Acceleration: Tachometers - Mechanical, Electric, Contact less, Frequency, Stroboscopic tachometers. Elementary accelerometers, Seismic, Practical accelerometers. Measurement of humidity and moisture–basic principles, hygrometers, psychrometers , humidity charts –dew point, measurement systems for humidity - Infrared moisture measuring systems , radioactive moisture measuring systems.

11 Periods

### **UNIT 3**

Pressure measurement-Units of pressure – manometers – different types – elastic type pressure gauges – Bourdon type bellows – diaphragms –measurement of vacuum – McLeod gauge, Pirani and Ionization Gauge– thermal conductivity gauges – Ionization gauge cold cathode and hot cathode types – testing and calibration of pressure gauges – dead weight tester. Vacuum pumps- Rotary and Diffusion types.

15 Periods

### **UNIT 4**

Recorders: strip chart, circular, X-Y, magnetic tape, printers-ink jet, laser.  
Refrigeration: Refrigerants- Compressor, Evaporator, Condenser, Expansion Device

11 Periods

### **UNIT 1**

Chapter 13- A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co., 12th Edition

Chapter 21- R.K. Jain, Mechanical and Industrial Measurements, TataMcGraw Hill, 11<sup>th</sup> edition

### **UNIT 2**

Chapter 12, 15-A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co., 12th Edition

Chapter 15, 17, 25 - R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996, 11<sup>th</sup> edition

### **UNIT 3**

Chapter 9 - A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co., 12th Edition

Chapter 15- D.S Mathur, Mechanics, S.Chand and Company Ltd., 5<sup>th</sup> edition

### **UNIT 4**

Chapter 7- A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co., 12th Edition

Chapter 8,9,10,11, 12 -R. S. Khurmi and J. K. Gupta, A Text book of Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd., 3<sup>rd</sup> edition

**Essential Books:**

1. A.K. Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co., 11<sup>th</sup> edition
2. R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996., 11<sup>th</sup> edition
3. R. S. Khurmi and J. K. Gupta, A Text book of Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, 3<sup>rd</sup> edition
- 4.D.S Mathur,Mechanics,, S.Chand and Company Ltd., 5<sup>th</sup> edition

**Suggested Books:**

1. Liptak B. G., Process Measurement and Analysis, Chilton Book Company, Pennsylvania, 1995, 3<sup>rd</sup> edition
2. D. Patranabis, Principles of Industrial Instrumentation, , Tata McGraw Hill Publishing Co., New Delhi, 1995, 3<sup>rd</sup> edition
- 3.CS Rangan and others, Instrumentation Devices and Systems, Tata McGraw Hill Education Pvt. Ltd., 2<sup>nd</sup> edition
4. Arun K. Ghosh, Introduction to Measurements and Instrumentation, Prentice Hall of India Pvt. Ltd., 3<sup>rd</sup> edition

**Industrial Instrumentation (Practical based on ELI-DC-I-301)**

(Any eight)

1. Discharge coefficient of orifice plate.
2. To study the calibration of pressure gauges using dead weight tester.
3. Calibration of thermocouple.
4. Calibration of RTD.
5. Level transmitters.
6. Conductivity meter calibration and measurements of conductivity of test solutions.
7. E.M. flowmeter.
8. Ultrasonic flowmeter.
9. Ratio control in combustion laboratory unit.
10. AC/DC meter calibrator.
11. Study of Circular chart recorder.

## Digital Electronics

48 Periods

### UNIT 1

**Number System and Codes:** Decimal, Binary, Hexadecimal, Octal, BCD, conversion of one code to another, Complements (one's and two's), Signed and Unsigned numbers, Addition, Subtraction, Multiplication. Gray and Hamming Codes.

**Logic Gates and Boolean algebra:** Truth Tables, OR, AND, NOT, XOR, XNOR, Universal (NOR and NAND) Gates, Boolean Theorems, DeMorgan's Theorems, Principle of duality.

**Digital Logic families:** Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, Current and Voltage parameters. TTL, MOS and CMOS families.

12 Periods

### UNIT 2

**Combinational Logic Analysis and Design:** Standard representation of logic functions (SOP and POS), Karnaugh map minimization. Encoder and Decoder. Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, half Adder, full Adder and subtractor. 4-bit parallel adder.

12 Periods

### UNIT 3

**Sequential logic design:** Latch, Flip flop (FF), S-R FF, J-K FF, T and D type FFs, Clocked FFs, Registers, Counters (ripple, synchronous and asynchronous, ring and modulo-N), State Table, State Diagrams.

15 Periods

### UNIT 4

**Programmable Logic Devices:** Introduction to Programmable circuits, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), PLD

**Memories:** General Memory Operation, ROM, RAM (Static and Dynamic), PROM, EPROM, EEPROM, EAPROM, Bubble memory, Basic operation of CD ROM, FLASH memory.

9 Periods

### UNIT 1

Chapter 1, 2- M. Morris Mano, Michael D. Ciletti, Digital Design, Third Edition, Pearson Education Asia, (2007)

Chapter 13- Malvino and Leach, Digital Principles & Applications, Fifth edition, Tata McGraw-Hill

### UNIT 2

Chapter 3, 4- M. Morris Mano, Michael D. Ciletti, Digital Design, Third Edition, Pearson Education Asia, (2007)

### UNIT 3

Chapter 5, 6- M. Morris Mano, Michael D. Ciletti, Digital Design, Pearson Education Asia, (2007)

Chapter 9, 10 - Malvino and Leach, Digital Principles & Applications, Fifth edition, Tata McGraw- Hill

### UNIT 4

Chapter 7- M. Morris Mano, Michael D. Ciletti, Digital Design, Third Edition, Pearson Education Asia, (2007)

Chapter12- Malvino and Leach, Digital Principles & Applications, Fifth edition, Tata McGraw-Hill

**Essential Books:**

1. M. Morris Mano, Michael D. Ciletti, Digital Design, Pearson Education Asia,(2007)
2. W. H. Gothman, Digital Electronics: An Introduction to Theory and Practice, Prentice Hall of India (2000).
3. Malvino and Leach, Digital Principles & Applications, Fourth edition, Tata McGraw-Hill.

**Suggested Books:**

1. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994).
2. Thomas L. Floyd, Digital Fundamentals, Pearson Education Asia (1994).
3. A.P Godse, D. A Godse, Digital Electronics-Digital Logic Design, Technical Publications, 3rd revised Edition (2008).
4. R.P Jain, Modern Digital Electronics, Tata McGraw Hill, 3rd Edition.

**Practical (based on ELI-DC-I-302)**

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate ICs.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates.(RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and Parallel shifting of data.
10. Binary to Gray Code conversion.

## Quality Control Techniques

48 Periods

### UNIT 1

Quality Concepts: Meaning of Quality, Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques Pareto Diagrams, Cause-Effect Diagrams Quality Circles, Kaizen, six sigma  
12 Periods

### UNIT 2

Control Charts: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, ARL, sensitizing rules for control charts, Control Charts for X-bar & R (statistical basis, development and use, estimating process capability; interpretation, the effect of non-normality on the chart, the OC function, average run length and control chart for attribute (p, np, c )  
14 Periods

### UNIT 3

Acceptance Sampling: Meaning, objective, and types of research, approaches, Principle of acceptance sampling, Producer's and consumer's risk. AOQL and LTPD, Sampling plans – single, double, O C curve  
12 Periods

### UNIT 4

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors.  
10 Periods

### UNIT 1

Chapter -1, 2, 3 - Janakiraman, B and Gopal, R.K, - Total Quality Management – Text and Cases, Prentice Hall (India) Pvt. Ltd., 2006.

### UNIT 2

Chapter -5, 6 - D. C. Montgomery , Introduction to Statistical Quality Control, 4th edition 2001, John Wiley and sons

### UNIT 3

Chapter-14 - D. C. Montgomery, Introduction to Statistical Quality Control, 4th edition 2001, John Wiley and sons

### UNIT 4

Appendix A and B- Janakiraman,B and Gopal, R.K, - Total Quality Management – Text and Cases, Prentice Hall (India) Pvt. Ltd., 2006.

Quality manuals of leading Industries (for case studies)

### Essential Books:

1. D. C. Montgomery , Introduction to Statistical Quality Control, John Wiley and sons, 4<sup>th</sup> edition
2. John Pike and Richard Barnes, TQM in action, A practical approach to continuous performance improvement, Chapman and Hall, 1<sup>st</sup> edition

3. Janakiraman, B and Gopal, R.K, - Total Quality Management – Text and Cases, Prentice Hall (India) Pvt. Ltd., 1st edition, 2006.
4. Quality Manuals of Government of India

**Suggested Books:**

1. Dale H. Besterfield, et al., - Total Quality Management, Pearson Education Asia, Third Edition, Indian Reprint (2006).
2. E.L.Grant and R.S. Leavenworth-Statistical Quality Control, 6th edition McGraw Hill International editions
3. Kaoru Ishikawa-Guide to Quality Control, Asian Productivity Organization
4. Jerry Banks –Principles of Quality Control, Wiley publisher.
5. James R. Evans and William M. Lindsay, The Management and Control of Quality, 6th Edition, South-Western (Thomson Learning), 2005.
6. Oakland, J.S. -TQM – Text with Cases, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
7. Suganthi,L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd.,2006.

**Practical (based on ELI-DC-I-503)**

(Using latest statistical software)

1. Collection, tabulation and statistical interpretation of data.
2. Construction & analysis of X-bar and R Chart
3. Construction and analysis of p, np and 'c' charts
4. Construction and analysis of OC curves
5. Computing and analyzing LTPD, AOQL graphically
6. Designing and implementing sampling plans
7. Implementation of TQM at industry level(based on case study)
8. Implementation of ISO 9000/ISO 14000 at industry level(based on case study)



## Electrical Instruments

48 Periods

### UNIT 1

#### Basic Power Devices and Circuits

SCR, Diacs and Triacs, Two transistor model of SCR, Resistive and RC triggering circuits. **Applications of SCR:** Basic series inverter circuit, Chopper circuit – Basic concept, step up and step down choppers.

12 Periods

### UNIT 2

**Types of motors and Motor Drives:** Constructional features and characteristics of DC Motors, AC Motors, Induction Motors, Single and three phase Motors, Synchronous Motors, Stepper Motors, and Servo Motors. Motor driving and speed control circuits and their applications, motor starters.

14 Periods

### UNIT 3

**Generators:** AC and DC generators, comparison between generator and motor action (without constructional comparison).

**AC Machines:** Types of transformers, Transformer Construction, E.M.F. equation, Transformer Losses, Condition for maximum efficiency, All day efficiency, Auto transformers.

12 Periods

### UNIT 4

**Supplies:** Regulated power supply, Un interrupted power supply (UPS) and Switched mode power supply (SMPS).

10 Periods

### UNIT 1

Chapter- 2, 3, 5, 8, 9 M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2004, 1<sup>st</sup> Edition

### UNIT 2

Chapter- 29, 30, 34, 35, 36, 38, 39, B. L. Thareja and A. K. Thareja, Electrical Technology, S. Chand & Sons, 23<sup>rd</sup> Edition

### UNIT 3

Chapter- 26, 32, B. L. Thareja and A. K. Thareja, Electrical Technology, S. Chand & Sons, 23<sup>rd</sup> Edition

### UNIT 4

Chapter- 24, A. Malvino, D. J. Bates, Electronic Principles, Tata McGraw Hill, 7<sup>th</sup> Edition  
Chapter- 11, P. S. Bimbhra, Power Electronics, Khanna Publishers, 3<sup>rd</sup> Edition

### Essential Books

1. A. Malvino, D. J. Bates, Electronic Principles, Tata McGraw Hill, 7<sup>th</sup> Edition
2. Khan Chandani, Power Electronics, Tata McGraw Hill, 1<sup>st</sup> Edition
3. P. S. Bimbhra, Power Electronics, Khanna Publishers, 3<sup>rd</sup> Edition
4. B. L. Thareja and A. K. Thareja, Electrical Technology, S. Chand & Sons, 23<sup>rd</sup> Edition

**Suggested Books:**

1. Datta S.K., Power Electronics and Controls, Prentice Hall Company, 1985, 1<sup>st</sup> Edition
2. P.C. Sen, Power Electronics, Tata McGraw Hill, 3<sup>rd</sup> Edition
3. M.H. Rashid, Power Electronics- Circuits Devices and applications, PHI publications, 3<sup>rd</sup> Edition
4. De N.K. and Sen P. K., Electric Drives, Prentice Hall of India (1999), 9<sup>th</sup> Edition
5. S. Ghose, Electrical Machines, Pearson Education (2005), 2<sup>nd</sup> Edition
6. J.B. Gupta, Fundamentals Of Electrical Engg. & Electronics, S. K. Kataria & Sons, 2009, 8<sup>th</sup> Edition
7. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill (1997), 4<sup>th</sup> Edition

**Electrical Instruments (Practicals)**

(Any eight)

1. Study of I-V characteristics of SCR.
2. Study of I-V characteristics of DIAC.
3. Study of I-V characteristics of TRIAC.
4. Power measurement in single & three phase circuit.
5. Load characteristics of D.C. motor.
6. Speed control of D.C. motor.
7. Break test of D.C. motor.
8. Break test of induction motor.
9. Study the stepper motor.
10. To study the induction motor starter.

## Linear Integrated Circuits

48 Periods

### UNIT 1

**Operational Amplifiers Fundamentals:** Differential amplifiers (Dual input balanced output), constant current bias, current mirror, cascaded differential amplifier stages, block diagram of an operational amplifier. Open loop Equivalent circuit of op-amp, ideal voltage transfer curve.

**Characteristics of Op Amp:** input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio, comparative study of different amplifier Integrated circuits (LM 741, LM 324) 13 Periods

### UNIT 2

**Feedback Amplifiers:** Op-Amp in open and closed loop configuration, Introduction to feedback amplifiers, Voltage series feedback amplifier, Voltage follower and its applications, Voltage shunt feedback, summing and difference amplifier, Integrator, Differentiator, voltage to current converter, current to voltage converter. Instrumentation amplifier 10 Periods

### UNIT 3

**Active filters:** First order low pass and high pass butter worth filter, Second order filters, Band pass filter, Band reject filter, All pass filter.

**Signal generators:** Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, saw tooth wave generator, and Voltage controlled oscillator (IC 566). 11 Periods

### UNIT 4

**Comparators:** Basic comparator, Level detector, Voltage limiters, Schmitt Trigger. Precision half wave and full wave rectifiers with IC 741

**Timers:** IC 555 Block diagram, Astable and monostablemultivibrator circuit, Applications of Monostable and Astablemultivibrators.

**Voltage regulators:** Linear and Switching DC Voltage regulators: Basic 78XX.

**Converters:** Analog to Digital and Dgital to Analog Converter. 14 Periods

### UNIT 1

Chapter 1 - R. A. Gayakwad, Op-Amps and Linear IC's, 3 edition, Pearson Education

Chapter 1, 2 - R. A. Gayakwad, Op-Amps and Linear IC's, 4th Edition, Pearson Education

### UNIT 2

Chapter 3, 6 - R. A. Gayakwad, Op-Amps and Linear IC's, 4th Edition, Pearson Education

### UNIT 3

Chapter 7 - R. A. Gayakwad, Op-Amps and Linear IC's, 4th Edition, Pearson Education

### UNIT 4

Chapter 8, 9 - R. A. Gayakwad, Op-Amps and Linear IC's, 4th Edition, Pearson Education

**Essential Books:**

1. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson Education, 3<sup>rd</sup> and 4th Editions.
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2001)

**Suggested Books:**

1. D.Roy Choudhry and Shail B Jain, Linear Integrated Circuits, New Age International Publishers Ltd, 2nd Edition.
2. James M Fiore, Op-Amps and Linear Integrated Circuits – Concepts and applications Cengage Learning, 1st Edition, India Edition.
3. U.A. Bakshi, A.P Godse, A.V. Bakshi, Linear Integrated Circuits and Applications, Technical Publications, 1st Edition (2010).

**Practicals**

1. To study op-amp characteristics: CMRR and Slew rate.
2. To design an amplifier of given gain for an inverting/non-inverting configuration using an op-amp.
3. To design an integrator using op-amp for a given specification and study its frequency response.
4. To design a differentiator using op-amp for a given specification and study its frequency response.
5. To design a First Order Low-pass/High filter using op-amp.
6. To design a RC Phase Shift Oscillator using op-amp.
7. To study IC 555 as an astablemultivibrator.
8. Instrumentation amplifier using LM 324.

## Measurement Science and Techniques

48 Periods

### UNIT 1

**Basic Measurement Instruments**-DC Bridges and applications: Wheatstone, Kelvin, Murray and Varley loop tests. AC Bridges: General form of AC bridge balance, comparison bridges, Maxwell, Hay, Schering, Wien, Wagner ground condition.

DC measurement: DC voltmeter, ammeter, ohmmeter, multimeter, Single Phase wattmeter.

AC measurement: voltmeter, ammeter. Digital type voltmeters, digital multimeter, Digital LCR meter. Digital frequency meter: elements of frequency meter, universal counter and its different modes, measurement errors and extending the frequency range. 16 Periods

### UNIT 2

**Signal Generators**-Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generators, Sweep generator. **Probes and Connectors**: Test leads, shielded cables, connectors, low capacitance probes, high voltage probes, RF demodulator probes, special probes for IC's, current probes. 10 Periods

### UNIT 3

**Electronic Displays**: Cathode Ray Oscilloscope (CRO) and applications: Block diagram of a General Purpose Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections, CRO probes. Types of CRO's: dual trace oscilloscope, digital storage oscilloscope. Amplitude, Frequency, Phase measurements, Lissajous Figures. 12 Periods

### UNIT 4

**Frequency Spectrum, Distortion and wave measurement** - Spectrum analyzer, Harmonic distortion analyzer, intermodulation distortion analyzer, wave analyzer and distortion factor meter, wave meter, Different type of wave meters: Lumped and cavity wave meters, Q-meter and its applications.

**Logic Analyzers**- Logic probes, timing analyzer, glitch detect, state analyzer 10 Periods

### UNIT 1

Chapter 4, 5, 6, 10- Cooper H, Modern electronic Instrumentation and measurement techniques, 3<sup>rd</sup> Ed., PHI Learning Private Limited, 2012

Chapter 7- Cooper H, Modern electronic Instrumentation and measurement techniques, PHI Learning Private Limited, 2<sup>nd</sup> Ed., 1994.

Chapter 4, 8- Bell D. A, Electronic Instrumentation & Measurements, 2<sup>nd</sup> Ed., PHI Learning.

Chapter 4, 5, 6- Kalsi H. S, Electronic Instrumentation, 3<sup>rd</sup> Ed., Tata McGraw Hill.

Chapter 13- Cooper W.D, Electronic Instrumentation and Measurement Techniques, Prentice Hall, 2<sup>nd</sup> Ed., 1976.

### UNIT 2

Chapter 11- Bell D. A, Electronic Instrumentation & Measurements, 2<sup>nd</sup> Ed., PHI Learning.

Chapter 8- Cooper H., Modern electronic Instrumentation and measurement techniques, 3<sup>rd</sup> Ed., PHI Learning Private Limited, 2012.

Chapter 14- Carr J. J., Elements of electronic instrumentation and measurements, 3<sup>rd</sup> Ed., Pearson Education.

Chapter 8- Kalsi H. S., Electronic Instrumentation, 3<sup>rd</sup> Ed., Tata McGraw Hill.

### **UNIT 3**

Chapter 7- Cooper H, Modern Electronic Instrumentation and measurement techniques, 3<sup>rd</sup> Ed., PHI Learning Private Limited, 2012.

Chapter 9- Cooper W. D., Electronic Instrumentation and Measurement Techniques, 2<sup>nd</sup> Ed., Prentice Hall, 1976.

Chapter 9, 10- Bell D. A., Electronic Instrumentation & Measurements, 2<sup>nd</sup> Ed., Oxford University Press..

### **UNIT 4**

Chapter 9, 16- Kalsi H.S., Electronic Instrumentation, 3<sup>rd</sup> Ed., Tata McGraw Hill.

Chapter 6, 9- Cooper H., Modern Electronic Instrumentation and Measurement Techniques, 3<sup>rd</sup> Ed., PHI Learning Private Limited, 2012.

Chapter 4- Bakshi U.A. and Bakshi A.V., Electronic Measurements and Instrumentation, 2<sup>nd</sup> Ed., Technical Publications Pune, 2009.

### **Essential Books**

1. Cooper H., Modern Electronic Instrumentation and Measurement Techniques, 3<sup>rd</sup> Ed., PHI Learning Private Limited, 2012.
2. Cooper H, Modern electronic Instrumentation and measurement techniques, PHI Learning Private Limited, 2<sup>nd</sup> Ed., 1994.
3. Cooper W. D., Electronic Instrumentation and Measurement Techniques, 2<sup>nd</sup> Ed., Prentice Hall, 1976.
4. Kalsi K. S., Electronic Instrumentation, 3<sup>rd</sup> Ed., Tata Mc-Graw Hill.
5. Bell D. A., Electronic Instrumentation and Measurements, 2<sup>nd</sup> Ed., Oxford University Press.
6. Bakshi U.A. and Bakshi A.V., Electronic Measurements and Instrumentation, 2<sup>nd</sup> Ed., Technical Publications Pune, 2009.
7. Carr J. J., Elements of electronic instrumentation and measurements, 3<sup>rd</sup> Ed., Pearson Education.

### **Suggested Books:**

1. Wolf S. and Smith R.F.M , Student Reference Manual, 2<sup>nd</sup> Ed., Pearson Education.
2. Rangan, Sharma and Mani, Instrumentation devices and systems, 2<sup>nd</sup> Ed.,Tata Mc-Graw Hill.
3. Witte R., Electronic test instruments: Analog and Digital measurements, 2<sup>nd</sup> Ed., Prentice Hall.
4. Witte R., Electronic Test Instruments, 1<sup>st</sup> Ed., Prentice Hall.

### **Practicals**

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO.
2. Study the generation of Lissajous figures to find unknown frequency and phase shift.
3. Frequency measurement using Wein Bridge.
4. Study and application of Universal Counters.
5. Study of R,L,C and Q meter.

6. Study of DSO-Measurement of response time of relay using DSO.
7. Measurements of L, C, R using bridges.
8. To study bridge based loop tests.

## **Microprocessor**

**48 Periods**

### **UNIT 1**

Introduction to 8085 Microprocessor, Pin description of 8085, Architecture, register of 8085, addressing mode. Instruction Type and Instruction Set, Machine Cycle, Instruction Cycle, Timing Diagram.

Memory System, internal and External memory and concept of Virtual Memory. Hardware Interfacing or Types of I/O addressing-Interfacing Memory and Peripheral (I/o Mapped I/O and memory mapped I/O) 16 Periods

### **UNIT 2**

Assembly Language Programming Stacks and Subroutine, Interrupts of 8085-Hardware and Software interrupts. Difference between RICS and CISC Processor 8 Periods

### **UNIT 3**

Interfacing ICs, Programmable Peripheral Interface: Intel 8255, DMA controller: Intel 8257, Programmable Interrupt Controller: Intel 8259, Rs232 serial port 13 Periods

### **UNIT 4**

Application of Microprocessor 8085 in Instrumentation-Interfacing of Printer, Stepper Motor, Annunciator. Basics of 8086(16 bit Microprocessor), Architecture of 8086, Concept of parallel processing in 8086 11 Periods

### **UNIT 1**

Chapter-1, 2, 3, 4, 5, 6- Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2<sup>nd</sup> Edition

### **UNIT 2**

Chapter-7, 9, 12, 18- Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2<sup>nd</sup> Edition

### **UNIT 3**

Chapter-10, 12, 13- P.K Ghosh & P.R Sridhar, 0000 to 8085 microprocessor, John Wiley & Sons, 2<sup>nd</sup> Edition

Chapter-16 - Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2<sup>nd</sup> Edition

### **UNIT 4**

Chapter-12 - R. Thegarajan and S. Dhanpal, Microprocessor and its Application, New Age International Private Ltd., 1st Edition

Chapter-2- Liu Gibson, Microprocessor Systems: The 8086/8088 family Architecture, Programming & Design, PHI, 1999, 2<sup>nd</sup> Edition



**Essential Books:**

1. Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2<sup>nd</sup> Edition
2. P.K Ghosh& P.R Sridhar, 0000 to 8085 microprocessor, John Wiley & Sons, 2<sup>nd</sup> Edition
3. Liu Gibson, Microprocessor Systems: The 8086/8088 family Architecture, Programming& Design, PHI, 1999, 2<sup>nd</sup> Edition
4. R. Thegarajan and S. Dhanpal, Microprocessor and its Application, New Age International Private Ltd, 1<sup>st</sup> Edition

**Suggested Books:**

1. K. Udaya Kumar & B.S. Uma Shankar, The 8085 Microprocessor: Architecture, Programming and Interfacing”, Pearson Education
2. Barry B. Brey and C R Sarma, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486,
3. Pentium and Pentium Pro-Processor Architecture, Programming and Interfacing, Pearson Education, (2005)
4. Walter Triebel &AvtarA.Singh, 8088 and 8086 Microprocessors: Programming, Interfacing, Software Hardware and Applications, Pearson Education, 4<sup>th</sup> edition
5. D. V. Hall, “Microprocessors and Interfacing”, Tata McGraw Hill (2005), revised 2<sup>nd</sup> edition

**Practical (based on ELI-DC-I-602)**

1. To write an assembly language program to perform basic mathematical operations (addition, subtraction, multiplication, division)
2. To write an assembly language program to generate first N terms of an A.P. / G.P. series
3. To write an assembly language program to generate first N terms of Fibonacci series
4. To write an assembly language program to arrange the given list of number in ascending / descending order
5. To write an assembly language program to calculate N!
6. To write an assembly language program to separate prime numbers in a given list of number
7. To write an assembly language program to convert a number from one number system to another.
8. To write an assembly language program to design a clock 36
9. To write an assembly language program to calculate a mathematical expression (for e.g.  $2N/N!$ )
10. To write an assembly language program to calculate value of  $\sin(x)$
11. To implement basic 8086 interrupts using assembler

## **Analytical Instrumentation-I**

**48 Periods**

### **UNIT 1**

Electro analytical Methods of Analysis: Potentiometry: Introduction, reference electrode, indicator electrodes, ion-selective electrodes and their applications, instrumentation, measurement of cell unit, direct potentiometry, potentiometric titrations, applications.

Polarography: Basic principle, direct current polarography, different kinds of currents, reversible and irreversible waves, pulse and ac polarography, applications. 15 Periods

### **UNIT 2**

Molecular spectro-analytical Methods of Analysis: Colorimetry and Spectro-photometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and numerical based on that, limitations, types of sources, monochromators and detectors, Instrumentation of single beam and double beam instrument.

Infrared Spectroscopy: Theory, diatomic molecules as a simple harmonic oscillator, instrumentation, sample handling techniques. Fourier Transform Infrared Spectroscopy (FTIR): advantages, instrumentation qualitative and quantitative applications, interpretation of Infrared (IR) spectra. 15 Periods

### **UNIT 3**

Atomic Spectroscopy: Principle, comparison of atomic and molecular spectroscopy, atomic transitions, atomic absorption, atomisation process, types of flames- fuel/ oxidant combinations, instrumentation of spectrophotometers; Interferences: spectral, chemical and ionisation, applications. Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, analysis using standard addition method, applications. 8 Periods

### **UNIT 4**

Separation methods: Theory of chromatography, Principle, instrumentation and application of Thin layer chromatography (TLC), High pressure thin layer chromatography (HPTLC), Electrophoresis: Theory, Principle, Instrumentation of Horizontal and vertical electrophoresis.

10 Periods

#### **UNIT 1**

Chapter 22, 23, 25- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 21, 22 and 23- H.H. Willard et al., Instrumental Methods of Analysis, CBS Publishers

Chapter 13, 15 and 16- Jeffery G.H. et al., Vogel's Text of Quantitative Chemical Analysis, Longman Scientific and Technical, New York.

#### **UNIT 2**

Chapter 6,7,8,13, 14, 16, 17- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 5, 6, 7, 11 - H.H. Willard et al., Instrumental Methods of Analysis, CBS Publishers

#### **UNIT 3**

Chapter 9, 10- H.H. Willard et al., Instrumental Methods of Analysis, CBS Publishers.

Chapter 9, 10- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning  
Chapter 21- Jeffery G.H. et al., Vogel's Text of Quantitative Chemical Analysis, Longman Scientific and Technical, New York.

#### **UNIT 4**

Chapter 26, 30- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning  
Chapter 10, 11 –Wilson K. And Walker J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press

#### **Essential Books:**

1. Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning .
2. H.H. Willard, Instrumental Methods of Analysis, CBS Publishers
3. Jeffery G.H. et al., Vogel's Text of Quantitative Chemical Analysis, Longman Scientific and Technical, New York.
4. Wilson K. And Walker J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.

#### **Suggested Books:**

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York
2. D.C. Harris, Quantitative Chemical Analysis, W.H. Freeman
3. Christian G.D, Analytical Chemistry, John & Sons, Singapore
4. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York
5. Vogel's Textbook of Qualitative Chemical Analysis, ELBS
6. S.E. Manahan, Fundamentals of Environmental Chemistry, Lewis Publishers
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
8. R.A. Day and A.L. Underwood, Quantitative Analysis, Prentice Hall of India
9. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication
10. W. Kemp, Organic Spectroscopy, ELBS

#### **Practicals:**

1. Determination of pK<sub>a</sub> value for bromophenol blue using double beam spectrophotometer.
2. Spectrometric determination of iron using double beam spectrophotometer.
3. Determination of concentration of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Determination of concentration of standard potassium ions in sample by standard addition method (Flame photometer).
5. Thin layer chromatographic (TLC) separation of samples from different origin (biological/pharmaceutical/food)
6. Group finding of Organic compound by IR spectroscopy
7. Spectrum analysis using FT-IR.
  - a) Qualitative analysis
  - b) Quantitative analysis

8. Analysis of various compounds using atomic absorption system.

a) Qualitative analysis

b) Quantitative analysis

9. Separation of macromolecules using Agarose gel electrophoresis

10. To use potential measurements to quantify the hydrogen peroxide concentration in an unknown sample

## Biomedical Instrumentation -I

48 Periods

### UNIT 1

**Biopotentials, bioamplifiers and bioelectrodes:** Introduction to bio-electric potential, bio-amplifier, components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms and transducers to measure various physiological events, types of bio-potential electrodes (Body surface electrodes, Internal electrodes, Micro electrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes . 12 periods

### UNIT 2

**Cardiac vascular system & measurements:** ECG: origin, Instrumentation, bipolar system lead system I, II, III, Einthovan's triangle, Augmented lead system, unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Defibrillators: AC, DC. Pacemakers- Internal, External. Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter. Oximeters: Different types of oximetry systems, pulse oximeter. 16 periods

### UNIT 3

**Respiratory Measurement Systems:** Types of volume, types of measurements, Instrumentation of respiratory system, principle & types of pneumograph, Spirometer, pneumotachometers, nitrogen wash out technique. Ventilators: Basic principles of ventilators, different generators, inspiratory phase and expiratory phase, types of ventilators.  
**Nervous system:** Action potential of brain, brain wave, Instrumentation of Electroencephalography (EEG), electrodes used for recording EEG analysis. 12 periods

### UNIT 4

**Medical Imaging system:** -Thermal imaging system, working, IR detectors, applications. Radiography- conventional X-ray, properties, generation of X-ray, Fluoroscopy. 8 periods

### UNIT 1

Chapter 1, 2, Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing, India (2009), 2<sup>nd</sup> edition

Chapter 3, 6, 7 - Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2009), 4<sup>th</sup> edition

Chapter 1, 2- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

Chapter 2, 3, 4 - Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition

### UNIT 2

Chapter 5, 6, 7- Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition

Chapter 2, 8, 9, - Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2009), 4<sup>th</sup> edition

Chapter 2, 6, 10, 11, 25, 26, - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing, India (2009), 2<sup>nd</sup> edition

Chapter 3, 9, 10- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

### **UNIT 3**

Chapter 10, 11, 12, 13- Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2010), 2<sup>nd</sup> edition

Chapter 2, 6, 33 - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing (2009), 2<sup>nd</sup> edition

Chapter 4, 5- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

Chapter 8, 10 - Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition

### **UNIT 4**

Chapter 23 -Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2010), 2<sup>nd</sup> edition

Chapter 19, 20, 24 - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing (2009), 2<sup>nd</sup> edition

Chapter 8- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

Chapter 14 - Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition

### **Essential Books:**

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition..
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc. (2009), 4<sup>th</sup> edition.
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing, India (2009), 2<sup>nd</sup> edition.

### **Suggested Books:**

8. Bertil Jacobson & John G. Webster, Medicine and Clinical Engineering, PHI.
9. Prof. S.K. Venkata Ram-Bio-Medical Electronics and Instrumentation, Galgotia Publications.
10. John G. Webster, Medical Instrumentation-Application and Design, Wiley Student Edition

### **Practicals (any eight)**

1. To design biopotential amplifier for ECG signals.
2. Measurement of heart sound using electronic stethoscope.
3. Real time acquisition and analysis of ECG and EEG signals.
4. Determination of pulmonary function using spirometer.

5. To study fingertip oximeter and analysis of various parameters.
6. Designing of pacemakers.
7. To load various biomedical signal in Matlab/Labview.
8. Filtering of ECG/EEG signals using Matlab/Labview.
9. Adding noise to a biomedical signal using Matlab/ Labview .
10. Display the frequency spectrum of a signal using Matlab/Labview .
11. Analysis of components of ECG Signals using Matlab/ Labview .

## Signals and Systems

48 Periods

### UNIT 1

Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties. 15 Periods

### UNIT 2

Linear Time-Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral. Properties of LTI systems, Commutative, Distributive, Associative. 11 Periods

### UNIT 3

LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response. Differential and Difference equation formulation, Block diagram representation of first order systems. 11 Periods

### UNIT 4

Laplace Transform: Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits. 11 Periods

#### UNIT 1

Chapter 1 A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)

Chapter 1 S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)

#### UNIT 2

Chapter 2 A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)

Chapter 2 S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)

#### UNIT 3

Chapter 2 A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)

Chapter 2 S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)

#### UNIT 4

Chapter 9 A. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)

Chapter 6 S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)

Chapter 15 & 16 C. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2008)

#### Suggested Books:

1. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007)



2. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, Publications (2008)
3. W. Y. Young, Signals and Systems with MATLAB, Springer (2009)
4. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007)

**Practicals:**

1. Learning SciLAB/MATLAB (Experiments based on available system)
2. Explorations of Signals and Systems using SciLAB/MATLAB
  - a. Generation of Signals: continuous time
  - b. Generation of Signals: discrete time
  - c. Convolution of Signals
  - d. Solution of Difference equations.
  - e. Introduction to SIMULINK and calculation of output of systems represented by block diagrams

## **Analytical Instrumentation II**

**48 Periods**

### **UNIT 1**

Spectro-analytical Methods of Analysis: Nuclear magnetic resonance: Theory, chemical shift and spin-spin splitting, coupling constant, environmental effects- shielding deshielding effects due to electronegativity on NMR spectra, instrumentation of NMR, FT-NMR and its advantages, applications.

Mass Spectroscopy: Theory, fragmentation modes, instrumentation: inlet systems, magnetic and electrostatic analysers, detectors. Isotopic abundances, metastable ions and applications  
14 Periods

### **UNIT 2**

Thermo-analytical Methods: Thermal detectors. Thermo-gravimetry, Differential Thermal analysis, Differential scanning calorimetry . Principle, Instrumentation: thermobalance. Interpretation of thermograms. Applications. Comparison and advantages of each technique  
10 Periods

### **UNIT 3**

Radiochemical methods: X-ray spectroscopy- Principle, absorption ,emission and diffraction of X-rays, Bragg's Law, Instrumentation: sources, X –ray tube, crystal monochromators , X-ray detectors (Ionization, proportional and GM counter,  $\gamma$  camera), applications 10 Periods

### **UNIT 4**

Advanced Chromatographic methods: Principle, process of elution through a column, chromatogram, band broadening, capacity factor, selectivity factor (definition and formulae), numerical based on them. Column efficiency- number of plates, plate height, column resolution (definition and formulae), numerical based on them.

Instrumentation of Gas Chromatography (GC): carrier gases,different type of injection systems, columns, stationary phases and detectors. Isothermal mode and temperature programming, analysis by internal standard method, applications.

Instrumentation of High Performance Liquid Chromatography (HPLC): mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, detectors. Applications  
14 Periods

### **UNIT 1**

Chapter 19, 20- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 15, 16 - H.H.Willard, Instrumental Methods of Analysis, CBS Publishers

### **UNIT 2**

Chapter 31- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 25- H.H.Willard, Instrumental Methods of Analysis, CBS Publishers

### **UNIT 3**

Chapter 32- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 14- H.H.Willard, Instrumental Methods of Analysis, CBS Publishers

### **UNIT 4**

Chapter 27, 28, 33- Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning

Chapter 18, 19, 20, 26- H.H.Willard, Instrumental Methods of Analysis, CBS Publishers

**Essential Books:**

5. Skoog, Holler and Crouch, Instrumental Analysis, Cengage Learning .
6. H.H. Willard, Instrumental Methods of Analysis, CBS Publishers

**Suggested Books:**

1. D.C. Harris, Quantitative Chemical Analysis, W.H. Freeman
2. Vogel's Textbook of Qualitative Chemical Analysis, ELBS
3. S.E. Manahan, Fundamentals of Environmental Chemistry, Lewis Publishers
4. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
5. R.A. Day and A.L. Underwood, Quantitative Analysis, Prentice Hall of India
6. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publications
7. W. Kemp, Organic Spectroscopy, ELBS

**Practicals based on Analytical Instrumentation II**

1. Qualitative Analysis of organic compounds using Gas chromatography
2. Quantitative Analysis of organic compounds using Gas chromatography
3. Qualitative Analysis of organic compounds using HPLC.
4. Quantitative Analysis of organic compounds using HPLC.
5. Study of NMR (Simulation based/Demo).
6. Study of Mass spectrometer (Simulation based/Demo).
7. Study of X ray spectrometer (Simulation based/Demo).
8. Study of the X-ray fluorescence (Simulation based/Demo).
9. Study of DTA, TGA and DSC.

**UNIT1**

Introduction of open loop and closed loop control systems, mathematical modeling of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function, Armature controlled and field controlled DC servomotors, AC servomotors, block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula. Effect of feedback on control systems, Basic Control Actions: Proportional, integral and Derivative controls 12 Periods

**UNIT 2**

**Time – Domain Analysis:**-Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices, response with P, PI and PID Controllers. **Concept of Stability:** Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications. 12 Periods

**UNIT3**

**Frequency Domain Analysis:** Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using nyquist criterion, constant M & N circles. 14 Periods

**UNIT4**

**Compensation Techniques:** Concept of compensation, Lag, Lead and Lag-Lead networks  
**State Space Analysis:** Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties 10 Periods

**UNIT 1**

Chapter 1,2,3,4- I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition

Chapter 1,3- K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition

Chapter 1,3,4- B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition

**UNIT 2**

Chapter 5,6,7 - I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition

Chapter 5,6,7 - K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition

Chapter 6,7,8,10 - B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition

**UNIT 3**

Chapter 8,9 - I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition

Chapter 8 - K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition

Chapter 9 - B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition

**UNIT 4**

Chapter 10,12 - I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition

Chapter 9,11 - K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition

Chapter 5,10 - B. C. Kuo, "Automatic control system", Prentice Hall of India, 2000, 7th Edition

**Essential Books:**

1. K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition
2. B. C. Kuo, "Automatic control system", Prentice Hall of India, 2000, 7th Edition
3. I. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition

**Suggested Books:**

1. Dr. N.K Jain, Automatic Control System Engineering, Dhanpat Rai Publication, 2005, 2nd Edition
2. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi, 7th Edition

**Control Systems (Practical based on ELI-DC-I-501)**

(Any eight)

1. To study characteristics of :
  - a. Synchro transmitter receiver
  - b. Synchro as an error detector
2. To study position control of DC motor
3. To study speed control of DC motor
4. To find characteristics of AC servo motor
5. To study time response of type 0,1 and 2 systems
6. To study frequency response of first and second order systems
7. To study time response characteristics of a second order system.
8. To study effect of damping factor on performance of second order system
9. To study frequency response of Lead and Lag networks.
10. Study of P, PI and PID controller.

Some of the experiments mentioned above can be simulated on software (Matlab, MathCAD, LabVIEW)

## Biomedical Instrumentation-II

48 Periods

### UNIT 1

**Anaesthesia machine:** Need of anesthesia, anesthesia delivery system, breathing circuits.

**Clinical Laboratory Instruments:** General principle and working of Blood Gases Analyzer, Auto-analyzer, Blood Cell Counters, ELISA reader, spectrophotometer, flame photometer.

12 Periods

### UNIT 2

**Medical Imaging system:** Ultrasound, properties, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, M Scan, real time ultrasonic imaging, linear array scanners.

X-ray computed tomography (CT Scanner) and computer-aided tomography (CAT)-principle, contrast scale, scanning system, processing unit, viewing, storage.

Magnetic Resonance Imaging: Basic principle, working and construction. 12 Periods

### UNIT 3

**Nuclear medicine system:** radioactive emissions, rectilinear scanner, gamma camera, imaging system, ECT (emission coupled tomography), positron emission tomography (PET), Single-photon emission computed tomography (SPECT), safety measures. 12 Periods

### UNIT 4

**Surgical scopy and diathermy equipments: Fibre Optics-** Endoscopes -light sources, video processors, camera, and fiber optic cable, Principles and applications.

**Diathermy:** Infrared radiation (IR) diathermy, ultraviolet (UV) diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, surgical Diathermy. 12 Periods

### UNIT 1

Chapter 14, 32 - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing, India (2009), 2<sup>nd</sup> edition

Chapter 16 - Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2009), 4<sup>th</sup> edition

Chapter 7- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

### UNIT 2

Chapter 14 - Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall (2010), 2<sup>nd</sup> edition

Chapter 17, 23 - Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2009), 4<sup>th</sup> edition

Chapter 19, 20, 22, 23- Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing, India (2009), 2<sup>nd</sup> edition

Chapter 8- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

### UNIT 3

Chapter 23- Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2010), 2<sup>nd</sup> edition

Chapter 21 - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing (2009), 2<sup>nd</sup> edition

#### **UNIT 4**

Chapter 21 -Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Pearson Education Inc (2010), 2<sup>nd</sup> edition

Chapter 27 - Khandpur R.S., Handbook of Biomedical Instrumentation, Tata MacGraw-Hill Publishing (2009), 2<sup>nd</sup> edition

Chapter 9, 12- Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

#### **Essential Books:**

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2<sup>nd</sup> edition
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2010), 2nd edition
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata MacGraw-Hill Publishing (2009), 2<sup>nd</sup> edition
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2000), 2<sup>nd</sup> edition, Volume 1.
5. Richard Aston, Principles of Biomedical Instrumentation & Measurement, Merrill Publishing Company, (1990), 1<sup>st</sup> edition
6. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1<sup>st</sup> edition

#### **Suggested Books:**

2. Bertil Jacobson & John G. Webster, Medicine and Clinical Engineering, PHI
3. Prof. S.K. Venkata Ram-Bio-Medical Electronics and Instrumentation, Galgotia Publications
4. John G. Webster, Medical Instrumentation-Application and Design,Wiley Student Edition

#### **Practicals based on Biomedical Instrumentation-II (any eight):**

1. Study of ultrasound transducers based on medical system.
2. Differentiating arteries and veins using ultrasound transducers.
3. Measurement of respiration rate using thermistor /other electrodes.
4. Measurement of pulse rate using photoelectric transducer & pulse counting for known period.
5. Study of X ray/CT machine (through demonstration).
6. Study of nuclear imaging techniques (through demonstration).
7. Study of mammograms and CT scan images.
8. Analysis of blood sample using Auto-analyzer
9. To check blood gases using blood gas analyzer
10. To estimate different parameters of blood using blood cell counter.
11. Estimation of serum total protein using spectrometer.
12. Estimation of sodium and potassium in blood serum or urine sample.

# Programming in C and Data Structures

48 Periods

## UNIT I

Introduction-Algorithm / pseudo code, flowchart, program development steps, structure of C program, identifiers, basic data types and sizes, Constants, variables, Operators, expressions, Input-output statements, if and switch statements, loops- while, do-while and for statements, break, continue, goto and labels. Designing structured programs, Functions, basics, parameter passing, storage classes- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, example C programs. 18 Periods

## UNIT II

Arrays- concepts, declaration, definition, accessing elements, storing elements, arrays and functions, two dimensional and multi-dimensional arrays, applications of arrays. pointers- concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, C program examples. 11 Periods

## UNIT III

Derived types- structures- declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, typedef, bitfields, C program examples. Input and output - concept of a file, streams, standard I/o, Formatted I/O, file I/O operations, error handling, C program examples. Searching - Linear and binary search methods, sorting - Bubble sort, selection sort, Insertion sort. 11 Periods

## UNIT IV

Introduction to data structures- singly linked lists, doubly linked lists, circular list, representing stacks and queues in C using arrays and linked lists, infix to post fix conversion, postfix expression evaluation. Trees- Binary trees, terminology, representation, traversals, graphs- terminology, representation, graph traversals (dfs & bfs). 8 Periods

### UNIT I

Chapter 1,2,3,4,5,6 - Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning

Chapter 1,2,3,4,5,6,7,8,14 - Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing

Chapter 1,2,3,4,5,6,9,14 - E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing

### UNIT II

Chapter 8,9,10,11 - Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning

Chapter 9,10,14 - Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing

Chapter 7,8,11,12,13 - E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing



### **UNIT III**

Chapter 7,12,13,14 - Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning

Chapter 11,12,13 - Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing

Chapter 10,12 - E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing

### **UNIT IV**

Chapter 15 - Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning

Chapter 13 - E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing

### **Essential Books:**

1. Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning.
2. Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing
3. E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing

### **Suggested Books:**

1. P. Padmanabham, C & Data structures, B.S. Publications.
2. B.W. Kernighan, Dennis M.Ritchie, The C Programming Language, Pearson Education
3. J.A. Jones & K. Harrow, C Programming with problem solving, Dreamtech Press
4. Stephen G. Kochan, Programming in C, III Edition, Pearson Education.
5. R. Kruse, C.L. Tondo, BP Leung, Shashi M, Data Structures and Program Design in C, Second Edition, Pearson Education.

## **8051 & Advanced Microcontrollers**

**48 Periods**

### **UNIT 1**

Introduction to RISC microcontrollers. Von- Neumann and Harvard architectures , Introduction to 8051 family microcontrollers. 8051 architecture, Register banks and Special Function Registers. 10 Periods

### **UNIT 2**

Memory organization. Addressing modes, Instruction set: Data transfer, Arithmetic, Logical, Boolean and Branch instructions. Oscillator and Clock Circuit, Input / Output Ports, Timers, Serial Interface, Interrupts, External Interrupts. 8051 Programing 16 Periods

### **UNIT 3**

8051 interfacing with Keyboard, display Units (LED, 7-segment display, LCD), ADC, DAC, Stepper motor , Introduction to AVR family and its architecture 11 Periods

### **UNIT4**

Introduction to advanced 16-bit Microcontroller -8096/80196 family, Architecture, Instructions,I/O features-Use of PTS to facilitate DMA, Timers, Difference between 8051 and 80196, difference in I2C and CAN bus 11 Periods

#### **UNIT 1**

Chapter 1, 2 – Mazidi M.A, Mazidi J.G, The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2<sup>nd</sup> Edition

#### **UNIT 2**

Chapter 2, 3, 4, 5, 6, 8, 9, 11 – Mazidi M.A., Mazidi J.G, The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2<sup>nd</sup> Edition

#### **UNIT 3**

Chapter 12, 13, 17 – Mazidi M.A., Mazidi J.G., The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2<sup>nd</sup> Edition

Chapter 3 – Gadre D.V., Programming and customizing the AVR microcontroller, Tata McGraw Hill, 2<sup>nd</sup> Edition

#### **UNIT4**

Chapter 14- Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Second Edition, Pearson Education India, 2nd Edition

#### **Essential Books:**

1. Muhammad Ali Mazidi, Janice GillispieMazidi, The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2<sup>nd</sup> Edition
2. D.V. Gadre, Programming and customizing the AVR microcontroller, Tata McGraw Hill, 2<sup>nd</sup> Edition
3. Raj Kamal Microcontrollers: Architecture, Programming, Interfacing and System Design, 2<sup>nd</sup> Edition
4. John B. Peatman, Design with PIC Microcontrollers, Pearson Education (1998)

#### **Suggested Books:**

1. Daniel W. Lewis, Fundamentals of Embedded Software – where C and Assembly Meet, Pearson Education (2002)
2. Kenneth J Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Penram Publications
3. Zdravko Karakehayov, Knud Smed Christensen and Ole Winther, Introduction by: Embedded Systems Design with 8051 Microcontrollers, Marcel Dekker Inc, (1999)
4. Dave Calcutt, Fred Cowan and Hassan Parchizadeh, 8051 Microcontroller: an application based, Elsevier.
5. Myke Predco, Programming & Customizing the 8051 Microcontroller, McGraw Hill, (2000)
6. Martin Bates, Interfacing PIC Microcontroller Embedded Design by interactive Simulation, Elsevier publication

**Practical (based on ELI-DC-I-802)**

(Any eight)

1. Write a program to add N 8 bit unsigned integer numbers.
2. Write a program to multiply two 16 bit unsigned numbers.
3. Write a program to arrange the unsigned integer numbers in ascending/descending order.
4. Interface a display to the micro controller and display number sequentially in a regular interval.
5. Write program to verify the switch condition and light the LED's accordingly.
6. Generate a PWM waveform whose width can be increased/decreased using switches.
7. Convert the analog voltage to digital using ADC and store the data in memory.
8. Generate the given waveform using DAC.
9. Using display and keys write program to work as a stop clock.
10. Using display and keys write program to work as a counter.

## **Virtual Instrumentation**

**48 Periods**

### **UNIT 1**

Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram & architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming. 8 Periods

### **UNIT 2**

VIS and sub-VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula nodes, local and global variable, string & file input and output Graphical Programming in data flow 14 Periods

### **UNIT 3**

Data Acquisition Basics: ADC, DAC, DIO, Counters and timers, PC Hardware' structure, Timing, Interrupts, DMA Software and hardware installation. Common Instrumentation Interfaces: Current loop RS232C/ RS485, GPIB System buses, Interface buses: USB, PCMCIA, VXI, PXI, Networking basics for office and industrial applications, VISA 14 Periods

### **UNIT 4**

Applications of VI, Advanced analysis tools, Correlation methods, windowing & filtering. Application in Process Control projects, DMM, waveform generator, Motion Control, Image acquisition & processing 12 Periods

#### **UNIT 1**

Chapter 1 - John Essick, Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition

Chapter 1, 2 - S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2<sup>nd</sup> Edition

#### **UNIT 2**

Chapter 1, 2, 3, 5, 7, 8 - John Essick, Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition

Chapter 3, 4, 5, 6, 8, 9 - S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition

#### **UNIT 3**

Chapter 4, 5, 11, 13- John Essick, Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition

Chapter 10, 11, 12, 13, - S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition

#### **UNIT 4**

Chapter 9, 10, 12 - John Essick, Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition

Chapter 14, 15 - S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994 2nd Edition

#### **Essential Books:**

1. John Essick , Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition
3. Gary Johnson, LABVIEW Graphical Programming, McGraw Hill, 1997, 2nd Edition.

**Suggested Books:**

1. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI, 1997
2. Skolkoff, Basic concepts of LABVIEW 4, PHI, 1998.
3. James K “PC interfacing and data acquisition “, 2002.
4. Technical Manuals for DAS Modules of Advantech and National Instruments. L.T. Amy, Automation System for Control and Data Acquisition, ISA, 1992

**Practicals:**

5. Simple programming structures and Timing Issues, Basic operations, controls and indicators.
6. Debugging a VI, Sub-VI's
7. Use of Loops & charts
8. Use of arrays
9. Use of clusters and graphs
10. Use of Case & sequence structures
11. Use of Formula modes
12. Use of String & file input and output
13. Developing applications on LabVIEW e.g process control, waveform generator, motion control, image acquisition, processing Programming Structure, Sub-VIs, Clusters
14. Digital-to-Analog acquisition interfacing - Analog I/O
15. Importing pictures, Global/ local variables.

# Artificial Intelligence Control Techniques

48 Periods

## UNIT I

The concept and importance of Artificial Intelligence, human intelligence vs machine intelligence. General concept of knowledge, Acquisition, Knowledge representation and organization, Expert systems: architecture, functions of various parts, Mechanism and role of inference engine, Types of Expert system, Role of Expert systems in instrumentation and process control 08 Periods

## UNIT II

**Neural Networks:** Biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptrons, training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications in identification, optimization, pattern recognition etc. 16 Periods

## UNIT III

**Fuzzy Logic:** Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers. Applications of Fuzzy Logic in process Control and motion control 16 Periods

## UNIT IV

**Genetic Algorithm:** An Overview: Introduction and concept as a process modeling tool, Implementation of Genetic algorithm. **Hybrid Systems:** Introduction to Neuro-fuzzy systems, Fuzzy-Expert system, Fuzzy-GA systems 08 Periods

### UNIT 1

Chapter 2, 3,7 – Padhy N.P., Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition

### UNIT 2

Chapter 2,3,4,7,10,11,13,14,18 – Hagan M.T , Demuth H.B, Beale M.H, Neural Network Design, PWS Publishing Company, Thomson Learning, 1st Edition

Chapter 2,3,4,5 – Rajasekaran S., Vijayalakshmi Pai G. A., Neural Networks, PHI Learning Pvt. Ltd., 2003, 1st Edition

### UNIT 3

Chapter 1,2,3,4,5,11,12,13 - Ross Timothy J., Fuzzy logic with Engineering Applications, McGraw Hill, New York, 3rd Edition

Chapter 6,7 - Rajasekaran S., Vijayalakshmi Pai G. A., Neural Networks, PHI Learning Pvt. Ltd., 2003, 1st Edition

### UNIT 4

Chapter 8,9,10 - Rajasekaran S., Vijayalakshmi Pai G. A., Neural Networks, PHI Learning Pvt. Ltd., 1st Edition

### Essential Books:

1. Ross Timothy. J, Fuzzy logic with Engineering Applications, McGraw Hill, New York, 3rd Edition
2. Hagan M.T , Demuth H.B, Beale M.H, Neural Network Design, PWS Publishing Company, Thomson Learning, 1st Edition
3. Padhy N.P., Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition
3. Rajasekaran S., Vijayalakshmi Pai G. A., Neural Networks, PHI Learning Pvt. Ltd., 2003  
1st Edition

#### **Suggested Books:**

1. Klir George J , Yuan B, Fuzzy Sets and Fuzzy Logic Theory and Applications, Prentice Hall PTR, 1st Edition
2. Laurene Fausett, Fundamentals of Neural Networks , Prentice Hall, New Jersey, 1st Edition
3. Driankov D., Helledorn H., Reinframe M., An Introduction to fuzzy control, Narosa publishing Co., New Delhi
4. Kosko.B, Neural Network and fuzzy systems, Prentice Hall of India Pvt. Ltd., New Delhi, 1992

#### **Practicals**

Implement programs using Mat lab Fuzzy logic and Neural Network toolbox exemplifying

1. Implementation of perceptron learning model
2. Pattern recognition using Hopfield network
3. Identification using associative memories
4. Implement fuzzy logic operations on fuzzy sets
5. Implement conversion of given crisp temperature into its equivalent fuzzy variable
6. Implement conversion of error into its equivalent fuzzy variable
7. Design model of fuzzy logic PID controller
8. Design fuzzy logic based temperature control system
9. Design fuzzy logic based washing machine/aircraft landing system

## Process Control Dynamics

48 Periods

### UNIT 1

Dynamics of Processes, Dead time processes. Inverse response behavior of processes. Dynamic behavior of first and second order systems. Interacting and non-interacting systems. Batch & Continuous Process, concept of self-regulation, Controller Principle, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID). Pneumatic, Hydraulic, Electronic controllers. Need for controller tuning, Evaluation criteria, Types of controller tuning 14 Periods

### UNIT 2

Cascade control, Selective control, Ratio Control, split range control, feed forward control, feed forward combined with feedback control, inferential control, dead time and inverse response compensators, selective control, Adaptive control. Examples from Distillation columns, Chemical Reactors, Heat Exchangers and Boiler. Multivariable Control, Interaction, Tuning of Multivariable systems, relative gain analysis, Decoupler design. 15 Periods

### UNIT 3

Discrete-State process control: Variables, process specification and event sequence description, Sampling and reconstruction, Transform analysis of sampled-data systems: z transform and its evaluation, inverse z transform, pulse transfer function, stability analysis in z-plane, implementation of digital controller. PLC Block Diagram, Scan cycle, memory organization, addressing, programming. Introduction to distributed control systems (DCS) 10 Periods

### UNIT 4

I/P, P/I converters, Final control elements, Pneumatic and electric actuators. Types of control valves, Valve positioner and its importance, Inherent and Installed characteristics of control valves 9 Periods

### UNIT 1

Chapter 1, 9, 10, 12 - Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition

Chapter 1, 2, 3, 5, 6, 8 – Bequette B. W., Process Control Modelling, Design and Simulation, PHI Learning, Original Edition

### UNIT 2

Chapter 8, 10, 12, 13, 14 – Bequette B. W., Process Control Modelling, Design and Simulation, PHI Learning, Original Edition

### UNIT 3

Chapter 8, 11 - Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition

Chapter 2, 3, 4 – Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition

Chapter 11- Kuo B. C. , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition

Chapter 11- Nagrath I. J. and Gopal M., Control System Engineering, New Age International, 2000, 2nd Edition

### UNIT 4

Chapter 7 – Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition



**Essential Books:**

1. Eckman. D.P, Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993, Original Edition
2. Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition
3. Bequette B. W. , Process Control Modelling, Design and Simulation, PHI Learning, Original Edition
4. Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition
5. Kuo B. C. , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition
6. Nagrath I. J. and Gopal M., Control System Engineering, New Age International,2000, 2nd Edition

**Suggested Books:**

1. Stephanopoulos G., Chemical Process Control, Prentice Hall of India, New Delhi, 1990, Original Edition
2. Liptak B.G., Instrument Engineers Handbook, Process Control, Chilton Book Company, 3rd Edition
3. Harriott P., Process Control, Tata McGraw Hill, Edition 1972.
4. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company 1980, 3rd Edition
5. Pollard A., Process Control, Heinemann educational books, London, 1971, Original Edition
6. Smith C.L. and Corripio A. B., Principles and Practice of Automatic Process Control, , John Wiley and Sons, New York, 2nd Edition
7. Shinskey, Process Control Systems, McGraw Hill, Singapore, 1996, 4th Edition.

**Practicals (based on ELI-DC-I-702)**

(Any eight)

1. Study of PID controller response and it's tuning
2. Study of ON-OFF and Proportional controller responses on temperature loop.
3. Analysis of Flow loop/Level loop/Temperature loop/Pressure loop.
4. Tuning of controllers on a pressure loop.
5. Control valve characteristics with and without positioner.
6. Study of cascade control
7. Study of ratio control/selective control
8. Study of feedforward control
9. Study of pneumatic/ hydraulic controllers
10. Problem solving/Ladder Programming in PLC.
11. Mathematical modeling and simulation of CSTR & STH systems

## Communication

48 Periods

### Unit-1

Introduction to Electronic Communication: Evolution of Communication System, Elements of Communication system, Types of electronic communications, Baseband signals and baseband transmission, Modulation techniques, Bandwidth requirements. Concept of noise: External noise, internal noise, signal to noise ratio, noise factor. 8 Periods

### Unit-2

Amplitude Modulation: Introduction , Equation of AM signal, Modulation index and percentage of modulation for sinusoidal AM, Frequency spectrum of the AM wave, Average power for sinusoidal AM wave, Effective voltage and current for sinusoidal AM, generation of AM, Amplitude demodulation, DSBSC & SSBSC generation, Vestigial Side band modulation. 14 Periods

### Unit-3

Angle modulation: Frequency and Phase modulation, modulation index, frequency spectrum, equivalence between FM & PM, generation of FM (Direct and Indirect method), FM detection (Slope detector, balanced slope detector, PLL).

Transmitter: AM transmitter (low level and high level modulation), FM transmitter.  
Receivers: Super Heterodyne receiver, AM receiver, FM receiver. 14 Periods

### Unit-4

Pulse Modulation: Pulse Amplitude Modulation, Pulse width Modulation, Pulse Position Modulation. Digital modulation: Sampling theorem, Pulse code modulation(PCM),differential pulse code modulation(DPCM),digital modulation schemes: amplitude, phase and frequency shift keying(ASK,PSK,FSK).  
Basics of TDMA, FDMA, CDMA and GSM. 12 Periods

#### UNIT-1

Chapter-1 & 2 of G.Kennedy, Electronic Communication System, Third edition, Tata McGraw-Hill (1997).

Chapter-1 of Simon Haykin & Michael Moher, Introduction to Analog & Digital Communications, Second Edition, John Wiley & Sons, Inc. (2007).

#### UNIT-2

Chapter-3 & 4 of G.Kennedy, Electronic Communication System, Third edition, Tata McGraw-Hill (1997).

Chapter-3 of Simon Haykin & Michael Moher, Introduction to Analog & Digital Communications, Second Edition, John Wiley & Sons, Inc. (2007).

#### UNIT-3

Chapter-5 of G.Kennedy, Electronic Communication System, Third edition, Tata McGraw-Hill (1997).

Chapter- 7, 8 & 10, Roddy & Coolen, Electronics Communication, Fourth Edition, Pearson Prentice Hall, Inc. (1995).

## **UNIT -4**

Chapter-5 & 7 of Simon Haykin & Michael Moher, Introduction to Analog & Digital Communication, Second Edition, John Wiley & Sons, Inc. (2007)

Chapter -3 & 5, Leon W. Couch, II, Digital and Analog Communication systems, Seventh Edition, Pearson Prentice-hall(2011).

### **Essential books**

1. G.Kennedy, Electronic Communication System, Third edition, Tata McGraw-Hill (1997).
2. Simon Haykin & Michael Moher, Introduction to Analog & Digital Communications, Second Edition, John Wiley & Sons, Inc. (2007).
3. Roddy & Coolen, Electronics Communication, Fourth Edition, Pearson Prentice Hall, Inc. (1995).
4. Leon W. Couch, II, Digital and Analog Communication systems, Seventh Edition, Pearson Prentice-hall (2011).

### **Suggested Books**

1. W. Schweber, Electronic Communication Systems, Prentice-Hall of India Private Limited (2002).
2. R.Blake, Electronic Communication Systems, Thomson Business Information (2008).
3. B.P. Lathi, Modern Analog and Digital Communication, Oxford University Press (2007).

### **Practical based on Communication:**

- 1) Study of Amplitude modulation and demodulation.
- 2) Study of Frequency modulation and demodulation.
- 3) Study of AM transmitter and receiver.
- 4) Study of FM transmitter and receiver.
- 5) Study of SSB modulation and demodulation.
- 6) Study of Pulse Amplitude modulation.
- 7) Study of Pulse Width modulation.
- 8) Study of Pulse Position modulation.
- 9) Study of Pulse Code modulation.
- 10) Study of Delta modulation.
- 11) Study of PSK, FSK and QPSK.
- 12) Study of Time Division Multiplexing.