West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Instrumentation & Control Engineering Syllabus upto 7th Semester
Other Syllabi to be Published

COURSE STRUCTURE FOR B.TECH DEGREE IN INSTRUMENTATION AND CONTROL ENGINEERING

3RD SEMESTER [2 ND YEAR 1ST SEMESTER]

THEORY

Sl NO	CODE	TITLE	CONTACT PERIODS PER WEEK			TOTAL PERIODS	CREDITS
			L	T	P		
1	CS 302	Data structure and Algorithms	3	1	_	4	4
2	M(CS) 312	Numerical Methods and Programming	3	0	_	3	3
3	EE 301	Circuit Theory and Networks	3	1	_	4	4
4	IC 301	Measurement Fundamentals	3	1	_	4	4
5	M 302	Mathematics	3	1	_	4	4
6	MS301	Material Science	3	0	_	3	3
TOTAL OF THEORY						22	22

PRACTICAL

1	M(CS) 382	Numerical Methods and Programming	_	_	3	3	2
2	CS 392	Data Structure Lab	_	_	3	3	2
3	EE 391	Circuits and Network Lab	_	_	3	3	2
4	IC 391	Measurement Fundamentals Lab	_	_	3	3	2
TOTAL OF PRACTICAL						12	8
TOTAL OF SEMESTER						34	30

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Course Structure of Instrumentation and Control Engineering

FOURTH SEMESTER

THEORY

Sl. No.	CODE	TITLE	Contact periods per week			Total	Credit
			L	T	P		
1	**IC401**	**Basic Control Theory**	**3**	**0**	**0**	**3**	**3**
2	EC 401	Analogue Electronic Circuits	3	0	0	3	3
3	EC 402	Digital Electronics and Integrated Circuits	3	1	0	4	4
4	EI 401	Sensors and Transducers	3	0	0	3	3
5	EI 402	Electronic Measurements and Instrumentation	3	1	0	4	4
		TOTAL THEORY				17	17

PRACTICAL

1	EI491	Sensors and Transducers Lab	0	0	3	3	2
2	EC491	Analogue Electronic Circuits Lab	0	0	3	3	2
3	EC492	Digital Electronics and Integrated Circuits Lab	0	0	3	3	2
4	EI 492	Electronic Measurements and Instrumentation Lab	0	0	3	3	2
		TOTAL PRACTICAL				12	8

SESSIONAL

1	HU 481	Technical Report Writing & / Language Practice Lab	0	0	0	3	2
		TOTAL SESSIONAL				3	2
		TOTAL OF SEMESTER				**32**	**27**

West Bengal University of Technology
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FIFTH SEMESTER

THEORY

SL. NO	CODE	TITLE	Contact periods per week			Total	Credits
			L	T	P		
1	IC 501	Industrial Instrumentation - I	3	1	0	4	4
2	IC 502	Object oriented programming and design	3	1	0	4	4
3	IC 503	Microprocessor and Micro-controller	3	0	0	3	3
4	IC 504	Advance Control System	3	1	0	4	4
5	IC 505	Data communication and Telemetry	3	0	0	3	3
		TOTAL THEORY				18	18

PRACTICAL

SL. NO	CODE	TITLE	Contact periods per week			Total	Credits
			L	T	P		
1	IC 591	Industrial Instrumentation – I Lab	0	0	3	3	2
2	IC 592	Computer Software Lab	0	0	3	3	2
3	IC 593	Microprocessor and Micro-controller Lab	0	0	3	3	2
4	IC 594	Advance Control System Lab	0	0	3	3	2
		TOTAL PRACTICAL				12	8

SESSIONAL

			0	0	0	0	0
		TOTAL SESSIONAL	0	0	0	0	0
		TOTAL OF SEMESTER				30	26

West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Instrumentation & Control Engineering Syllabus upto 7th Semester
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Course Structure of Instrumentation and Control Engineering

SIXTH SEMESTER

THEORY

Sl. No.	CODE	TITLE	Contact periods per week			Total	Credit
			L	T	P		
1	IC 601	Process Control	3	1	0	4	4
2	EI 602	Microprocessor based system	3	0	0	3	3
3	CS 611	Computer Network & Internetworking	3	0	0	3	3
4	IC 602	Multimedia	3	0	0	3	3
5	IC 603	Industrial Instrumentation - II	3	1	0	4	4
		TOTAL THEORY				**17**	**17**

PRACTICAL

1	IC 691	Process Control Lab	0	0	3	3	2
2	EI 692	Microprocessor based system Lab	0	0	3	3	2
3	CS 681	Computer networking Lab	0	0	3	3	2
4	IC 692	Multimedia Lab	0	0	3	3	2
		TOTAL PRACTICAL				**12**	**8**

SESSIONAL

1	IC 682	Group Discussion and Seminar				3	2
		TOTAL SESSIONAL				**3**	**2**
		TOTAL OF SEMESTER				**32**	**27**

6-weeks' Industrial Training during summer vacation

West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Instrumentation & Control Engineering Syllabus upto 7th Semester
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SEVENTH SEMESTER

A. THEORY:

SL NO.	CODE	THEORY	CONTACT PERIODS PER WEEK			TOTAL	CREDITS
			L	T	P		
1	IC 701	Digital Signal Processing	3	0	0	3	3
2	HU 701	Financial Management & Accounts	3	0	0	3	3
3	IC 702	Logic and Distributed control system	3	0	0	3	3
4	IC 703	Elective I	3	0	0	3	3
5	EI 703	Elective II	3	0	0	3	3
		TOTAL THEORY	**15**	**0**	**0**	**15**	**15**

B.PRATICAL:

SL NO.	CODE	PRACTICAL	CONTACT PERIODS PER WEEK			TOTAL	CREDITS
			L	T	P		
1	IC 791	DSP Lab	0	0	3	3	2
2	IC 792	Logic and Distributed control system Lab	0	0	3	3	2
3	IC 794	Assigned Project	-	-	6	6	4
		TOTAL PRACTICAL	**0**	**0**	**12**	**12**	**8**

A. SESSIONAL:

1	IC 781	Practical Training Evaluation	-	-	-	-	3
2	IC 782	Seminar on Assigned/selected Topics	0	0	3	3	2
		TOTAL SESSIONAL				**3**	**5**

Total of Semester: **30** **28**

List of Elective Papers:

Elective I (IC 703)	Elective II (EI 703)
a) Biomedical Instrumentation b) Power Electronics c) Reliability and safety engineering	**a) Ultrasonic Instrumentation** b) Advanced Sensors d) Microelectronics & VLSI Technology

West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Instrumentation & Control Engineering Syllabus upto 7th Semester
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Instrumentation and Control Engineering

EIGHTH SEMESTER

Sl. No.	Code	Subject	Contact Periods per Week				Credits
			L	T	P	Total	
A. Theory							
1	HU 801	Values and Ethics in Profession	3	0	0	3	3
2	HU 802	Industrial Management	3	0	0	3	3
3	EI/IC 801	Elective III	3	0	0	3	3
4	M/EE/ EI/CS 801/802	Elective IV	3	0	0	3	3
		Total Theory	**12**	**0**	**0**	**12**	**12**
B. Practical							
1	IC 893	Assigned Project	-	-	12	12	8
		Total Practical	**-**	**-**	**12**	**12**	**8**
C. Sessional							
1	IC 881	Personality Development	-	-	3	3	2
2	IC 882	Comprehensive Viva Voce	-	-	-	-	4
		Total Sessional			**3**	**3**	**6**
		Total of Semester				**27**	**26**

List of Elective Papers:

Elective III		Elective IV	
EI 801(C)	Analytical Instrumentation	**M 801(A)**	Project Management and Operations Research
IC 801(A)	Opto-electronics and Laser-based Instrumentation	**EE 802(G)**	Non Conventional Energy Sources
IC 801(B)	Product Design and Development	**EI 802(C)**	Robotics
IC 801(C)	Power Plant Instrumentation and Control	**CS 802(G)**	Soft Computing – Theory and Applications

Data Structures and Algorithms
Code: CS 302
Contact: 3L + IT
Credit: 4

Overview of C language
Time and Space analysis of Algorithms - Order Notations.
Linear Data Structures - Sequential representations - Arrays and Lists, Stacks, Queues and Dequeues, strings, Application.
Linear Data Structures, Link Representation, Linear linked lists, Circularly linked lists. Doubly linked lists, application.
Recursion - Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.
Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Graphs - Representations, Breadth-first and Depth-first Search.
Hashing - Hashing Functions, collision Resolution Techniques.
Sorting and Searching Algorithms - Bubble sort, Selection Sort, Insertion Sort, Quick sort, Merge Sort, Heap sort and Radix Sort
File Structures - Sequential and Direct Access. Relative Files, Indexed Files - B+ tree as index. Multi-indexed Files, Inverted Files, Hashed Files.

***Text book* :**

1. Data Structures and Algorithms, O.G. Kakde and U.A. Deshpandey, ISTE/EXCEL BOOKS
2. Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley
3. Drozdek- Data Structures and Algorithms, Vikas
    1. Ajoy Agarwal.: Data Structures Through C, Cybertech.
    2. Lipschutz: Data Structures TMH

***References* :**

1.Heileman :Datastructure Algorithims &OOP
2. Data Structure Using C – M.Radhakrishnan, V.Srinivasan, ISTE/EXCEL BOOKS
2.Weiss Mark Allen, "Algorithms, Data Structures, and Problem Solving with C++", Addison Wesley.
3. Horowitz Ellis & Sartaj Sahni, "Fundamentals of Data Structures", Galgotria Pub.
4.. Tanenbaum A. S. , "Data Structures using 'C' "

Circuit Theory & Networks
Code: EE 301
Contact: 3L + IT
Credit: 4

Different types of systems & networks: continuous & Discrete, Fixed and Time varying, Linear and Non-linear, Lumped and distributed, Passive & Active Networks & Systems
Laplace transform of impulse and sinusoidal steps waveforms for RL, RC, LC and RLC Circuits. Transient analysis of different electrical circuits with and without initial conditions, Fourier Series and Fourier Transform
Network theorems and their applications in circuit analysis, Formulation of network equations, Source transformations, Loop variable analysis and node variable analysis
Graph of network, concept of tree branch, tree link. Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials
Two port networks, Open circuit Impedance and Short circuit Admittance parameters, Transmission parameters, hybrid parameters, and their inter-relations
Indefinite admittance matrix- their applications to the analysis of active network

Active filter analysis and synthesis using operational amplifier

SPICE: How SPICE works. Model statement, models for passive and active device, D.C. circuits analysis, small signal analysis, capacitors and inductors in D.C. Circuits, steady state and transient, plotting and printing, input and output Impedance, D.C. sensitivity analysis, harmonic decomposition (Fourier Series), Harmonic re-composition, voltage controlled components

Text books **:**

1. Sudhakar:Circuits & Networks:Analysis & Synthesis 2/e TMH New Delhi
2. Valkenburg M. E. Van, "Network Analysis", Prentice Hall.
3.Engineering circuit analysis with PSPICE and probe-Roger
4.Engg Circuit Analysis,: Hayt 6/e Tata Mcgraw-Hill
5.A. Chakravarty: Networks, Filters & Transmission Lines
6.D.Chattopadhyay and P.C.Rakshit: Electrical Circuits
7.A.V. Oppenheimer and A.S.Wilsky: Signals & Systems, PHI
8.R.V.Jalgaonkar.: Network Analysis & Synthasis.EPH.
9.Sivandam- Electric Circuits Analysis,Vikas

References **:**

1. Reza F. M. and Seely S., "Modern Network Analysis", Mc.Graw Hill Book Company
2.Roy Choudhury D., "Networks and Systems", New Age International Publishers.
1. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.

MATHEMATICS

Code: **M 302**
Contacts: **3L + 1T**
Credits: **4**

Fourier Series:

Introduction: Euler's formula; Problems on general Fourier Series; Conditions for Fourier Expansion; Fourier Expansions of Discontinuous Functions; Even and Odd functions; Change of interval; Half range series; Typical Waveforms (Square, Saw-toothed, Triangular, Half Wave rectifier, Full Wave rectifier); Parseval's Identity (statement only); Fourier Transform (FT) and its properties; Inverse Fourier Transform (statement only); Fourier transform of derivative (statement only); Convolution (statement only); Application of Fourier Transform in solving partial differential equations — Laplace's Equation (2D only), Heat Conduction Equation (1D only) and Wave Equation (1D only). ***12L***

Calculus of Complex Variable:

Functions; Limits and Continuity; Analytic Functions; Cauchy Riemann Conditions; Analytic Continuation; Complex Integration and Cauchy's Theorem; Cauchy's Integral Formula; Taylor's and Laurent Series; Zeros of an Analytic Function; Poles; Essential Singularities; Residue Theorem (statement only) and it's application to evaluation of integral; Introduction to Conformal Mapping; Simple problems. ***14L***

Probability and Statistics:

Mean, Median, Mode and Standard Deviation; Samples Space; Definition of Probability; Conditional Probability; General Multiplication Theorem; Independent Events; Bayes' Theorem; Random Variable; Discrete and Continuous Probability Distributions - Probability mass function; Probability density function; Distribution Function; Expectation; Variance; Probability Distribution—Binomial, Poisson and Normal. Correlation and Regression; Method of Least Squares; Linear Curve Fitting. ***10L***

Graph Theory:

Graphs; Digraphs; Isomorphism; Walk; Path; Circuit; Shortest Path: Dijkstra's Algorithm; Tree; Properties of Tree; Binary Tree; Fundamental Circuit; Minimal Spanning Tree: Kruskal's Algorithm; Prim's Algorithm. Cut Set; Fundamental Cut Set and Cut Vertices; Matrix Representation of Graphs (Adjacency and Incidence Matrices); Network; Flow Augmenting Path; Ford-Fulkerson Algorithm for Maximum Flow; Max Flow – Min Cut Theorem (statement only). ***12L***

48L

Total

Text Books:

1. Rathor, Choudhari,: Descrete Structure And Graph Theory.
2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics - Sultan Chand & Sons.
3. Lipschutz S: Theory and Problems of Probability (Schaum's Outline Series) - McGraw Hill Book. Co.
4. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series) - McGraw Hill Book Co.
5. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics - The World Press Pvt. Ltd.
6. Spiegel M R: Theory and Problems of Complex Variables (Schaum's Outline Series) - McGraw Hill Book Co.
7. Bronson R: Differential Equations (Schaum's Outline Series) - McGraw Hill Book Co.
8. Ross S L: Differential Equations - John Willey & Sons.
9. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
10. West D.B.: Introduction to Graph Theory - Prentice Hall
11. Deo N: Graph Theory with Applications to Engineering and Computer Science - Prentice Hall.
12. Grewal B S: Higher Engineering Mathematics (thirtyfifth edn) - Khanna Pub.
13. Kreyzig E: Advanced Engineering Mathematics - John Wiley and Sons.
14. Jana- Undergradute Mathematics
15. Lakshminarayan- Engineering Math 1.2.3
16. Gupta- Mathematical Physics (Vikas)
17. Singh- Modern Algebra
18. Rao B: Differential Equations with Applications & Programs, Universities Press
19. Murray: Introductory Courses in Differential Equations, Universities Press
20. Delampady, M: Probability & Statistics, Universities Press
21. Prasad: Partial Differential Equations, New Age International
22. Chowdhury: Elements of Complex Analysis, New Age International
23. Bhat: Modern Probability Theory, New Age International
24. Dutta: A Textbook of Engineering Mathematics Vol.1 & 2, New Age International
25. Sarveswarao: Engineering Mathematics, Universities Press
26. Dhami: Differential Calculus, New Age International

NUMERICAL METHODS AND PROGRAMMING

Code: **M(CS) 312**
Contacts: **3L**
Credits: 3

Computer Number Systems; Overflow and underflow;
Approximation in numerical computation; Truncation and round off errors; Propagation and control of round off errors; Chopping and rounding off errors; Pitfalls (hazards) in numerical computations (ill conditioned and well conditioned problems). ***2L***

Algorithmic Approach in C Language to all the Numerical Problems Discussed below must be followed:

Interpolation:
Lagrange's Interpolation, Newton's forward & backward Interpolation Formula. Extrapolation; Newton's Divided Difference Formula; Error; Problems. ***4L***

Numerical Differentiation:
Use of Newton's forward and backward interpolation formula only. ***1L***

Numerical Integration:
Trapezoidal formula (composite); Simson's 1/3rd formula (composite); Romberg Integration (statement only); Problems. ***2L***

Numerical Solution of System of Linear Equations:
Gauss elimination method; Matrix Inversion; Operations Count; LU Factorization Method (Crout's Method); Gauss-Jordan Method; Gauss-Seidel Method; Sufficient Condition of Convergence. ***6L***

Numerical Solution of Algebraic and Transcendental Equations:
Iteration Method: Bisection Method; Secant Method; Regula-Falsi Method; Newton-Raphson Method. ***4L***

Numerical solution of Initial Value Problems of First Order Ordinary Differential Equations:
Taylor's Series Method; Euler's Method; Runge-Kutta Method (4^{th} order); Modified Euler's Method and Adams-Moulton Method. ***6L***

C Language Overview:
Loop; Recursion; Function; Array; Pointers; Structures and Unions; Various types of File Access Methods: Sequential, Indexed Sequential, Random; Binary. ***11L***
Various types of Files in C and Various types of File Handling Statements in C

36L

Total

Implementation above Numerical & Statistical Problems in C Language;

Text Books:

1. Numerical Analysis & Algorithms, Pradeep Niyogi, TMH, 1^{st} ed.
2. C Language and Numerical Methods by C.Xavier
3. Introductory Numerical Analysis by Dutta & Jana
4. Numerical Method:Balagurusamy
5. Numerical Mathematical Analysis by J.B.Scarborough
6. Numerical Methods (Problems and Solution) by Jain, Iyengar , & Jain
7. Numerical Methods In Computer Applications – P.U.Wayse. EPH
8. Computer Oreinted Numerical Method- Dutta,N. ,Vikas
9. Numerical Methods with Programs in Basic Fortran Pascal & C++ - S.B.Rao, Universities Press
10. Computer Programming & Numerical Analysis – N.Dutta, Universities Press
11. Numerical Methods for Engineers – Gupta, New Age International
12. Numerical Solutions of Differential Equations – Jain M.K.,New Age International
13. Numerical Methods for Scientific & Engg Computation – Jain M.K.,New Age International
14. Numerical Analysis – Rao G.S.,New Age International

15. Discrete Mathematical Structures – Rao G.S., New Age International
16. Foundations of Discrete Mathematics – Joshi K.D., New Age International
17. Applied Discrete Structures – Joshi, New Age International
18. Groups, Rings & Modules with Applications – Adhikari, M.R.,Universities Press

MATERIAL SCIENCE
Code : MS 301
Contacts : 3L
Credits :3

Introduction : Classification of materials; Structure-property Relations; Metals & Alloys, Ceramics, Polymers, Composites and Semiconductors. Atomic Structure & Interatomic Bonding ; Fundamentals of Atomic Structure and Chemical Bonding; Atomic Bonding in Solids.

Phase Diagrams : Phase Rules; Single component and Binary Phase diagrams; The Level Rule; Hume-Rothery rules of alloying.

Diffusion in solids : Fick's Laws of Diffusion; The Atomic Model of Diffusion

Phase Transformations: Nucleation and Growth , Recovery, Re crystallization and Grain Growth.

Environmental Degradation of materials : Oxidation and Corrosion; Thermal and Photo Degradation ; Chemical Degradation ; Radiation Damage.

Structure of solids : Crystalline and Non-crystalline states; Crystallographic directions and phases; Determination of crystal structures.

Defects and imperfections in solids : Point, Line and Planer defects; Interfacial defects and volume defects; impurities in solids.

Elastic, Plastic and Viscoelastic Behaviour of materials: Stress-strain relationship; relaxation and creep; strengthening mechanism and fracture.

Thermal properties of materials : Heat capacity; Thermal expansion and thermal conductivity.

Electrical properties : Electronic and Ionic conduction; Energy Band structures in solids ; Electron Mobility ; Temperature variation of conductivity.

Dielectric behaviour : Capacitance ; Types of polarization ; Frequency dependence of dielectric constant; Ferroelectricity and Piezoelectricity in materials.

Magnetic properties : Diamagnetic; Ferromagnetic, antiferromagnetic and Ferrimagnetic behaviour of materials; soft and hard magnetic materials; superconductivity.

Optimal properties : Light interaction with solids; Absorption, Transmission and Reflection; Luminescence; Photoconductivity ; Lasers.

Materials selection: Material properties and Engineering Design parameters; General effects of processing on parameters; selection of structural; Electronic and Magnetic Materials – case studies.

Text Books:

1. L.H. Van Vlack - Elements of Materials Science & Engineering – Addison-Wesley Publishing Company, New York.

2. V Raghavan – Materials Science & Engineering. – Prentice Hall of India Pvt. Ltd., New Delhi.

3. Murthy & Jena: Structure and properties of Engineering Materials ,TMH New Delhi

4. W D Callister, Jr. – Materials Science & Engineering – An Introduction – John Willey & Sons, Inc, New York.

5. J F Shackelford – Introduction to Materials Science for Engineers – Maxwell Macmilan International Editions, Singapore.

6. C M Srivastava & C Srinivasan – Science of Engineering materials – New Age International (P) Ltd. Publishers, New Delhi.

Reference Books:

1. J W Mayer and S S Lau – Electronic Materials Science - Maxwell Macmilan International Editions, Singapore

2. R E Hummel – Electronic Properties of Materials – Narosa Publishing House, New Delhi.

IC – 301: MEASUREMENT FUNDAMENTALS

OBJECTIVE:

Exposing the students to the art and science of measurement with a view to impress:

- *Knowledge of the physical world depends on observation and measurement adds quantitative meaning to our knowledge.*
- *Observation, monitoring, control, analysis and sympathy towards the instruments form the basis of measurement.*
- *The method of measurement is a comparison.*
- *The aids of measurement are standard.*
- *Measurement is complete only when accompanied by a quantitative statement of its uncertainty.*

NOTE

Students are required to answer six questions out of nine set as follows:

1. There shall be one objective compulsory question comprising ten parts spread evenly over the syllabus and each carrying two marks.
2. There shall be at least one question form each module of the syllabus out of the remaining eight.

PREREQUISITE: None

MODULE – I:

Introduction to measurements. Physical measurement. Forms and methods of measurements. Fundamental SI Units. Derived Units. Definition of standards. International standards. Primary standards. Secondary standards. Working standards. Current standard. Voltage standard. Resistance standard. Capacitance

standard. Time and frequency standards. Introduction to Transducers – Classification and Selection Criteria.

(09 lectures)

MODULE – II:
Measurement Errors. Human Error. Systematic Error. Limiting and Random Errors. Statistical analysis of measurement data. Probability of Errors. Error estimates from the Normal Distribution. Curve Fitting – Method of Least Squares. Chi-Square test. Notion of Signal conditioning.

(07 lectures)

MODULE – III:
Static characteristics of measurement system – Range, Span, Linearity, Non-linearity, Sensitivity, Dependence on environmental effects, Hysteresis, Resolution, Wear and ageing, Accuracy, Precision, Repeatability, Reproducibility, Tolerance, Bias, Threshold and Loading Effect.

Dynamic characteristics of measurement system: Step-response – rise time. Frequency response – bandwidth. Time lag (dead-time) ***(09 lectures)***

MODULE – IV:
Testing and calibration: Traceability. Measurement reliability. Calibration experiment and evaluation of results. Primary calibration. Secondary calibration. Direct calibration. Indirect calibration. Routine calibration. Calibration of a voltmeter, ammeter and an oscilloscope.

(07 lectures)

MODULE – V:
Product standards: Reasons for product standards. Standards setting Organizations. Bureau of Indian Standards. Example of a product standard. Conformance testing of products. Process quality standard: ISO 9000 family of standards. Relationship between product standard and process quality standard. *(05 lectures)*

TEXT BOOKS

1. A K Ghosh: Introduction to Instrumentation and Control, Prentice Hall of India, New Delhi 2004.
2. A K Sawhney: A course on electrical and electronic measurements and instrumentation, Dhanpat Raj & Co, 2005
3. D Patranabis: Principle of Industrial Instrumentation, Tata McGraw-Hill, New Delhi 2004
4. John P.Bentley: Principles of measurement systems, 3rd edition, Addison Wesley Longman, 2000.
5. David A Bell: Electronic Instrumentation and measurement, Prentice Hall of India

6. M.M.S.Anand: Electronic instruments and instrumentation Technology, Prentice-Hall of India, 2004.

REFERENCES

1. Alan S.Morris: Principles of measurement and instrumentation, 2nd edition, Prentice-Hall of India,2004.
2. Ernest O. Doebelin: Measurement systems, 4th edition, Tata-McGraw Hill, 1990.
3. Measurement Fundamentals, National Instruments, www.ni.com

WEB RESOURCES:
www.bis.org.in
www.iso.org
www.ul.com
www.nist.gov
www.npl.co.uk

IC- 391: MEASUREMENT FUNDAMENTALS (PRACTICAL)
CONTACT:3P
CREDIT : 3L

OBJECTIVE: Confirmation of Engineering Concepts

In the classroom, the teachers present physical concept, theories and formulas without much emphasis on the validity of such material in the laboratory environment. On the contrary, in the laboratory students assume the validity of the concept introduced in the classroom and proceed with experimentation to produce results in order to audit the validity of these concepts.

PREREQUISITE: IC – 301

Hands-on Experience

Connect two resistances 100 KΩ and 50 KΩ in series driven by a dc voltage source. Measure the voltages across these resistances using a multi-range voltmeter and an oscilloscope. Repeat the experiment with an ac source. *[Note that in the dc measuring setup the supply and the measuring equipment are floating. Whereas in the ac measuring situation one of the terminals of the supply and the oscilloscope has internal connection with the outside world.]*

- Troubleshoot simple measurement systems.
- Apply judgement when faced with indeterminate problems.
- Acknowledge disparity between theory and experimental results in terms of the scientific method.

Measurement Basics

Draw the load voltage versus load current characteristic when the load is driven by a voltage source with an appreciable internal resistance. Perform experiment in order to determine the value of the source voltage and the source resistance using the graphical technique. Use both analog and digital measuring instruments.

- Understand the purposes of measurements: comparison with models, performance measurements, and physical constant determination.
- Choose and apply appropriate measurement techniques based on linearity

- Compute uncertainty, and understand the concept of error.
- Apply standards for calibration, if necessary.
- Comment on the range and linearity for a large number of readings.

Repeatability and Accuracy

Connect a voltage source in series with a switch, a 100KΩ resistance and a 1000μF capacitor. Close the switch and plot the voltage using an appropriate voltmeter across the capacitance against time recorded by a stopwatch. Take large number of readings.

- Comment on the repeatability, precision and accuracy.
- Analyze the cause of possible errors

Loading Effect

A 20V dc source is connected in series with two resistances one having 150KΩ value and a variable R. With an analog voltmeter having sensitivity, say 1.0KΩ/V, set on, say 50V range, measure the voltage across R varying from a low to high value. Repeat the experiment with a voltmeter of sensitivity, say 10KΩ/V set on 20V range (say).

- Compare the measured voltages with the theoretical values.
- Comment on and interpret results.
- Estimate errors due to loading effect.

Sensitivity

Measure an unknown resistance using a dc Wheatstone bridge set on voltage sensitive mode. Use a voltmeter of sensitivity 1.0 KΩ/V (say) as a measuring instrument. Repeat the experiment with a voltmeter having a sensitivity of 20.0 KΩ/V (say).

- Select three resistors from decade resistance box.
- Measure and record their values, using DMM.
- Connect the unknown resistance and determine its value, using the two voltmeters.
- Comment on the use of two voltmeters.
- Select four 1.0 KΩ resistors (Check the color code)
- Measure and record their values, using DMM.
- Check the voltage across the balancing points using the two voltmeters.
- Comment on the observed voltages measured by the two voltmeters.
- Change the resistances of the ratio arms and exhibit in a tabular form.
- Explain the possibility of using an oscilloscope as a null detector.

Modeling, Curve Fitting and Uncertainty Analysis

A mercury-in-glass thermometer ($0 – 110^0$ C) is dipped in a temperature-controlled water-bath maintained at 100^0C (boiling water). Measure the temperature with a stopwatch. Repeat the observations at time t= 4.0s, 8.0s, 12.0s, 16.0s, 20.0s, 24.0s

- Evaluate the time constant of the thermometer by drawing smooth curve through scattered observed points (regression).
- Develop a model of the experiment and use MATLAB SIMULINK to compare the outcome of the experiment.
- Comment on the uncertainty for the single measurement and the repeated measurements.
- Compute and apply basic statistics concepts for the analysis of data.

Calibration [using standards]

- Calibrate an ammeter and evaluate the result.
- Calibrate a voltmeter and evaluate the result.
- Calibrate an oscilloscope and evaluate the result.

Product standard

- Conformance test a simple ISI marked product.
- Implementing specifications of a simple process according to ISO standa

NUMERICAL METHODS & PROGRAMMING LAB (PRACTICAL)
(CORRESPONDING TO M(CS) 312)

Code: **M(CS) 382**
Contact: **3P**
Credit: 2

1. Assignments on Interpolation: Newton forward & backward, Lagrange.
2. Assignments on Numerical Integration: Trapezoidal Rule, Simson's 1/3rd Rule, Weddle's Rule.
3. Assignments on Numerical solution of a system of Linear Equations: Gauss elimination, Gauss Jordan, Matrix Inversion, Gauss Seidel.
4. Assignments on Solution of Algebraic Equations: Bisection, Secant, Regula-Falsi, Newton-Raphson Methods.
5. Assignments on Ordinary Differential Equations: Taylor Series, Euler's Method, Runge-Kutta (4^{th} Order).
6. Assignments on Statistical Problems: Mean, Median, Mode, Standard deviation (for simple & frequency type data), Linear Correlation & Regression.

CIRCUITS & NETWORK LAB

Code: EE 391
Contact: 3P
Credit: 2

List of Experiments:

1. Transient response in R-L and R-C Network: Simulation/hardware
2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware
3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
4. Frequency response of LP and HP filters
5. Frequency response of BP and BR filters
6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form
7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB
8. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB
9. Determination of Laplace transform and inverse Laplace transformation using MATLAB
10. Spectrum analysis of different signals

Note: An Institution/College may opt for some other software or hardware simulation wherever possible in place of MATLAB

DATA STRUCTURE LAB
Code: CS 392
Contact: 3P
Credit: 2

Experiments should include but not limited to :
Implementation of array operations
Stacks and Queues : adding, deleting elements Circular Queue : Adding & deleting elements Merging Problem : Evaluation of expressions operations on Multiple stacks & queues :
Implementation of linked lists: inserting, deleting, inverting a linked list. Implementation of stacks & queues using linked lists:
Polynomial addition, Polynomial multiplication
Sparse Matrices: Multiplication, addition.
Recursive and Non-recursive traversal of Trees
Threaded binary tree traversal. AVL tree implementation.
Application of Trees, Application of sorting and searching algorithms
Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.

Laboratory Report Writing

It is extremely important that a student should learn to communicate ideas, concepts, and results clearly and accurately to other individuals. The results of the experiment loose significance if not meaningfully developed, appropriately formatted and reported in a professional manner.

Cover Page
- Laboratory Report
- Name of the experiment and Subject Code.
- Submitted by
- Student's name, year and roll number.

Abstract
- What is the report about?
- What was the objective of the experiment?
- Briefly describe the results.
- Give major conclusions of the experiment.

INTRODUCTION
- What is the objective for performing the experiment?
- What is the motivation behind the experiment?
- What are the principles or concepts of the experiment?
- What results do you expect and why?

EXPERIMENT SETUP
- What was measured?
- What were the measurement instruments?
- What were the physical parameters (i.e. dimensions) of the system?
- What observations were made while performing the experiment?
- What are the sources of error for the experiment?
- What were the results of the uncertainty analysis?

RESULTS AND DISCUSSION
- What were the results?
- How do your results compare with what you expected?

- How do you explain the trends seen in your data?
- Do the results support the underlying concepts of the experiment?

Concluding Remarks

West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Syllabus of Instrumentation & Control Engineering
IC-401: Basic Control Theory

Preamble

Instrumentation design combines knowledge from physics and chemistry with signal processing techniques. For example, CAT-Scans combine X-ray imaging (from physics) with image reconstruction algorithms (from signal processing) to produce three-dimensional images of the body. Accurate instrumentation is vital to control. Control performance is limited by the precision of measurement. An Instrumentation and Control Engineer needs to have various skills at his command - knowledge of control system engineering, instrumentation engineering, electronics and pneumatic systems, a working understanding of process applications and, increasingly today, an understanding of computers and digital communications.

OBJECTIVES

Control engineering is about controlling systems. This course introduces the basic concepts of control system, design and analysis.

NOTE

a. **Nine questions are to be set, out of which six are to be answered.**
b. **Question No. 1 shall be compulsory and objective type with ten parts distributed evenly over the entire syllabus each having two marks.**
c. **Remaining eight questions each of ten marks will be set taking at least one from each module.**

Module I: **Basic definition; basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, automatic controlled closed loop systems, basic elements of a servo mechanism, electrical analogue of mechanical, thermal, hydraulic and pneumatic systems, block diagram representation of physical systems, derivation of transfer functions of physical systems, signal flow graphs, basic control action; block diagram reduction technique, signal flow graph, Mason's gain formula, conversion of block diagram to signal flow graph.** ***(10 hours)***

Module II: **Standard test signals, Time response analysis, impulse response function, Analysis of first, and second systems, stability of control system, Routh-Hurwitz's stability criterion, static and dynamic errors coefficients, and errors criteria.** ***(8 hours)***

Module III: **Introduction of Root Locus method; Rules for constructing root loci, stability analysis of systems using Root locus, determination of roots of the closed loop system, transient response and stability from root locus inverse root locus, concept of dominant, effects of parameter variations on closed loop poles, closed loop pole pair, Root-contour plots, effect of zeros & poles.** ***(8 hours)***

Module IV: **Introduction of Frequency Response, Bode plots, stability margins on the Bode plot, stability analysis of systems using Bode plots, polar plots, Nyquist stability criterion, relative stability.** ***(6 hours)***

Module V: **State Space Representation of systems, conversion of state variable models to transfer functions.** ***(3 hours)***

Module VI: **Compensators: Introduction, different types of compensators, design of lag, lead, lag-lead compensators using root locus and Bode diagrams; design of P, I and PID controllers by analytical method, frequency response method and root locus technique.** ***(5 hours)***

Module VII: Introduction to the use of computers in control. ***(2 hours)***

HISTORICAL NOTE

Feedback control is the basic mechanism by which systems, whether mechanical, electrical, or biological, maintain their equilibrium or homeostasis. In the higher life forms, the conditions under which life can continue are quite narrow. A change in body temperature of half a degree is generally a sign of illness. In 1948 N Wiener showed that the homeostasis of the body is maintained through the use of feedback control. A primary contribution of C.R. Darwin during the nineteenth century was the theory that feedback over long time periods is responsible for the evolution of species. In 1931 V. Volterra explained the balance between two populations of fish in a closed pond using the theory of feedback. In 1934, Házen coined the word **servomechanisms***, which implies a master/slave relationship in systems*

BOOK

1 K. Ogata: Modern Control Engineering. (PHI)
2 I.J. Nagrath & M.Gopal: Control System Engineering. (Wiley Eastern)
3 M. Gopal: Digital Control Systems Principles & Design (TMH)

INDUSTRIAL INSTRUMENTATION – I

IC – 501

MODULE	OBJECT	NO OF CLASSES
I	Introduction to Industrial Instrumentation: Temperature and heating, definitions, temperature scales, bimetallic thermometers, filled-bull and glass stem thermometers. Thermocouples: Thermoelectric effects, law of thermocouple, cold junction compensation techniques, thermocouple types, construction, installation and protection, measuring circuits thermocouple burnout detection and high temperature measurement methods.	**10**
II	Temperature Measurement: Resistance Temperature Detector (RTD), principle, and types, construction requirements for industry, measuring circuits. **Thermistors:** Principle and sensor types, manufacturing techniques, measuring circuits linearization methods and applications. Pneumatic and suction pyrometers, Integrated circuit sensor, diode type sensors, Ultrasonic thermometers, Johnson noise thermometer, fluidic sensors, Spectroscopic temperature measurement, thermograph, temperature switches and thermostats.	**9**

III	Radiation measurement: Radiation thermometers, introduction, definition of terms, general form of radiation measurement system , radiation thermometer types , photo electric radiation thermometers, signal conditioning for radiation thermometers , remote reading thermometers. Temperature sensor selection and application, sensor calibrators and simulators.	**7**
IV	**Pressure measurement basics, mechanical type instruments, electro mechanical type, low-pressure measurement, related accessories, pressure measuring standards, selection and application.** Transmitter definition, classification, pneumatic transmitter – force balance type, torque balance type , two wire and four wire transmitter , I/P and P/I converter.	**8**
V	**Measurement of viscosity: definition, units, Newtonian and Non-Newtonian behavior, Measurement of viscosity using laboratory viscometer, industrial viscometers, viscometer selection and application.** Measurement of density – definitions, units, liquid density measurement, gas densitometers – application and selection.	**6**

TEXT BOOKS :-

1. Doeblin E. O., Measurementt Systems : Application and Design, 4th edition McGraw Hill , NewYork, 1992.
2. Patranabis D, Principle of Industrial Instrumentation, 2nd edition Tata McGraw Hill , NewDelhi, 1997.

References:-

1. Noltingk B.E., Instrumentation Reference Book, 2nd edition , Butterworth Heinmann , Oxford, 1996.
2. Liptak B.G., Process Measurement and Analysis, 3rd edition , Chilton Book Company, Radnor, Pennsylvania, 1995.
3. Douglas M. Considine , Process/Industrial Instruments and Control Handbook, 4th edition, McGraw Hill , Singapore, 1993.
4. Kerlin T.W., Practical Thermocouple Thermometry, ISA Press, New York,1999.
5. Gillum D., Industrial Pressure, Level and Density Measurement, ISA Press, New York, 1995
6. Smith.E., Principles of Industrial Measurement and Control Applications, ISA Press, New York, 1984.

OBJECT ORIENTED PROGRAMMING AND DESIGN
IC-502

MODULE-I

Introduction to C++. Tokens, expressions and control structures in C++. Functions in **C++**

MODULE -II

Classes and objects in C++. Constructors and destructors. Operator overloading and type conversions.

MODULE -III

Inheritance in C++, pointers, virtual functions and polymorphism, templates and exception handling. Managing console input output operations with C++. Working with files using C++.

MODULE -IV

Software complexity; designing complex system; Elements of the objects model; Applying the object model; Nature of an object; Relationship among objects; Nature of a class; Relationship among classes; Interplay of classes and objects; Identifying classes and objects; Key abstraction and mechanism.

MODULE -V

Elements of the notation; Class diagrams; state transition diagrams; process diagrams; module diagrams. Applying the notation. Applications: Data acquisition; Inventory tracking, command and control.

TUTORIALS:

These tutorials are to be conducted in a computer centre with any availabe C++ compile to give the students a hands on pragramming experience of C++ language.

Creating objects

Using member functions, Using constructors and destructors, Designing and Implementing classes, Overloading operators, Using different forms of inheritence, Using pointer, Templates and Exception handling, Console I/O operations, File operations

TEXT BOOKS:

1. Grady Boock, Object Oriented Analysis and Design with Applicaions, Second Edition, Adison Wesley Longman Inc, USA, 1994.
2. Robert Lafore, The Waite Group's Object - Oriented Programming in Turbo C++, Galgotia Publications, New Delhi, 1999.

REFERENCES:

1. Stanley B Lippman C++ Primer, Second Edition, Addison Wesley 1995.
2. Bjarne Stroustrup, The C++ Programming Language, Addison Wesley 1991.

MICROPROCESSOR AND MICROCONTROLLER

IC – 503

Introduction to 8085A CPU architecture-register organization, addressing modes and their features. Software instruction set and Assembly Language Programming. Pin description and features.

Instruction cycle, machine cycle, Timing diagram.

Hardware Interfacing: Interfacing memory, peripheral chips (IO mapped IO & Memory mapped IO).

Interrupts and DMA.

Peripherals: 8255, 8251, 8253, 8237, 8259, A/D and D/A converters and interfacing of the same.

Microcontroller system software and hardware design, development and trouble shooting tools.

Typical applications of a microprocessor.

16 bit processors: 8086 and architecture, segmented memory has cycles, read/write cycle in min/max mode. Reset operation, wait state, Halt state, Hold state, Lock operation, interrupt processing. Addressing modes and their features. Software instruction set (including specific instructions like string instructions, repeat, segment override, lock prefizers and their use) and Assembly Language programming with the same.

Brief overview of some other microprocessors (eg. 6800 Microprocessor).

References:

1. Microprocessor architecture, programming and applications with 8085/8085A, Wiley eastern Ltd, 1989 by Ramesh S. Gaonkar.
2. Intel Corp: The 8085 / 8085A. Microprocessor Book – Intel marketing communication, Wiley inter science publications, 1980.
3. An introduction to micro computers Vol. 2 – some real Microprocessor – Galgotia Book Source, New Delhi by Adam Osborne and J. Kane
4. Advanced Microprocessors by Ray and Bhurchandi - TMH
5. Intel Corp. Micro Controller Handbook – Intel Publications, 1994.
6. Microprocessors and Interfacing by Douglas V. Hall, McGraw Hill International Ed. 1992
7. Assembly Language Programming the IBM PC by Alan R. Miller, Subex Inc, 1987
8. The Intel Microprocessors: 8086/8088, 80186, 80286, 80386 & 80486, Bary B. Brey, Prentice Hall, India 1996.

ADVANCED CONTROL SYSTEMS
IC – 504

MODULE	OBJECT	NO OF CLASSES
I	**Systems in State Space** Introduction of state space, Modeling of dynamic systems, State-Space Representation in Canonical forms : Diagonal, Controllable, Observable, & Jordan Diagonal canonical form. Linear transformations : i) State space to transfer function ii) Transfer function to state space Solution of state equation in Laplace transform approach : i) Homogeneous state equations, ii) Non-homogeneous state equations. State transition matrix, Properties of state transition matrix, Computation of state transition matrix an analysis of continuous time invariant systems. State space representation of discrete-time : State space representation of time-invariant difference equations, Discretization of Continuous-Time State-Space Equation, Z-Transform Approach to Solution of Discrete-Time State Equations.	**12**
II	**Definitions :** Controllability, Observability, Stabilizability & Detectability. Principle of duality, Design of control systems in state space : Design via pole placement method, Determination of matrix K using : i) Transformation matrix T, ii) Direct substitution method, and iii) Ackermann,s formula. Design of observers : Full and reduced order observers.	**6**

III	**Non-linear systems Analysis** Introduction to non-linear systems, Behaviour of non-linear systems, Different methods of linearization, Phase plane analysis : Phase plane analysis of linear and non-linear control systems. Singular points, Classification of singular points, Constructing phase portraits, Limit cycle: existence of limit cycles.	**10**
IV	**Describing Function Analysis** Describing function fundamental, Basic assumptions and basic definitions, Common Physical non-linearities, Describing function of common non-linearities, Describing function analysis of non-linear system, Stability of limit cycles, Reliability of describing function analysis.	**8**
V	**Liapunov Stability Analysis** Definitions : Systems, Equilibrium state, Equilibrium points. Stability definitions : Asymptotic stability, Asymptotic stability in the large, Instability. Scalar functions, i) Positive definiteness of scalar functions ii) Negative definiteness of scalar functions iii) Positive semidefiniteness of scalar functions iv) Negatives semidefiniteness of scalar functions v) Indefiniteness of scalar functions Quadratic Forms, Direct method or Second Method of Liapunov, Liapunov's stability analysis of linear system, Liapunov's methods in feedback design.	**6**

TEXT BOOKS :-

1. Brogan W. L. , Modern Control System, 3rd edition, Prentical Hill Inc. New Jersey 1990.
2. Shinners S. M. Modern Control Theory and Design, 2nd edition, John Wiley, Singapore,1998.
3. Raymand A. DeCarlo, Linear System, A state variable approach with numerical implementation, Prentical Hill Inc. New Jersey 1987.

References:-

1. Skelton R. E. Dynamic System Control and Linear System Analysis and Synthesis. John Wiley,1993.
2. Kuo B. C. , Automatic Control System, 7th edition, Prentical Hill, New Delha1995.
3. C. T. Chen Linear System Theory and Design, 3rd edition, Oxfod University Press, U.K. 1998.

DATA COMMUNICATION AND TELEMETRY
IC – 505

*Course aim : The course introduces basic concepts used in the communication engineering for transferring information and lays foundation for a higher level course in computer networking***.**

Module : I

Linear Modulation: Introduction , Amplitude Modulation (AM) , modulators and demodulators, power in AM wave , spectrum of AM wave , DSB/SC, SSB and VSB signals, their spectra and circuitry for generation and demodulation. Phase modulation.

Module : II

Pulse analog modulation: Practical aspects of sampling, reconstruction of a message process from its samples , Time Division Multiplexing (TDM), comparison of TDM and FDM , Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), circuitry for generation and recovery. Pulse digital modulation: Pulse Code Modulation (PCM), noise PCM system, Differential Pulse Code Modulation (DPCM), Delta Modulation (DM), Digital multiplexers, T1 System.

Module : III

Telemetry : Fundamentals of telemetry, signal conditioning, FDM / FM telemetry, PAM , PWM telemetry systems. Multiplexing , decommutation , PCM telemetry systems. Signal generations , bit word and frame synchronization . Power line carrier communication. Spread spectrum techniques.

Module-IV

Introduction to data communication: Data transfer modes, parallel I/O and serial I/O,asynchronous and synchronous data transfer schemes, using USART for data transfer,interface standards for serialI/O and parallel I/O,protocols for synchronous communication ,BISYNC and HDLC,stop and wait, go back N and selective repeat request protocols.

Module –V

Data communication through telephone network, the basic telephone, telephone office function, Telephone line Echoes. Digital Private Automatic Branch Exchanges (PABX),modems, modem functions,interface between modem and USART, synchronous and statistical multiplexers.

TEXT:

1.Bruce Carlson A,Communication Systems,Third edition,McGraw Hill,New York 1987.
2.Viswanathan T, Telecommunication and Switching systems and Networks, Prentice Hall, New Delhi, 1992
3.D.Patranabis, Telemetry Principles, Tata McGraw Hill, New Delhi, 1999.

References:

4. Taub & Schilling, Principles of Communication Systems, Tata Mcgraw Hill, New Delhi, 1991.
5. Dauglas Hall V, Microprocessors and Interfacing, Fourth edition, Tata McGraw Hill, 1990
6. Swoboda G, Telecontrol Methods and Applications of Telemetry and Remote Control, Reinhold Publishing Corp., London, 1991.

Industrial Instrumentation-I Laboratory
IC – 591

Experimentation on:

1. Calibration of pressure gauge by Dead weight Tester
2. Measurement of temperature by using Thermocouple.
3. Study of RTD characteristics and use in temperature sensitive bridge.
4. Measurement of temperature by using Thirmistor.

5. Measurement of viscosity.

COMPUTER SOFTWARE LABORATORY
IC – 592

1. Structures
2. Classes and Objects
   3. Function Overloading.
   4. Operator Overloading.
   5. Pointers.
   6. Inheritance.
7. Virtual Functions
8. Input-Output File handling.

Microprocessor and Micro-controller Lab

IC – 593

Sl. No.	Name of the Experiments	NO. OF HOURS
1.	Familiarization with 8085 register level architecture and trainer kit components, including the memory map. Familiarization with the process of storing and viewing the contents of memory as well as registers.	**3**
2.	a) Study of prewritten programs on trainer kit using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical) b) Assignments based on above.	**3**
3.	a) Familiarization with 8085 simulator on PC. c) Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the simulator. b) Assignments based on above	**3**
4.	**Programming using kit/simulator for** i) table look up ii) Copying a block of memory iii) Shifting a block of memory iv) Packing and unpacking of BCD numbers v) Addition of BCD numbers vi) Binary to ASCII conversion vii) String Matching viii) Multiplication using Booth's Algorithm	**9**
5.	**Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit eg, subroutine for delay, reading switch state & glowing LEDs accordingly, finding out the frequency of a pulse train etc**	**3**
6.	**Interfacing any 8-bit Latch (eg, 74LS373) with trainer kit as a peripheral mapped output port with absolute address decoding**	**3**
7.	**Interfacing with I/O modules:** a) ADC b) Speed control of mini DC motor using DAC	**12**

c) Keyboard
d) Multi-digit Display with multiplexing
e) Stepper motor

8.	**Writing programs for 'Wait Loop (busy waiting)' and ISR for vectored interrupts (eg, counting number of pulses within specified time period)**	**3**
9.	**Study of 8051 Micro controller kit and writing programs for the following tasks using the kit**	**6**

a) Table look up
b) Basic arithmetic and logical operations
c) Interfacing of Keyboard and stepper motor

10.	**Familiarization with EPROM programming and Erasing**	**3**

ADVANCED CONTROL SYSTEMS LABORATORY

IC- 594

1. Microprocessor based servo system.
2. Voltage regulator system. (Open loop & closed loop).
3. Speed Control system (Open loop & closed loop).
4. Frequency response characteristics of a second order system.
5. Time response characteristics of a second order system.
6. Determination of phase margin and gain margin.
7. Constant gain compensation in time and frequency domain.
8. a) Lead compensator b) Lag compensator
9. Gifford's bridge.
10. Design of state feedback.
11. Observer design.
12. Study of PD, PI, PID controller.

PROCESS CONTROL
IC – 601

Terms and objectives of process control, Classification of variables, Process characteristics; Process lag, load disturbance and its effects - Self regulating, interacting and non-interacting process. Controller modes. Continuous controller modes and composite controller modes, Electronics Controllers.

Process loop tuning; Closed loop response of I & II order systems.

Final control elements.

Cascade control, Ratio control, feed forward control, dead time compensation. Interaction of control loops.

Case studies.

Text Books:

1. Stephanopoulos, "*Chemical Process Control: An introduction to Theory and Practice*", Prentice Hall, New Delhi, 1999.
2. Coughanowr, "*Process Systems Analysis and Control*", 2nd Edition, McGraw Hill, Singapore, 1991.
3. Peter Harriott, "*Process Control*", Tata McGraw Hill, New Delhi, 1985.

Reference Books:

1. Smith C.L and Corripio.A..B, "*Principles and Practice of Automatic Process Control*", 2nd Edition, John Wiley and Sons, New York, 1985.
2. Shinskey, "*Process Control Systems*", 4th Edition, McGraw Hill, Singapore, 1996.

3. Paul W.Murril, "*Fundamentals of Process Control Theory*", 3rd Edition, ISA press, New York, 2000.

MICROPROCESSOR BASED SYSTEM
EI 602

INTRODUCTION
Block Diagram of a typical microprocessor based system pointing out the role of microprocessor and other peripheral blocks.

MICROPROCESSOR
Review: Intel 8086/8088 Microprocessor: Architecture, Clock Generator, Resetting the microprocessor, Wait State Inserting, Bus Buffering, Interrupts, and Assembly Language Programming.

ADDING MEMORY
Classification, Memory Timing, Interfacing requirements, Interfacing Slow Memory, Interfacing Static RAM (6116 – 2K, 6264 – 8K), Interfacing EPROM (2764 – 8K, 27256 – 32K), Address decoding (using logic gates and decoders, using PAL), Designing Memory Modules (higher capacity say 512K) using memory chips (say 8K), Interfacing Memory Modules to the microprocessor, Interfacing Dynamic RAM, Non Volatile Memories

ADDING INPUT/ OUTPUT DEVICES
Designing an 8-bit input port, Designing an 8-bit output port, I/O space, Address decoding for Memory mapped I/O and I/O mapped I/O
Review: I/O Controllers – 8255A, 8250/1, 8279, 8253/4, 8259A, 8237A
Interfacing of Digital I/O Devices: Handshaking Logic, Programmed I/O, Interrupt driven I/O, Direct memory access, High Power Device Interfacing – Wave shaping, Driving and level shifting, Isolation
Examples: Interfacing and assembly language monitor program for Key Board (one dimensional, two dimensional) through 8255A and 8279, Centronics-type Parallel Printer through 8255A, Display (7-segment, dot-matrix, alphanumeric) through 8255A and 8279, Data Transfer between two microprocessor based systems through 8255As, Mechanical and solid state Relays, Stepper Motor etc.
Analog Interfacing and Industrial Control: Review of Operational amplifier characteristics and circuits, Sensors and transducers (light sensors, temperature sensors, Force and pressure transducers, etc.), signal conditioning – multiplexing, linearization and scaling, 4-20 mA current loop
Examples: Interfacing and assembly language monitor program for D/A Converter (MC1408 8-bit D/A, DAC 1208 12-bit D/A etc.), A/D Converter (ADC0808 8-bit ADC, ICL7109 12-bit ADC etc.)

ADDING TOGETHER
Designing microprocessor based systems with monitor programs for single/ multipoint Temperature Monitoring, Data Logger, PID Controller, etc.

EMBEDED CONTROLLER
Intel 8051 embedded controller – Architecture and Assembly language programming, system design using 8051

COMMUNICATING WITH OTHERS
Asynchronous serial data communication, Serial Data transmission methods and standards, RS-232C Serial Data Standard (Rs-232C to TTL interfacing, RS-232C signal definitions, Connection), Modems

References:

1. Douglas V. Hall – Microprocessors & Interfacing, Tata McGraw-Hill
2. Mohamed Rafiquzzaman – Microprocessors and Microcomputer based system Design, PHI
3. Muhammad Ali Mazidi – The 8051 Microcontroller and embedded systems, Pearson Ed. Asia
4. Ray & Bhurchandi, Advanced Microprocessors & Peripherals, TMH
5. Predko, Programming & Customising 8051 Microcontroller, TMH

6. John Uffenbeck – Microcomputers and Microprocessors, PHI/ Pearson Education
7. Chowdhury & Chowdhury, Microprocessor & Perpherals, Scitech
8. Thyagarajan, Microprocessor & Microcontrollers, Scitech
9. Michel Slater – Microprocessor Based Design, PHI
10. Walter A. Tribel – The 8088 and 8086 Microprocessors, PHI
11. Barry B. Brey – The Intel Microprocessors, PHI/Pearson Ed. Asia
12. Mathivanan, Microprocessors PC Hardware & Interfacing, PHI

Computer Network & Internetworking

CS 611

Introduction to computer networks: What it is; advantage of; structure of communication network; point-to-point, circuit switched, packet switched; network topologies; network protocols; OSI reference model, example networks; physical layer and data transmission – analog and digital; transmission impairments; delay, distortion; transmission media; twisted pair, co-axial, optical fibre, terrestrial microwave, satellite microwave, radio; data encoding and communication: recap on PCM; AM; asynchronous and synchronous transmission; error detection techniques; interfacing: RS-232C, X.21 Digital interface; modems, multiplexer, demultiplexer.

Media access control and data link layer – framing; error detection and correlation methods; stop-and-wait ARQ; Back-N ARQ; Selective Repeat ARQ etc; media access protocols: ALOHA, slotted ALOHA, CSMA/CD, Token Ring, Token Bus, FDDI-I, FDDI-II, ATM.

Network layer – connection oriented vs. connectionless services; routing; X2.5; IP; congestion control, internetworking, network layer in the Internet; IP protocol, IP addresses, subnets, OSPF, BGP, CIDR; network layer in ATM.

Transport layer – transport services and protocols; the Internet transport protocols; TCP and UDP, Remote procedure call, ATM AAL layer protocols.

Application layer – network security, DNS, SNMP, FTP, Telnet, E-mail, X-400, digital networks-ISDN; B-ISDN

Text Books:

1. Forouzan, Data Communication & Networking, (3rd Edition), TMH
2. A S Tanenbaum – Computer networks, Prentice Hall of India, 3rd Ed/ Pearson Education.
3. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP
4. Black, Data Communication & Networking, PHI
5. Zeimer & Tarnter, Principles of Communication, Jaico
6. Miller, Data Communication & Network, Vikas
7. Mansfield,An introduction to Computer Networking, PHI

References:

1. Black Uyless – Computer Network Protocols, Standards and Interfaces, PHI
2. J A Stankovic – A perspective on Distributed Computer System, IEEE Trans. Computer
3. S. Mullender – Distributed Systems, Pearson Education
4. Paul E Green – Computer Network Architechtures and Protocols, Plenum Press, New York, 1982
5. P. R Green – Protocol Conversion, IEEE Trans Communication
6. Stallings William – Data and Computer Communication, PHI/ Pearson Education

MULTIMEDIA SYSTEMS
IC - 602

Introduction to Multimedia: Overview, Importance, Components, Uses of multimedia, Future Hypertext and hypermedia, different media and channels and modes of communication.

Multimedia Resources: Data rate, cost effectiveness and production time considerations, Analog and digital representations, Image, Video and Audio Standards, Colour space and models, communication standards - ISDN, ATM

Equipment and devices: Display screen, storage devices, communication and interactive peripherals.

Test: Attributes and guidelines, Text markup, HTML, models of hypertext document, XML

Digital Graphics: Vector and raster graphics, Graphics file formats, image manipulation.

Audio: Digital audio, MIDI, Processing sound, sampling, compression.

Video: MPEG Compression standards, Compression through Spatial and Temporal Redundancy, inter-frame and intra-frame Compression.

Animation: Types, techniques, key frame animation, utility, Morphing

Compression techniques: Lossless and lossy compression, Simple compression techniques Interpolative, Predictive, Transform Coding, Discrete Cosine Transform, Statistical Coding - Huffman encoding. JPEG, MPEG

Design and development of multimedia: Tools to support multimedia development, Authoring Multimedia - different type of authoring environments, Media synchronization, Design process, development team Evaluation and Testing - Gagne events, Project management.

Human Computer Interaction (HCI): Objective, norms and guidelines, Shneiderman's rules for design, Norman's seven stages of action, Interaction Design & Notations - Meta notations and state transition graphs, Screen design norms and guidelines.

Multimedia information management application: Multimedia database and design consideration.

Intellectual property: Foundations of intellectual property, copyrights, issues regarding the use of intellectual property.

Future developments: Virtual reality, newer devices, performance support, knowledge management, interactive interfaces

Text Books:

1. Ben Shneiderman - "Designing the User Interface", Addison Wesley Longman Publishing Co. (ISBN:0-201-69497-2)
2. Jakob Nielsen - "Hypertext and hypermedia", Boston, Academic Press, 1990
3. Arch C Luther - "Design interactive multimedia", Bantam Books, NY, 1992

References:

1. D Norman - "Design of Everyday Things" - M.I.T. Press, 1998. (ISBN 0-262-64037-6)
2. Jeff Burger - "Multimedia for decision makers: a business primer", Addison - Wesley, 1995, Reading, Mass
3. Chapman, N. and Chapman J. - "Digital multimedia", John Wiley, 2000
4. Elsom Cook - "Principles of Interactive Multimedia", McGraw Hill, 2001, ISBN 007-709610 x
5. Buford, J. K., - "Multimedia Systems", Pearson Education Asia, 2000
6. Vannevar Bush (Foundation Paper) - "As we may think"
7. Hillman – Multimedia Technology & Applications, Galgotia Publications
8. Bunzel – Multimedia Applications & Development, MGH Pub.

INDUSTRIAL INSTRUMENTATION - II

IC – 603

MODULE – I

Flow measurement: Introduction, definitions and Modules, classification of flow meters, Pitot tubes, orifice meters, venturi tubes,flow tubes, flow nozzles, positive displacement liquid meters and provers, positive displacement gas flowmeters, variable area

MODULE – II

Anemometers: Hot wire / hot film anemometer, Laser Doppler Anemometer (LDA), electromagnetic flowmeter, turbine and other rotary element flowmeters, ultrasonic flowmeters, Doppler flowmeters, cross-correlation flowmeters, vortex flowmeters.Measurement of mass flowrate: Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, coriolis, gyroscopic and heat transfer type mass flowmeters.

MODULE – III

Target flowmeters, V-cone flowmeters, purge flow regulators, flow switches, flowmeter calibration concepts, flowmeter selection and application. Level measurement: Introduction, float level devices, displacer level detectors, rotating paddle switches, diaphragm and differential pressure detectors, resistance, capacitance and RF probes, radiation, conductivity, field effect, thermal, ultrasonic, microwave, radar and vibrating type level sensors. Level sensor selection and application.

MODULE – IV

Level Measurement : Introduction , float level device , Displacer level detectors
Differential pressure type level detector , Electrical type – resistance and capacitance type , Microwave and Ultrasonic type level detectors.

MODULE – V

EMC: Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding. Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures –NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.

MODULE – VI

Specification of Instruments, preparation of project documentation, process flow sheet, instrument index sheet, instrument specification sheet, panel drawing and specifications instrument specifications. Project procedure, schedules, vendor drawing, tender documentation.

TEXT BOOKS:

1. Doebelin E. O, Measurement Systems : Application and Design, Fourth edition, McGraw Hill, Singapore, 1992.

2. D Patranabis , Principle of Industrial Instrumentation , TMH publication.

REFERENCES:

1. Andrew W. G, Applied Instrumentation in Process Industries - A survey, Vol.1 & Vol.2, Gulf

Publishing Company,Houston, 1992.

2. Liptak B. G, Process Measurement and Analysis, Third edition, Chilton Book Company, Pennsylvania, 1995.

3. Considine D. M, Process Instruments and Control Handbook, Fourth edition, McGraw Hill, Singapore, 1993

4. R.K. Jain, Mechanical and Industrial Measurements, Tenth edition, Tata McGraw Hill, New Delhi, 1996.
5. Spitzer D.W., Industrial flow measurement, Second edition, ISA press, New york, 1990.
6. Spitzer D.W., Flow measurement, ISA press, New york, 1998.

PROCESS CONTROL LABORATORY
IC – 691

1.Experimental study of PID controller response on a level loop.

2.Experimental study of ON-OFF and Proportional controller responses on temperature loop.

3.Tuning of controllers on a pressure loop.

4.Control valve characteristics with and without positioner.

5.Modeling of flow process.

6.Study of complex control systems (Ratio, Feedforward, and Cascade).

7.Study of basic logic operations, timer, counter, arithmetic operations in PLC.

8.Study of analog operations in PLC.

9.Problem solving in PLC.

The following experiments will be conducted on virtual DCS.

10.Three – element boiler control

11. Binary distillation column control

12. Level control in coupled tanks

13. Pressure control in different sized vessels

14. Heat exchanger control

16.Control of rotary dryer

Microprocessor Based Systems Laboratory

EI – 692

List of Experiments:

11. Familiarization with 8086/88 register level architecture and trainer kit components, including the memory map. Familiarization with the process of storing and viewing the contents of memory as well as registers. 3 Hrs.

12.	d)	Study of prewritten programs on trainer kit using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical)	3 Hrs.
	e)	Assignments based on above.	
13.	c)	Familiarization with 8086/88 simulator on PC.	3 Hrs.
	f)	Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the simulator.	
	d)	Assignments based on above	
14.		Programming using kit/simulator for	9 Hrs.
	ix)	table look up	
	x)	Copying a block of memory	
	xi)	Shifting a block of memory	
	xii)	Packing and unpacking of BCD numbers	
	xiii)	Addition of BCD numbers	
	xiv)	Binary to ASCII conversion	
	xv)	String Matching	
	xvi)	Sorting etc.	
15.		Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit eg, subroutine for delay, reading switch state & glowing LEDs accordingly, finding out the frequency of a pulse train etc	3 Hrs.
16.		Interfacing with I/O modules:	15 Hrs.
	f)	ADC	
	g)	Speed control of mini DC motor using DAC	
	h)	Temperature sensor and display temperature	
	i)	Relay	
	j)	Keyboard through 8279 and 8255A	
	k)	Multi-digit Display with multiplexing through 8255A & 8279	
	l)	Stepper motor	
17.		Writing programs for 'Wait Loop (busy waiting)' and ISR for vectored interrupts (eg, counting number of pulses within specified time period)	3 Hrs.
18.		Familiarization with EPROM programming and Erasing	3 Hrs.

Computer network & Internetworking Lab

CS – 681

Experiments are based on Linux / Unix / Solaris (Text Mode) Operating System

1. Familiarization of NIC, different cabling options (e.g. UTP, Coaxial, optical fibre), Connectors – BNC, RJ45, RS-232C, Interconnecting Devices – Hub, switch, router etc., Preparation of some UTP cables with RJ45 connectors and setting up a small network using either Hub or switch.
2. Configuring NIC, preparing routing table, assignment of IP address & net mask to each machine, concept of subnet, CIDR, socket interface
3. Configuring PPP
4. Configuring DNS server (e.g. Bind)
5. Configuring web server (e.g. Apache)
6. Configuring mail server (e.g. Postfix, Qmail etc.)
7. Configuring Telnet, FTP server

8. Configuring Firewall (e.g. IP chains, IP tables etc. in Linux)
9. Configuring NFS & NIS
10. C program to implement a simple client
11. C program to implement a simple server (e.g. echo)
12. Concurrent server using process
13. Concurrent server using thread (Linux, Windows)
14. C program to compute checksum
15. C program to implement stop-and-wait ARQ
16. C program to implement GO-back-n ARQ
17. C program to implement selective repeat ARQ

Symbols:

NIC – Network Interface Card
UTP – Unshielded Twisted Pair
CIDR – Classless Inter Domain Routing
PPP – Point to Point Protocol
DNS – Domain Name Server
FTP – File Transfer Protocol
NFS – Network File System
NIS – Network Information System
ARQ – Automatic Repeat request

Multimedia System Laboratory
IC - 692

1. Web document creation using Dreamweaver (6P)
2. Image manipulation and editing with Photoshop (6P)
3. Audio recording and editing (3P)
4. Creating animation using Flash (9P)
5. Individual Project: Development of personal web page and documentation (6P)

Main Project: Group project, complete design documents, implementation of an application (15P).

Seventh Semester

Digital Signal Processing
IC 701
Contacts: 3L
Module I

Classification of Signals and Systems: Description of signals and their characteristics, types of systems and their behavior.	1
Discrete-time description of signals: Discrete-time sequences, their frequency domain behavior, comparison with analog signals, convolution of two sequences, sampling a continuous function to generate a sequence, reconstruction of continuous-time signals from discrete-time sequences.	5
Discrete-time description of systems: Unit-sample response of a system, Time-invariant systems, Superposition principle for linear systems, Stability criterion for discrete-time systems, Causality criterion for discrete-time systems, Linear constant-coefficient difference equations.	4

Module II

Modeling and analysis of signals and systems using mathematical tools like Fourier transform , z- transform. Discrete-time Fourier transform: Definition of Fourier transform (FT), important properties of FT, properties of FT for real-valued sequences, use of FT in signal processing, FT of special sequences, the inverse FT, FT of the product two discrete-time	4

sequences	
Discrete Fourier Transform: The definition of the Discrete Fourier Transform (DFT), computation of the DFT from the discrete-time sequence, properties of the DFT, circular convolution, performing a linear convolution with the DFT, computations for evaluating the DFT	6
Z-transform: Definition of the z-transform, properties of the z-transform, the system function of a digital filter, combining filter sections to form more complex filters, digital filter implementation from the system function	4
Relationship between the Fourier transform and the z-transform, the z-transform of symmetric sequences, the inverse z-transform	2

Module III

Digital filter: Definition and anatomy of a digital filter, frequency domain description of signals and systems, typical applications of digital filters, filter categories: IIR and FIR, recursive and non-recursive	3
Digital Filter Structures: The direct form I and II structures, Cascade combination of second-order sections, parallel combination of second-order sections, Linear-phase FIR filter structures, Frequency-sampling structure for the FIR filter.	8
	37

Books :

1. Theory and Applications of Digital Signal Processing – Rabiner and Gold, Pearson
2. Digital Signal Processing – Oppenheim and Schafer, Pearson
3. Discrete Time Signal Processing - Oppenheim ,Schafer and Buck, Pearson

Financial Management and Accounts
Code : HU 701
Contacts : 3L
Credits : 3

Introduction: Fundamental Concepts, factors of Production, Demand and supply, Consumer behavior, Demand-functions, elasticity of demand and demand forecasting, theory of firm, Engineering economics, Equivalence, value of time, present value and annual equivalent cost, rate of return, replacement analysis, Evaluation of public activity - socio-economic considerations. Materials management and inventory. Market structure, pricing and output decisions under different market conditions. Technological considerations under competitive economic and business environments. Financial statements, double-entry book keeping. Cash and revenue, price and income etc., cost concepts, volume profit analysis, breakeven analysis – its application/cost in engineering and management decision making.

Introduction to book-keeping and accounting, Preparation of final accounts. Interpretation of final accounts through ratio analysis, fund flow, cash flow, investment, capital structure and dividend decisions. Working capital management. Failure and re-organization of a business.

Production & cost analysis - use of production and demand functions. Determination of price - pricing under different objectives. Roles, objectives and goals of financial management.

Industrial financing - capital formation and growth. Foreign Industries - export, import and balance of trade.

References:

1. Riggs J L - Engineering Economics
2. Dean J - Managerial Economics
3. Samuelson - Economics
4. White, Agree & Case - Principles of Engineering Economic Analysis, John Wiley, 1977
5. Batliboi - Double Entry Book Keeping.

West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064
Syllabus of Instrumentation & Control Engineering
LOGIC AND DISTRIBUTED CONTROL SYSTEMS

Code – IC 702

MODULE-I

Review of computers in process control: Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC) .Supervisory Control And Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. Alarms , interrupts. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

MODULE-II

Programmable logic controller(PLC) basics:Overview of PLC systems , input/output modules, power supplies and isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions, PLC Basic Functions, register basics, timer functions, counter functions

MODULE-III

PLC intermediate functions: Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems.. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance. Design of interlocks and alarms using PLC, creating ladder diagrams from process control descriptions.

MODULE-IV

Interface and backplane bus standards for instrumentation systems. Field bus: Introduction, concept. HART protocol: Method of operation, structure, operating conditions and applications. Smart transmitters, IEEE 1451 protocol, smart valves and smart actuators.

MODULE-V

Distributed Control Systems (DCS): Definition, Local Control unit (LCU) architecture, LCU languages, LCU -Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept -case studies in DCS.

TEXTBOOKS:

1. 1. John. W .Webb Ronald A Reis , Programmable Logic Controllers -Principles and Applications, Fourth edition,Prentice Hall Inc., New Jersey, 1998.
2. 2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
3. 3. Frank D. Petruzella, Programmable Logic Controllers, Second edition, McGraw Hill, Newyork, 1997.

REFERENCES:

1. 1. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, New York, 1995.
2. 2. Curtis D. Johnson, Process Control Instrumentation Technology, Seventh edition, Prentice Hall, New Delhi, 2002

3. Krishna Kant , Comp uter-based Industrial Control, Prentice Hall, New Delhi ,1997.

Elective- I (IC 703)

BIOMEDICAL INSTRUMENTATION (IC 703 A)

Review of physiology and anatomy, Bioelectric potential, electrode theory and types, physiological transducers, Systems approach to biological systems.

Cardiovascular measurements - EMG, EEG, BP, blood flow cardiac output, plethysmography, impedance cardiology, cardiac arrhythmia's, pace makers, defibrillators.

Respirator and pulmonary measurements and rehabilitation.

Patient monitoring systems. Sources of electrical hazards and safety techniques.

Recent trends in Imaging.

Text Books:

1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "*Biomedical Instrumentation and Measurements*", 2nd Edition, Prentice Hall, New Delhi, 1998.

Reference Books:

1. Geddes L. A. and Baker L. E., "*Principles of Applied Biomedical Instrumentation*", 3rd Edition, John Wiley, New York, 1989.
2. Richard Aston, "*Principles of Bio-medical Instrumentation and Measurement*", Merril Publishing Company, New York, 1990.
3. Kandpur R. S, "*Handbook of Biomedical Instrumentation*", Tata McGraw Hill, New Delhi, 1987.

POWER ELECTRONICS (IC 703 B)

Power semiconductors switches - Static and dynamic characteristics, Turn on and turn off characteristics. Power semiconductor devices: PNPN diodes, DIACS Thyristors, TRIACS, GTO devices, Power Transistors, Power MOSFET. Rating, losses and cooling. Triggering circuits for SCRs, UJT.

1ϕ and 3ϕ bridge rectifiers. Uncontrolled and controlled rectifiers: single phase and poly phase, Bridge rectifiers, Transformer ratings, Inductive load, free wheeling diodes.

Chopper; Principle of chopper operation, **Commutation circuits.**

Inverters, AC voltage controllers; Single phase and three phase inverters, constant voltage source and constant current source inverters, HF inverters for heating.

Cycloconverters; Basic principle of operation, single phase to single phase cycloconverter, three phase half wave cycloconverters;

Effect of EMI and harmonics.

Text Books:

1.Rashid M. H, "*Power Electronics - Circuits, Devices and Applications*", 2nd Edition, Prentice Hall, New Delhi, 1995.
2.Dubey G. K, Doradla S.R, Joshi and Sinha R.M, "*Thyristorised Power Controllers*", New Age International Publishers, New Delhi, 1996.
3. MD Singh, K B Khanchandani, "Power Electronics", TMH, 1998.

Reference Books:

1.Vedam Subramanyam K, "*Power Electronics*", 2nd Edition, New Age International Publishers, New Delhi, 1997.
2. Mohan, Undeland and Robbins, "*Power Electronics*", John Wiley and Sons, New York, 1995.
3. Joseph Vithyathil, "*Power Electronics*", McGraw Hill, New York, 1995.

RELIABILITY AND SAFETY ENGINEERING(IC 703 C)

Reliability.

Use of redundancy and system reliability improvement methods.

Maintainability.

Introduction to life-testing, destructive and non-destructive tests.

Safety.

Text Books:

1.Govil A.K, "*Reliability Engineering*", Tata McGraw Hill, New Delhi, 1983.
2.Sinha and Kale, "*Introduction to Life-Testing*", Wiley Eastern, New Delhi, 1992.

Reference Books:

1.Wisley et al, "*Human Engineering - Guide for Equipment Designers*", University of California Press, California, 1973.

Elective – II (EI 703)

Ultrasonic Instrumentation
Code : EI 703 (a)
Contacts : 3L
Credits : 3

Ultrasonic waves, principles and propagation of various waves, Characterization of Ultrasonic transmission – reflection and transmission coefficients, intensity and attenuation of sound beam. Power level, medium parameters. Generation of ultrasonic waves – Magnetostrictive and Piezoelectric effects. Search unit – types construction, characteristics. Ultrasonic test methods – pulse echo, transit time, resonance, direct contact and immersion type. Ultrasonic methods of flaw detection. Ultrasonic method of measuring thickness, depth, flow etc. Variables affecting ultrasonic testing in various applications, Ultrasonic applications in Medical Diagnosis and Therapy, Acoustical holography.

References:

1. Krauthkamer J and Krauthkamer H – Ultrasonic Testing of Materials, Springer Verlag, Berlin, New York.
2. Wells N T – Biomedical ultrasonics, Academic Press, London 1977.

Advanced Sensors
Code : EI 703 (b)
Contacts : 3L
Credits : 3

Semiconductor sensors : Metal Oxide Semiconductors, Hall Elements. Silicon Sensors: Silicon Planar Technology. Micro-machine Technology. Silicon sensors for sensing radiation, mechanical magnetic, chemical and other signals IC sensors : Chemical and Biochemical Sensors : Polymers. Chemically

modified electrodes. Membrane. Electrodes. Thick film devices. Catalytic devices. Gas sensors: Optical sensors: Lasers. Photo-detectors and optical fiber as sensors, Integrated Optics: Micro Sensors: Thin film sensors, Micro sensors for sensing thermal, Radiation, Mechanical, Magnetic and Chemical signals; Interfacing and signal processing : Intelligent and smart Sensors, Concepts of redundant and multisensor systems. Operation in coded mode and mapping mode.

References:

1. Silicon Sensors – Middlehoek S and Audel S. A. – Academic Press, London 1989
2. Sensors and Actuators – No. 8, 1985 (pp 227-233)-No. 1986 (pp.65-82)
   No. 12, 1987 (pp.129-144)
3. Chemical Sensors – Edmonds T. E. (Ed); Blackie – London, 1988
4. Sensors and Transducer – Patranabis D: PHI

Microelectronics and VLSI Technology

Code : EI 703 (d)
Contacts : 3L
Credits : 3

Basic Consideration in Microelectronics :

Discrete circuits vis-à-vis Microelectronics; Classification of different types of integrated circuits; General outline of hybrid integrated circuits based on thin and thick film technology; Semiconductor monolithic circuits based on bipolar, MOS and CMOS technology, advantages and disadvantages of different types of integrated circuits; Structure-based classification of integrated circuits-SSI, MSI, LSI, VLSI and ULSI.

Thin and Thick Film Integrated Circuits

Methods of producing film, monitoring and control of film thickness; Design and fabrication of individual components; Processing steps for realization of systems.

Monolithic IC Technology :

Planner processing steps for realization of integrated circuit using bipolar, MOS and CMOS technology; Epitaxy; Diffusion; Ion-Implantation; Oxidation and passivation; Masking and lithography; Etching; Metallisation and ohmic contacts; Die and wire bonding, packaging and encapsulation; Advantages and disadvantages of bipolar, MOS and CMOS systems.

VLSI and submicron Technology :

Limitations for micron and submicron integrated circuits; VLSI technology for doping, masking, lithography, etching and contacting.

Design Features and Systems :

Basic consideration and design approach using bipolar and MOS technology; Realisation of passive components, restrictive components and building blocks; Realisation of different active structures.
Design considerations in respect of the isolation between components; Polarity dependence, high

temperature dependence, poor tolerance of the components; Poor dissipation capability and cost; Design of

op-amps, power amplifiers, regulated power supply, digital circuits and memory systems in the integrable

form.

Layout :

Basic considerations design rules, hand layout and digitization, geometry specific and symbolic layout language; CIF to LSI layout description, Introduction to realization, and characterization of components and systems.

Yield and Reliability:

Failure mechanisms and yield loss; Failure analysis; Reliability considerations and improvements.

References:

1. Mead and Conway – Introduction to VLSI systems, Addison Wesley.
2. Amar Mukherjee – Introduction to CMOS VLSI, Prentice Hall
3. B. T. Press and M.J. Lorenzetti Benjamin (Eds.) physical design automation of VLSI systems.
4. R.K. Brayton et al – Logic Minimization for VLSI Synthesis – Klumer Academic Publisher.
5. T. Ohtsuki (Eds.) – Layout design and verification.
6. Wolf: Modern VLSI Design, Pearson Education.

Digital Signal Processing Laboratory

IC-791

1. Sine wave generation using C.
2. Designing an FIR Filter using MATLAB and DSP kit.
3. Designing an IIR Filter using MATLAB and DSP kit.
4. Fourier analysis of periodic signal.
5. Time and frequency domain properties of different windows using MATLAB.

LOGIC AND DISTRIBUTED CONTROL SYSTEM LABORATORY

IC – 792

6. Study of basic logic operations in PLC
7. Study the timer operation in PLC
8. Study the counter operation in PLC
9. Study the arithmetic operations in PLC.
10. Study of analog operations in PLC.
11. Study the architecture of DCS
12. Study the analog and digital I/O operation in DCS
13. Study the closed loop control in DCS for different process like flow, pressure , temperature.
14. Study the interfacing of PLC with DCS.
15. Troubleshooting in PLC and D

Values and Ethics in Profession
Code : HU 801
Contacts : 3L
Credits : 3

Science, Technology and Engineering as knowledge and as social and professional activities

Effects of Technological Growth: Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development

Energy Crisis: Renewable Energy Resources

Environmental degradation and pollution. Eco-friendly technologies. Environmental regulations, Environmental ethics

Appropriate Technology Movement of Schumacher; later developments

Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.

Human Operator in Engineering projects and industries: Problems of man, machine, interaction, Impact of assembly line and automation. Human centered technology.

Ethics of Profession: Engineering profession: Ethical issues in engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.

Profession and Human Values: Values Crisis in contemporary society. Nature of values: Value Spectrum of a good life. Psychological values: Integrated personality; mental health. Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.

Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity

Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Reference Books:

1. Stephen H Unger, *Controlling Technology: Ethics and the Responsible Engineers*, John Wiley & Sons, New York, 1994 (2nd Ed)
2. Deborah Johnson, *Ethical Issues in Engineering*, Prentice Hall, Englewood Cliffs, New Jersey, 1991.
3. A N Tripathi, *Human values in the Engineering Profession*, Monograph published by IIM, Calcutta 1996.

Industrial Management

Code : HU 802
Contacts : 3L
Credits : 3

Basic concepts of management, objectives, classification and hierarchy, different schools of management thought, principal functions of management, Management as an organizing and directing force, Structure of the management decision making process, Organization structure, authority and responsibility, Organisation dynamics, Managerial leadership, communication systems, Managing human factors in business and industry, Industrial relation, Union activities, trade union acts, collective bargaining, disciplinary procedure.

Organizational objectives and long range forecasting, planning, organizing, programming and controlling process, managerial control strategies; quantity and quality control, cost benefit analysis, present work and breakeven analysis, budgetary control, use of management science for the efficient administration of economic units, production, financial and marketing management.

Adoption of statistical and computer methods and techniques to managerial research and managerial decision making and general management.

Reference Books:

1. S C Jain, W S Bawa, *Industrial Management*, Dhanpal Rai & Co. (P) Ltd.
2. Martand Telsang, *Industrial Engineering and Production Management*, S Chand
3. Martand T Telsang, *Industrial and Business Management*, S Chand
4. J Tony Arnold and Stephen N Chapman, *Introduction to Materials Management*, Pearson Education Asia
5. Adam, *Production and Operations Management*, Pearson Education Asia
6. Sinha, *Industrial Relations, Trade Unions and Labour Legislation*, Pearson Education Asia
7. Tulsian, *Business Organisation and Management*, Pearson Education Asia.
8. Freeman, Bell and Balkwill, *Management in Engineering: Principles and Practice*, PHI
9. Massie, *Essentials of Managements*, PHI

ELECTIVE III

ANALYTICAL INSTRUMENTATION
Code : EI 801(C)
Contacts : 3L
Credits : 3

Introduction – Difference between analytical and other instruments. On-line instrumentation and laboratory techniques. Sampling techniques for liquids and gases for analysis purpose. Gas analysis : Gas analysis : Gas chromatography, Thermal conductivity method, Head of reaction method, Estimation of oxygen, hydrogen, methane, carbon-dioxide, carbon-monoxide, etc. in binary or complex gas mixtures. Zirconia-probe oxygen analysers, Paramagnetic oxygen meters. Electrochemical reaction method. Humidity and moisture measurement techniques. Chemical composition analysis: Measurement of viscosity, turbidity meter, consistency. pH and redox potential, electrical conductivity. Techniques of density measurement: solids, liquids and gases. Spectrochemical analysis, Mass spectrometry, Emission spectrometry, Absorption spectrometry. Dispersive and nondispersive techniques.

Reference Books:

1. Patranabis D, *Principles of Industrial Instrumentation*, TMH publication, N Delhi, 1976.
2. Liptak B.G (Ed), *Instrument Engineers' Handbook*, Vols. I and II and supplements I and II, Chilton Book Co., Philadelphia, 1972.
3. Jones E B, *Instrument Technology*, Vol. II, Analysis Instruments, Butterworths Scientific Publication, London.
4. O'Higgins P J, *Basic Instrumentation in Industrial Measurement*, McGraw Hill Book Co., NY 1966.

Opto-electronics and Laser-based Instrumentation
Code : IC 801(A)
Contacts : 3L
Credits : 3

Photometry, radiometry, units and definitions; Photodetectors, CCD, Thermal detectors, Photon devices and their performance parameters.

Light sources.

Opto-electronic devices; LED, LASERs – characteristics and its industrial applications, active and passive components.

Optical fibre – types, properties, application in instrumentation. Fibre optic sensors – different industrial types.

Opto-electronic instruments: Light power meter, wave length meter, optical time domain refractometer (OTDR); Introduction to integrated optics.

Text Books:

1. Wilson and Hawkes, *Opto Electronics—An Introduction*, 3rd Edition, Prentice Hall, New Delhi, 1998.
2. Bhattacharya P, *Semiconductor Optoelectronics*, 2nd Edition, Prentice Hall, New Delhi, 1998.
3. Djafar K Mynbaev and Lowell.L.Scheiner, *Fiber-Optic Communications Technology*, 2nd Indian Reprint, Pearson Education Pte. Ltd., 2001.

Reference Books:

1. Culshaw B and Dakin J (Eds.), *Optical Fibre SensorsI,* Vols. I, II and III, Artech House, 1989.
2. Fukuda, *Optical Semiconductor Devices*, Allied Publishers Limited, Chennai, 1999.
3. Kasap, *Optoelectronics and Photonics: Principles and practices*, Allied Publishers Limited, Chennai, 2001.

Product Design and Development
Code : IC 801(B)
Contacts : 3L
Credits : 3

Introduction.

Product Planning: Identifying Customer Needs, Project Selection, Product Specification.

Concept Generation: Concept Selection, Industrial Design, Prototyping, Product Architecture, Peer Concept Review.

Product Development Economics.

Robust Design. Organizing Concurrent Engineering. Supply Chain Design

Intellectual Property: Financial model and patent review.

Concept Testing: Case Study, Design for Environment, Alpha prototype submission, Report on alpha prototype testing and evaluation and the beta prototype submission. The report on beta prototype testing and customer evaluation submission along with final market ready model. Final Presentation.

Text Books:

1. Karl T Ulrich and Steven D Eppinger, *Product Design and Development*, 3rd Edition, Tata McGraw- Hill, 2003.
2. Kevin Otto and Kristin Wood, *Product Design*, Pearson Education, 2003.

Web Resources:

1. www.ocw.mit.edu
2. www.uspto.gov
3. www.businessweek.com
4. www.epa.gov
5. www.hbsp.harvard.edu
6. www.patent.gov.uk

Power Plant Instrumentation
Code : IC 801(C)
Contacts : 3L
Credits : 3

General concepts of different power plant set-ups and energy conversion processes.

Thermal power plant Instrumentation – Controlling, monitoring and testing boilers, turbaines, condensers , generaters, coal handling units and auxiliary systems; Quality monitoring of air, water and exhaust gases.

Salient features of Instrumentation in nuclear, hydro-electric and non conventional power plants.

Instrumentation for safety interlocks protective devices; Emergency measures—alarms and alarm analysis, monitoring of environmental pollution .

Text Books:

1. Sam G Dukelow, *The Control of Boilers*, 2nd Edition, ISA Press, New York, 1991
2. Gill A B, *Power Plant Performance*, Butterworth, London, 1984.
3. P C Martin and I W Hannah, *Modern Power Station Practice*, British Electricity International Vols. 1 & VI, Pergamon Press, London, 1992.

Reference Books:

1. David Lindsley, *Boiler Control Systems*, McGraw Hill, New York, 1991.
2. Jervis M.J, *Power Station Instrumentation*, Butterworth Heinemann, Oxford, 1993.
3. Modern Power Station Practice, Vol.6, *Instrumentation, Controls and Testing*, Pergamon Press, Oxford, 1971.

ELECTIVE IV

Project Management and Operations Research
Code : M 801 (A)
Contacts : 3L
Credits : 3

Project formalities – feasibility study-technical and economic evaluation; UNI DO, OECD and RBI guidelines. Network based project management-graph-theoretic applications. CPM, PERT, GERT and DCPM activities. Scheduling with limited resources, cash scheduling to multi projects situation. Project monitoring and control. Project management under risk and uncertainty.

Operations research-decision-making, development of OR Linear programming; Formulating of LP models, graphical solution, simples method, duality theory and application. Transportation problem. Assignment problem. Waiting line models; elements of queuing models. Poisson arrival and exponential service time distribution, M/M/I Queue. Finite population models. Queuing art models. Applications. Simulation; modeling, use of random members, flow-chart development. Inventory control-introduction, costs, deterministic and stochastic models, buffer stocks.

Reference Books:

1. Hillier, *Introduction to Operations Research*, 6th Edn., MGH
2. A Ravindran, *Introduction to Operations Research*, John Wiley, 1993.
3. Juran, *Quality Planning and Analysis*, 3rd Edn. MGH
4. R Kapoor, *Computer Assisted Decision Models*. TMH, 1991
5. Taha, *Operations Research*, Pearson
6. P Iyer, *Engineering Project Management*, Wheeler
7. Admn and Ebert, *Production and Operations Management: Concepts, Models and Behavior*, 5th Edn., PHI.
8. Rardin, *Optimization in Operation Research*, Pearson
9. Mohanty, *Advanced Operations Management*, Pearson

Non Conventional Energy Sources
Code : EE 802(G)
Contacts : 3L
Credits : 3

Energy Sources - Classification, Need and potential of NCES, Electricity generation from NCES: Photovoltaics, Mono; poly - crystalline and amorphous Silicon solar cells, Efficiency and cost of PV

systems; Wind electricity - wind as an energy source, wind electricity generating system - basic components, wind electric generators, siting of wind forms; Energy from Biomass - gasifiers and bio-gas reactors; Tidal energy; Wave energy and Geothermal energy; Environmental effects and Economics of NCES.

Reference Books:

1. Bansal, Kleeman and Melisa, *Renewable Energy Sources and Conversion Technology*, TMH, New Delhi.
2. S P Sukhatme, *Solar Energy*
3. Twidell and Weir, *Renewable Energy Resources*, ELBS

Robotics

Code : EI 802(C)
Contacts : 3L
Credits : 3

Robot Anatomy Arm Geometry – Direct and Inverse Kinematics Problem, Arm Dynamics, D Alembert Equations of Motion, Synthesis of elements with movability constraints, manipulations – trajectory planning, joint interpolated trajectories.
Control of Robot Manipulation – computed torque technique, sequential and adaptive control, resolved motion control Robots.
Robots Sensing – range and Proximity and Higher – Level vision, illumination techniques, Imaging Geometry, Segmentation Recognition and Interpretation. Robot Programming languages Characteristics of Robot Level and Task Level Languages.
Robot Intelligence – State space search, Robot Learning, Robot Task planning, Knowledge engineering.

Reference Books:

1. K S Fu, R C Ganzalez and C S G Lee, *Robotics Control, Sensing, Vision and Intelligence*, McGraw-Hill, International Edition, 1987.
2. M P Groover, M Weins, R N Nagel and N C Odrey, *Industrial Robotics*, McGraw Hill, 1986.
3. Andrew C Straugard, *Robotics and AI*, Prentice Hall, Inc.
4. S Sitharama Iyengar and Albetro Elefes, *Autonomous Mobile Robots Control, Planning and Architecture*, IEEE Computer Society Press.
5. Murphy, *Introduction to AI Robotics*, PHI
6. Niku, *Introduction to Robotics*, Pearson
7. Craig, *Introduction to Robotics*, 2/e, Pearson.

Soft Computing – Theory and Applications
Code : CS 802 (G)
Contacts : 3L
Credits : 3

Introduction to soft Computing and its constituents.

Introduction to Fuzzy Sets and its importance in real life. Definition, Basic Operators, T-norm, S-norm, other aggregation operators. Fuzzy Relations, implications, cylindrical extensions, projection and composition.

Approximate reasoning, compositional rule of inference, rule based system, term set, Fuzzification, reasoning, defuzzyfication, different fuzzy models (MA/TS) – some applications of fuzzy rule based systems.

Introduction to artificial neural networks, basic models like Hopfield networks, multilayer perception and learning vector quantization network, self organizing features maps – their properties and applications.

Basics of genetic algorithm (GA) and its applications.

Some Hybrid (Neuro-fuzzy, fuzzy-neural and fuzzy-GA) systems.

Reference Books:

1. Dirankov and Hellemdron, *Fuzzy Logic Contro*l, Narosa
2. S Haykians, *Neural Networks*, Pearson
3. Anderson, *An Introduction to Neural Network*, PHI
4. Goldberg, *Genetic Algorithm*, Pearson
5. Rajsekaran and Pai, Neural Networks, *Fuzzy Logic and Genetic Algorithm: Synthesis and Applications*, Pearson
6. Bose, *Neural Network Fundamentals and Graphs – Algorithms and Applications*, TMH