

Curriculum Undergraduate Programme

B TECH INSTRUMENTATION AND CONTROL ENGINEERING



Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY

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PREFACE

With rapidly changing industrial scene and technological advances that have taken place in microelectronics, telecommunications and computer technologies the field of Instrumentation and Control Engineering (ICE) has been revolutionalized. This needs upgradation and updating the existing academic programmes, so that trained human resources are competent to meet requirements of today's industries. Accordingly the Department of Instrumentation and Control Engineering has come forward to restructure the academic programmes stipulated under the credit based system.

We have tried our best to prepare a Model Curriculum and syllabi for four year under graduate programme in Instrumentation and Control Engineering. The exercise was handicapped with the following difficulties:

- i) It is interdisciplinary in character involving considerable inputs from other disciplines.
- ii) It depends on advances in science, microelectronics and computer technologies
- iii) Its differential status at the National and International level viz. the discipline of Instrumentation and Control Engineering is yet to get an independent status in advanced countries though it has been able to get a distinctly separate status at the national level.

It is really challenging to evolve a common programme for this discipline that meets the need of national and international industries and research establishments. However, with the rich experience of successful experimentation with above idea for over forty years, the task of development of a model curriculum could be possible.

The suggested curriculum is based on philosophy presented by the Dean (Academic Programmes) during the Senate meeting of the institute. It possesses the following features:

- i) The suggested curriculum is in conformity with IIT/AICTE norms with emphasis on analysis and design of industrial processes required to work in control environment.
- ii) The graduates turned out have to be acceptable by national and international industry and academic / research establishments.
- iii) The programme has to be forward looking in context of the rapid changing scenario of science and technology which provides a proper balance in teaching of basic sciences, social sciences and management, engineering sciences and technical arts, technologies and their applications.
- iv) Core subjects have been selected to cover all those, which are essential in training of ICE-graduates.
- v) The curriculum presents flexibility so that new programmes started with reasonable sources can be managed with a scope of further updating as the resource position improves.

The above features have been achieved by offering a number of electives courses (14) both departmental and open in nature.

I take this opportunity to express my deep appreciation to members of the Senate for their valuable suggestions and critical comments in finalizing the curriculum and Professor Moin Uddin, Director, NIT Jalandhar for his initiative and direction. I am also grateful to Dr S S Bhasin, Panjab University Chandigarh, Sh R C Arora, Deputy Director, CSIO Chandigarh and Professor Vinod Kumar, IIT Roorkee for suggesting essential ingredients, which needs to be incorporated. It is hoped that the curriculum compiled in form of the booklet will be of immense help to the students and the faculty in smooth offering the under graduate programme in Instrumentation and Control Engineering. I thank all the members of curriculum committee and the faculty of ICE Department for help and cooperation rendered in bringing out this booklet in time.

(R JHA)

Professor and Head
Department of Instrumentation and Control Engineering
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**Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY, JALANDHAR
BACHELOR OF TECHNOLOGY (B. TECH INSTRUMENTATION AND CONTROL ENGG.)**

TEACHING SCHEME

1ST SEMESTER

GROUP-A

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-101	Mathematics-I	3	1	0	4	4
2.	PH-101	Physics	3	1	0	4	4
3.	IC/EC-101	Electrical Sciences	3	1	0	4	4
4.	CS-101	Computer Programming	2	0	0	2	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	3	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	2	2
7.	PH-102	Physics Lab	0	0	2	2	1
8.	ME-101	Engineering Graphics	1	0	4	5	3
9.	IC/EC-102	Electrical Science lab	0	0	2	2	1
10.	CS-102	Computer Programming Lab	0	0	2	2	1
		Total	17	03	10	30	25

GROUP-B

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-101	Mathematics-I	3	1	0	4	4
2.	CH-101	Chemistry	3	1	0	4	4
3.	ME-102	Elements of Mechanical Engg.	3	1	0	4	4
4.	HM-102	English Communication	3	0	0	3	3
5.	CE-101	Environmental Science & Tech.	2	0	0	2	2
6.	HM-103	Introduction to Management	2	0	0	2	2
7.	IN-101	Manufacturing Process	1	0	4	5	3
8.	ME-103	Mechanical Engineering Lab	0	0	2	2	1
9.	HM-104	English Communication Lab	0	0	2	2	1
10.	CH-102	Chemistry Lab	0	0	2	2	1
		Total	17	03	10	30	25

2ND SEMESTER

GROUP-A

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-102	Mathematics-II	3	1	0	4	4
2.	CH-101	Chemistry	3	1	0	4	4
3.	ME-102	Elements of Mechanical Engg.	3	1	0	4	4
4.	HM-102	English Communication	3	0	0	3	3
5.	CE-101	Environmental Science & Tech.	2	0	0	2	2
6.	HM-103	Introduction to Management	2	0	0	2	2
7.	IN-101	Manufacturing Process	1	0	4	5	3
8.	ME-103	Mechanical Engineering Lab	0	0	2	2	1
9.	HM-104	English Communication Lab	0	0	2	2	1
10.	CH-102	Chemistry Lab	0	0	2	2	1
		Total	17	03	10	30	25

GROUP-B

Sr. No	Course Code	Name	L	T	P	Contact Hours	Credit
1.	MA-102	Mathematics-II	3	1	0	4	4
2.	PH-101	Physics	3	1	0	4	4
3.	IC/EC-101	Electrical Sciences	3	1	0	4	4
4.	CS-101	Computer Programming	2	0	0	2	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	3	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	2	2
7.	PH-102	Physics Lab	0	0	2	2	1
8.	ME-101	Engineering Graphics	1	0	4	5	3
9.	IC/EC-102	Electrical Science lab	0	0	2	2	1
10.	CS-102	Computer Programming Lab	0	0	2	2	1
		Total	17	03	10	30	25

3RD SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	Cat	AICTE Parameters
			L	T	P/D					
1.	MA-201	Mathematics-III	3	1	0	4	4	Math-I & II	ID	BS
2.	IC-201	Circuit Theory	3	1	0	4	4	Electrical Science	DC	DC
3.	IC-205	Electrical Measurement and Measuring Instruments	3	1	0	4	4	Electrical Science	DC	DC
4.	EC-205	Digital Electronics	3	1	0	4	4		ID	ESTA
5.	HM-201	Engineering Economics & Industrial Management	3	1	0	4	4		ID	HSS&M
6.	IC-203	Circuit Theory Laboratory	0	0	2	2	1		DC	DC
7.	IC-207	Electrical Measurement and Measuring Instruments Laboratory	0	0	2	2	1		DC	DC
8.	EC-225	Digital Electronics Laboratory	0	0	2	2	1		ID	ESTA
TOTAL			15	5	6	26	23			

4TH SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	Cat	AICTE Parameters
			L	T	P/D					
1.	IC-202	EMF Theory	3	1	0	4	4		DC	ESTA
2.	MA-202	Numerical Methods	3	1	0	4	4		ID	BS
3.	IC-204	Electrical Machines	3	1	0	4	4	Electrical Science	DC	DC
4.	EC-252	Electronic Devices and Analog Integrated Circuits	3	1	0	4	4		ID	DC
5.	CS-207	Object Oriented Programming	3	0	0	3	3	Computer Software-Theory & Practice	ID	ESTA
6.	HM-202	Entrepreneurial Development & Management	3	0	0	3	3		ID	HSS&M
7.	IC-206	Electrical Machines Laboratory	0	0	2	2	1		DC	DC

8.	EC-272	Electronic Devices and Analog Integrated Circuits Laboratory	0	0	2	2	1		ID	DC
9.	CS-217	Object Oriented Programming Laboratory	0	0	2	2	1		ID	ESTA
		TOTAL	18	4	6	28	25			

5TH SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	C at	AIC TE Par a- met ers
			L	T	P/D					
1.	IC-301	Microprocessors and Applications	3	1	0	4	4	Digital Electronics	DC	DC
2.	IC-305	Control Engineering-I	3	1	0	4	4	Circuit Theory	DC	DC
3.	IC-309	Transducers and Signal Conditioning	3	1	0	4	4	Electrical Measurement & Measuring Instruments	DC	DC
4.	PH-206	Material Science (Nano Science)	3	1	0	4	4		ID	EA
5.	IC-	Elective-I	3	0	0	3	3		DE	DC
6.	IC-	Elective-II	3	0	0	3	3		DE	DC
7.	IC-303	Microprocessors and Applications Laboratory	0	0	2	2	1		DC	DC
8.	IC-307	Control Engineering-I Laboratory	0	0	2	2	1		DC	DC
9.	IC-311	Transducers and Signal Conditioning Laboratory	0	0	2	2	1		DC	DC
		TOTAL	18	4	6	28	25			

6TH SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	C at	AIC TE Par a- met ers
			L	T	P/D					
1.	IC-302	Process Dynamics and Control	3	1	0	4	4	Control Engineering-I	DC	DC
2.	IC-304	Signal Processing	3	1	0	4	4	Circuit Theory	DC	DC
3.	IC-	Elective-III	3	0	0	3	3		DE	DC
4.	IC-308	Data Acquisition and Transmission	3	0	0	3	3	Transducers & Signal Conditioning	DC	DC
5.	IC-	Elective-IV	3	0	0	3	3		DE	DC
6.	IC-	Elective-V	3	0	0	3	3		DE	DC
7.	IC-306	Signal Processing Laboratory	0	0	2	2	1		DC	DC
8.	IC-310	Minor Project (ISD)	0	0	2	2	1		DC	DC
		TOTAL	18	2	4	24	22			

7TH SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	Cat	AICTE Parameters
			L	T	P/D					
1.	IC-401	Biomedical Instrumentation	3	0	0	3	3	Transducers & Signal Conditioning	DC	DC
2.	IC-	Elective-VI	3	0	0	3	3		DE	DC
3.	IC-	Elective-VII	3	0	0	3	3		DE	DC
4.	-	Open Elective-I	3	0	0	3	3		ID	OE
5.	-	Open Elective-II	3	0	0	3	3		ID	OE
6.	IC-403	Biomedical Instrumentation Lab	0	0	2	2	1		DC	DC
7.	IC-	Major Project (Part-I)	0	0	4	4	2		DC	DC
8.	IC-	Training	0	0	0	0	4		-	DC
9.	IC-405	Seminar	0	0	4	4	2		DE	DC
		TOTAL	15	0	10	25	24			

8TH SEMESTER

S No	Course No	Course Title	Periods			Contact Hours	Credits	Pre-requisite	Cat	AICTE Parameters
			L	T	P/D					
1.	IC-	Elective-VIII	3	0	0	3	3		DE	DC
2.	IC-	Elective-IX	3	0	0	3	3		DE	DC
3.	IC-	Elective-X	3	0	0	3	3		DE	DC
4.	-	Open Elective-III	3	0	0	3	3		ID	OE
5.	-	Open Elective-IV	3	0	0	3	3		ID	OE
6.	IC-402	Analytical Instrumentation Laboratory	0	0	2	2	1		DC	DC
7.	IC-404	Process Control Laboratory	0	0	2	2	1		DC	DC
8.	IC-	Major Project (Part-II)	0	0	8	8	4		DC	DC
		TOTAL	15	0	12	27	21			

LIST OF DEPARTMENTAL ELECTIVES (FOR BATCH 2007 ONWARDS)

SR NO.	COURSE CODE	COURSE TITLE	L-T-P-C
5TH SEMESTER			
ELECTIVE-I			
1.	IC-321	*Signals & Systems	3-0-0-3
2.	IC-323	Computer Networks	3-0-0-3
3.	IC-325	Power Electronics	3-0-0-3
ELECTIVE-II			
4.	IC-341	*Electrical Power Systems	3-0-0-3
5.	IC-343	Electrical Drives	3-0-0-3
6.	IC-345	Computer Aided Network Design	3-0-0-3
6TH SEMESTR			
ELECTIVE-III			
7.	IC-322	*Control Engineering-II	3-0-0-3
8.	IC-324	Computer Organization & Architecture	3-0-0-3
9.	IC-326	Advanced Techniques in Measurement	3-0-0-3
ELECTIVE-IV			
10.	IC-342	*Microcontrollers & Applications	3-0-0-3
11.	IC-344	Nuclear Instrumentation	3-0-0-3
12.	IC-346	Environmental Instrumentation & Safety	3-0-0-3
13.	IC-348	Optical Instrumentation & Measurement	3-0-0-3
ELECTIVE-V			
14.	IC-362	Instrumentation System Design	3-0-0-3
15.	IC-364	*Industrial Measurement	3-0-0-3
16.	IC-366	Advanced Sensors	3-0-0-3
17.	IC-368	Power Plant Instrumentation	3-0-0-3

7TH SEMESTER			
ELECTIVE-VI			
18.	IC-421	Robotics & Automation	3-0-0-3
19.	IC-423	PLC & SCADA	3-0-0-3
20.	IC-425	Mechatronics	3-0-0-3
21.	IC-427	Intelligent Instrumentation	3-0-0-3
ELECTIVE-VII			
22.	IC-441	Optimal Control Theory	3-0-0-3
23.	IC-443	Control System Design	3-0-0-3
24.	IC-445	Digital Control system	3-0-0-3
25.	IC-447	Modeling & Simulation	3-0-0-3
8TH SEMESTER			
ELECTIVE-VIII			
26.	IC-422	*Analytical Instrumentation	3-0-0-3
27.	IC-424	Embedded Systems	3-0-0-3
28.	IC-426	Neural Network and Fuzzy Logic	3-0-0-3
29.	IC-428	Virtual Instrumentation	3-0-0-3
ELECTIVE-IX			
30.	IC-432	*Advanced Process Control	3-0-0-3
31.	IC-434	Identification & Adaptive Control	3-0-0-3
32.	IC-436	Computer Control of Industrial Processes	3-0-0-3
33.	IC-438	Adaptive Signal Processing	3-0-0-3
ELECTIVE-X			
34.	IC-442	Advanced Networks	3-0-0-3
35.	IC-444	Soft Computing	3-0-0-3
36.	IC-446	Image Processing	3-0-0-3
37.	IC-448	Matlab	3-0-0-3

LIST OF OPEN ELECTIVES (TO BE OFFERED TO OTHER DEPARTMENTS)

SR NO.	COURSE CODE	COURSE TITLE	L-T-P-C
7TH SEMESTER			
OPEN ELECTIVE-I			
1.	IC-01	Elements of Control Engineering	3-0-0-3
2.	IC-03	Transducers	3-0-0-3
3.	IC-05	Optimization Techniques	3-0-0-3
OPEN ELECTIVE-II			
4.	IC-07	Virtual Instrumentation	3-0-0-3
5.	IC-09	Non-conventional Energy Sources	3-0-0-3
6.	IC-11	Signals & Systems	3-0-0-3
8TH SEMESTER			
OPEN ELECTIVE-III			
7.	IC-02	Generation & Control of Electric Power	3-0-0-3
8.	IC-04	Intellectual Property Rights	3-0-0-3
9.	IC-06	Experimental Methods for Engineers	3-0-0-3
OPEN ELECTIVE-IV			
10.	IC-08	Industrial instrumentation	3-0-0-3
11.	IC-10	Biomedical Instrumentation	3-0-0-3
12.	IC-12	Physiological Control Systems	3-0-0-3

Course Structure

B. Tech in Instrumentation and Control Engineering

Sem											Lecture Courses	L	T	P	Weekly Contact Hrs	Credits
I	MA-101 Mathematics-I (3 1 0) 4	PH-101 Physics (3 1 0) 4	PH-102 Physics Lab (0 0 2) 1	IC/EC-101 Electrical Sci (3 1 0) 4	IC-103 Electrical Sci Lab (0 0 2) 1	CS-101 Computer Programming (2 0 0) 2	CS-102 Computer Prog. Lab (0 0 2) 1	HM-101 Psychology of Human Behaviour (2 0 0) 2	ME-101 Engineering Graphics (1 0 4) 3	BT-101 Introduction to Bio Sciences (3 0 0) 3	07	17	03	10	30	25
II	MA-102 Mathematics- II (3 1 0) 4	CH-101 Chemistry (3 1 0) 4	CH-102 Chemistry Lab (0 0 2) 1	CE-101 Environmental Sci. & Tech. (2 0 0) 2	IN-101 Mfg. Process (1 0 4) 3	ME-102 Elements of Mechanical Engg. (3 1 0) 4	ME-103 Mechanical Engg. Lab (0 0 2) 1	HM-102 English Communicatio n (3 0 0) 3	HM-103 Introduction to Management (2 0 0) 2	HM-104 English Comm. Lab (0 0 2) 1	07	17	03	10	30	25
III	MA-201 Mathematics- III (3 1 0) 4	IC-201 Circuit Theory (3 1 0) 4	IC-203 Circuit Theory Lab (0 0 2) 1	IC-205 EMMI (3 1 0) 4	IC-207 EMMI Lab (0 0 2) 1			HM-201 Engg. Eco. & Industrial Mgmt. (3 1 0) 4	EC-205 Digital Electronics (3 1 0) 4	EC-225 Digital Electronics Lab (0 0 2) 1	05	15	05	06	26	23
IV	MA-202 Numerical Methods (3 1 0) 4	IC-202 EMF Theory (3 1 0) 4	IC-204 Electrical Machines (3 1 0) 4	IC-206 Electrical Machines Lab (0 0 2) 1		CS-207 Object Oriented Programming (3 0 0) 3	CS-217 Object Oriented Prog. Lab (0 0 2) 1	HM-202 Entrepreneuri al Dev. & Mgmt (3 0 0) 3	EC-252 EDAIC (3 1 0) 4	EC-272 EDAIC Lab (0 0 2) 1	06	18	04	06	28	25
V	IC-301 Microprocess or & Applications (3 1 0) 4	IC-303 Microprocess or & App. Lab (0 0 2) 1	PH-206 Material Science (Nano Science) (3 1 0) 4	IC-305 Control Engg-I (3 1 0) 4	IC-307 Control Engg-I Lab (0 0 2) 1	IC-309 Transducers & Signal Conditioning (3 1 0) 4	IC-311 Transducers & Signal Condt. Lab (0 0 2) 1	IC-2XX Elective-I (3 0 0) 3	IC-2XX Elective-II (3 0 0) 3		06	18	04	06	28	25
VI	IC-302 Process Dynamics &Control (3 1 0) 4	IC-304 Signal Processing (3 1 0) 4	IC-306 Signal Processing Lab (0 0 2) 1	IC-308 Data Acquisition & Transmission (3 0 0) 3	IC-310 Minor Project (ISD) (0 0 2) 1	IC-3XX Elective-III (3 0 0) 3	IC-3XX Elective-IV (3 0 0) 3	IC-3XX Elective-V (3 0 0) 3			06	18	02	04	24	22
VII	IC-401 Biomedical Inst. (3 0 0) 3	IC-403 Biomedical Inst. Lab (0 0 2) 1	IC-400 Project (Ph-I) (0 0 4) 2	IC-300 Training (0 0 0) 4	IC-405 Seminar (0 0 4) 2	IC-4XX Elective-VI (3 0 0) 3	IC-4XX Elective-VII (3 0 0) 3		Open Elective-I (3 0 0) 3	Open Elect-II (3 0 0) 3	05	15	00	10	25	24
VIII	IC-402 Analytical Inst. Lab (0 0 2) 1	IC-404 Process Control Lab (0 0 2) 1	IC-400 Project (Ph-II) (0 0 8) 4			IC-4XX Elective-VIII (3 0 0) 3	IC-4XX Elective-IX (3 0 0) 3	IC-4XX Elective-X (3 0 0) 3	Open Elect-III (3 0 0) 3	Open Elect-IV (3 0 0) 3	05	15	00	12	27	21
															Total	190

Note: Course codes for elective courses will be corresponding to courses listed as elective subjects in the teaching scheme

1ST SEMESTER

IC/EC-101 Electrical Science

[3 1 0 4]

Network Laws and Theorems: Network Laws for D.C. networks, Node voltage & mesh current methods, Delta-star and star-delta conversion, Classification of network elements, Principle of superposition, Thevenin's & Norton's Theorems.

Single Phase A.C. Circuits: 1-phase EMF generation, Effective and Average values of sinusoids and determination of form factor, Analysis of simple RLC-series circuits, Solution of parallel circuits and resonance.

Three Phase A.C. Circuits: 3-phase EMF generation, Delta and star connection, Line & phase quantities and relations, Solution of 3-phase circuits – balanced voltage & balanced load, Phasor diagrams, Measurement of power in three-phase circuits. Concept & working of wattmeter & A.C. watt-hour meters.

Magnetic Circuits and Transformers: Analogy between electric & magnetic circuits, Ampere's circuital law, Solutions of Magnetic Circuits, Hysteresis and Eddy current losses, constructional details, EMF equation, rating and phasor diagrams on no-load & full-load, Equivalent circuits, Regulation and efficiency, Open-circuit & short-circuit tests.

Basic Semiconductor Concepts and Devices: Intrinsic and extrinsic semiconductors, diffusion and drift currents, p-n junction under open-circuit, reverse-bias and forward-bias conditions, p-n junction in the breakdown region, Ideal diode, terminal characteristics of junction diode, Load-line analysis of diode circuits, Bipolar junction transistor- physical structure and modes of operation, Transistor as a switch.

Feedback Amplifiers and Oscillators: Concept of feedback, positive and negative feedback, General feedback structure, Effect of positive and negative feedback on amplifier gain and bandwidth, advantages of negative feedback, basic principles of sinusoidal oscillators, Oscillation criteria.

Operational Amplifiers: Op-amp terminals, ideal Op-amp, equivalent model, Inverting and non-inverting configurations, Application of Op-amps.

Power Supplies: Block diagram of power supply, Half-wave, Full-wave and Bridge rectifiers, passive filters, Regulators, Line regulation and load regulation, Zener diode as voltage regulator, Working of Switched Mode Power Supply (SMPS).

Books Recommended

1. Del Torro, "*Electrical Engineering Fundamentals*", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi (1994)
2. Kothari D P and Nagrath I J, "*Basic Electrical Engineering*", Tata McGraw Hill, New Delhi (1996).
3. Nagsarkar T K and Suhija M S, "*Basic Electrical Engineering*", Oxford Univ. Press, New Delhi (2005).
4. John D Ryder, "*Electronic Fundamentals and Applications*", 5th PHI, New Delhi.
5. Boylestad and Nashelsky, "*Electronic Devices and Circuit Theory*", 8th Ed, Pearson Education India, New Delhi (2002).
6. Edward Hughes, Mr Ian McKenzie Smith, Dr John Hiley, Dr Keith Brown, "*Hughes Electrical & Electronic Technology*", 8th Ed., Pearson Education India, New Delhi (2002).

IC/EC-102 Electrical Science Laboratory

[0 0 2 1]

1. To measure the armature and field resistance of a DC Machine
2. To calibrate a test (moving iron) ammeter and a (dynamometer) wattmeter with respect to standard (DC PMMC) ammeter and voltmeters.
3. Verification of circuit theorems, Thevenin's and Superposition theorems (with DC sources only).
4. To obtain voltage-current characteristics of incandescent lamps and fusing time-current characteristics of fuse wire.
5. Measurement of current and voltages in R-L-C series circuit excited by (single phase) AC supply and to develop phasor diagram.
6. Open circuit and short circuit tests on a single-phase transformer and to obtain P_i -loss, P_c -loss efficiency & regulation.
7. Connection and starting of a three-phase induction motor using direct on line (DOL), or star-delta starter.
8. Connection and measurement of power consumption of a fluorescent lamp.
9. Determination of open circuit characteristics (OCC) of a DC machine.

10. Starting and speed control of a DC shunt motor.
11. Connection and testing of a single-phase energy meter (unit power factor load only).
12. Two-wattmeter method of measuring power in three-phase circuit (resistive load only).
13. To get familiar with the working knowledge of the following instruments:
 - a) Cathode ray oscilloscope (CRO)
 - b) Multimeter (Analog and Digital)
 - c) Function generator
 - d) Power supply
14.
 - a) To measure phase difference between two waveforms using CRO
 - b) To measure an unknown frequency from Lissajous figures using CRO
15.
 - a) Plot the forward and reverse V-I characteristics of P-N junction diode
 - b) Calculation of cut-in voltage
 - c) Study of Zener diode in breakdown region
16. To plot and study the input and output characteristics of BJT in common-emitter configuration
17. To find frequency response of a given amplifier and calculate its bandwidth
18. To get familiar with pin-configuration of typical op-amp(741) and its use as:
 - a) Inverting amplifier
 - b) Non-inverting amplifier
 - c) Summing amplifier
 - d) Difference amplifier
19. Use of op-amp as
 - a) Integrator
 - b) Differentiator
20. To assemble Wein Bridge oscillator circuit and calculation of oscillation-frequency and its verification from the observed output
21. To assemble and test 5V/9 V DC regulated power supply and find its line-regulation and load-regulation

Note: Students are required to perform at least 10-experiments out of the above list.

Limit and derivative of a complex function, analytic functions and Cauchy Riemann equations, line integral of elementary functions, Cauchy's integral theorem, Cauchy's integral formula and derivatives of analytic functions, Taylor and Laurent series, zeros and singularities, residues and residue theorem, evaluation of real improper integrals, conformal mappings, linear fractional transformations and mappings by elementary functions
 Series solution of differential equations, Bessel's differential equation and Bessel functions and their properties, differential equations reducible to Bessel's differential equation, Legendre's differential equation, Legendre's polynomials and their properties, Fourier-Legendre expansion of a function.
 Fundamental concepts of calculus of variations, functional involving several independent functions, one end fixed- other end free problems, both end free problems, constrained extrema.

Books Recommended

1. Grewal, B S , "Higher Engineering Mathematics", Thirty-fifth edition, Khanna Publishers ,Delhi.
2. Elsgole L E, " Calculus of Variations ", 1961Pergamon Press ,Addison-Wisley Publishing Company
3. Conway J B, "Functions of One Complex Variables", Narosa Publishing House, 1980.

Network Analysis Techniques: Reciprocity Theorem, Milliman's Theorem, Telegen's Theorem and Maximum Power Transfer Theorem – Applications of Network Theorems to network analysis both with dc and ac inputs and magnetic coupling.

Applications of Laplace Transform: Introduction, some basic theorems, solutions of Linear Differential Equations for electric network-problems, partial fraction expansion-Heaviside's Expansion Theorem, The convolution Integral-evaluation. Application of Laplace Transform analysis of electrical circuits – Linear time invariant first and second order circuits. Zero input response, Zero state response and complete response. Impulse response of first and second order circuits, time varying circuits, Introduction to Fourier Transform.

Network Functions: Ports and terminal pairs, network functions, Poles and zeros, necessary conditions for driving point functions and transfer functions, Time domain behavior from pole-zero plot.

Two Port Networks: Introduction, Characterization of linear time invariant two port networks, Z-,Y-, h- and transmission parameters, Interrelationship between these parameters, Interconnection of 2-port networks, Image parameters, Attenuation and phase shift in symmetrical T- and π - networks.

Filters and Active Networks: Classifications of filters, Filter networks, pass band and stop band types, Constant k-low pass and high pass filters, Characteristics impedance and cut off frequency, m-derived filters.

Graph Theory and Network Equations: Introduction, graph of a network, trees, co-trees and loops, incidence matrix, Cut-set matrix, Tie-set matrix and loop currents, Analysis of networks using graph theory, duality, and general network transformations.

Network Synthesis: Introduction, Hurwitz polynomials, positive real functions, driving point and transfer impedance function, LC-network, synthesis of dissipative network, Two-terminal R-L network, Two-terminal R-C networks, Synthesis of R-L and R-C networks by Cauer and Foster – methods.

Books Recommended

1. Van-Valkenburg M E, "*Network Analysis*", 3rd Ed. Prentice Hall, New Delhi (1999)
2. Aatre V K, "Network Theory and Filter Design", Wiley (1980)
3. Roy Choudhury D, "Networks and Systems", New Age International Publisheres (1997)
4. Roy Choudhury D, "Networks and Systems", New Age International Publishers (2000)
5. Van-Valkenburg M E, "Introduction to Modern Network Synthesis", Wiley and Sons (1999).

1. To study resonance in circuits
2. To Verify Telegen's theorem
3. To verify Thevenin's Theorem and Norton Theorem for a given network
4. To verify maximum power transfer theorem and reciprocity theorem
5. To evaluate two-port parameters for a TTPN
6. To verify working of inter-connected two TTPNs

7. To evaluate transmission parameters of a ladder network
8. To plot current locus of R-L and R-C series circuits
9.
 - a) To observe the response of a RLC circuit to a.c. input.
 - b) Determining the phase shift between the applied voltage and current using Lissajous figures.
10. To find the Q of a coil by a series resonance method and verify it using Q meter.
11.
 - a) To draw the characteristics of output voltage of a coupled circuit
 - b) Determination of self and mutual inductances of a coupled circuit
12. To convert a four terminal network into a three terminal network (i.e. equivalent T network)
13. To design, fabricate and to obtain characteristics of a low pass T type filter
14. To design, fabricate and to obtain characteristics of a high pass T type filter
15. To design, fabricate and to obtain characteristics of a band pass T type filter
16. To design, fabricate and to obtain characteristics of a composite low pass filter
17. To design, fabricate and to obtain characteristics of a composite high pass filter
18. To design, fabricate and to obtain characteristics of a composite band pass filter
19. To obtain the response of a given network to step and impulse inputs and to verify the result
20. To obtain the impulse response and frequency response of a zero hold circuit
21. To study an active filter and to obtain characteristics in respect of Butterworth filter
22. To study Chebyshev filter and to realize it in both active and passive form

Note: At least 8-10 experiments are to be performed

IC-205 Electrical Measurement and Measuring Instruments [3 1 0 4]

Analog Measuring Instruments: Classification of analog instruments, operating forces in indicating instruments, T/W ratio, pointers and scales. Working principle, theory, construction and salient features of electromechanical indicating / registering instrument viz. PMMC, Electro dynamometer, Moving iron, Rectifier type, Induction type for the measurement of dc and ac voltage, current, power, energy (1-phase induction type wattmeter), power factor (single phase Electro dynamometer), Volt ohmmeter or multimeter.

Measurement of Resistances: Classification of resistances, measurement of medium resistance, Measurement of low resistance (Kelvin double bridge, Ammeter -Voltmeter) and Measurement of high resistance including loss of charge method and Mega ohm bridge method.

AC Bridges: General theory of ac bridge, Measurement of self inductance, Measurement of capacitance, Measurement of mutual inductance, Measurement of frequency, Sources of error in ac bridges and their minimization.

Potentiometer: Introduction to basic principle, Laboratory type Crompton's potentiometer, Dual range potentiometer, Volt ratio box, application of dc potentiometer, self balancing potentiometer.

Magnetic Measurement: Working principle and theory of Ballistic galvanometer, Measurement of flux density, Determination of B-H curve, hysteresis loop, Ewing Double bar permeameter, Hopkinson permeameter, separation of iron losses by wattmeter and Bridge methods.

Instrument Transformers: Theory and construction of current and potential transformers, transformation ratio and phase angle errors and their minimization, effects of pf, secondary burden and frequency.

Cathode Ray Oscilloscope: Principle and working of CRO, Block diagram presentation of CRO and brief description of various elements of CRO – CRT, horizontal Deflecting system, Vertical deflecting system, CRO screen, Measurement of voltage, frequency and phase angle using CRO, CRO probes.

Books Recommended

1. Cooper W D, "*Electronic Instrumentation and Measurement Techniques*", Prentice Hall, New Delhi (1982)
2. Sawhney A K, "*Electrical and Electronics Measurements and Instrumentation*", Dhanpat Rai and Sons, New Delhi (1993)
3. Bell David A, "*Electronic Instrumentation and Measurements*", Prentice Hall, Inc, New Delhi (1994)
4. Reissland Martin V, "*Electrical Measurements Fundamentals, Concepts, Applications*", Wiley Eastern Limited, New Delhi (1989).
5. Wolf S and Smith R F M, "*Student Reference Manual for Electronic Instrumentation Laboratories*", Prentice Hall, New Delhi (1996).

IC -207 Electrical Measurement and Measuring Instruments Laboratory [0 0 2 1]

1. To measure amplitude and frequency of the signal using CRO (Y-t mode)

2. To measure frequency of an unknown signal and phase angle between two signals obtaining Lissajous pattern using a CRO
3. Measurement of medium resistance with the help of a Wheatstone Bridge
4. Measurement of low resistance with the help of a Kelvin Double Bridge
5. Measurement of high resistance using a Meggar
6. Measurement of capacitance and inductance by Maxwell's Bridge
7. Measurement of capacitance by Schering Bridge
8. Measurement of frequency by Wein's Bridge
9. To study potentiometer and to plot EMF Vs. Displacement characteristics of a potentiometer
10. To plot calibration curve for PMMC, Moving Iron and Electrodynamic type of voltmeters
11. To measure power consumed by a 3-phase load and to find its power factor using 2-Wattmeter method
12. To plot calibration curve for a single phase energy meter
13. To find Q-factor of the coil using series resonance method and verify it using LCR-Q meter
14. To draw a B-H loop of toroidal specimen by the Fluxmeter
15. To measure iron losses in the magnetic specimen using Wattmeter method.

Note: At least 8 Experiments are to be performed

EC-205 Digital Electronics

[3 1 0 4]

Number Systems and Boolean Algebra: Number systems, Radix conversion, Complements 9's & 10's, Subtraction using 1's & 2's complements, Binary codes, Error detecting and Correcting codes, Theorems of Boolean algebra, Canonical forms, Logic gates.

Digital Logic Families: Introduction to bipolar Logic families: RTL, DCTL, DTL, TTL, ECL and MOS Logic families: NMOS, PMOS, CMOS, Details of TTL logic family - Totem pole, open collector outputs, TTL subfamilies, Comparison of different logic families.

Combinational Logic: Representation of logic functions, Simplification using Karnaugh map, Tabulation method, Implementation of combinational logic using standard logic gates, Multiplexers and Demultiplexers, Encoders and Decoders, Code Converters, Adders, Subtractors, Parity Checker and Magnitude Comparator.

Sequential Logic Concepts And Components: Flip flops - SR, JK, D and T flip flops - Level triggering and edge triggering, Excitation tables - Counters - Asynchronous and synchronous type Modulo counters, design with state equation state diagram, Shift registers, type of registers, circuit diagrams.

D/A And A/D Converters: Weighted resistor type D/A Converter, Binary ladder D/A converter, Steady state accuracy test, D/A accuracy and resolution, Parallel A/D Converter, counter type A/D converter, Successive approximation A/D converter, Single and Dual slope A/D converter, A/D accuracy and resolution.

Semiconductor Memories: Memory organization, Classification, and characteristics of memories, Sequential memories, ROMs, R/W memories, Content Addressable memories, Charged-Coupled Device memory, PLA, PAL and Gate Array.

Books Recommended

1. Malvino and Leach "Digital principles and Applications" Tata McGraw Hill.
2. Jain R P "Modern Digital Electronics", Tata McGraw-Hill, Third Edition, (2003)
3. Mano M Morris, "Digital Design" Pearson Education, Third Edition, (2006)
4. James W. Bignell and Robert Donovan, "Digital Electronics", 5th Edition (2007)
5. Fletcher "An Engineering Approach to Digital Design", Prentice Hall of India, New Delhi.

EC-225 Digital Electronics Laboratory

[0 0 2 1]

1. Verification of the truth tables of TTL gates, e.g., 7400, 7402, 7404, 7408, 7432, 7486.
2. Verify the NAND and NOR gates as universal logic gates.
3. Verification of the truth table of the Multiplexer 74150.
4. Verification of the truth table of the De-Multiplexer 74154.
5. Design and verification of the truth tables of Half and Full adder circuits.
6. Design and verification of the truth tables of Half and Full subtractor circuits.
7. Design and test of an S-R flip-flop using NOR/NAND gates.
8. Verify the truth table of a J-K flip-flop (7476)
9. Verify the truth table of a D flip-flop (7474)

10. Operate the counters 7490, 7493. Verify the frequency division at each stage and with a low frequency clock (say 1 Hz) display the count on LEDs.
 11. Operate the universal shift register 74194.
 12. Verify the truth table of decoder driver 7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock.
 13. Design and test D/A converter using R-2R Ladder Network
- Experimentation work to be supported by simulated results.

HM-201 Engineering Economics and Industrial Management

[3 1 0 4]

Definition and Scope of Engineering Economics: Concept of revenue and costs, break-even analysis. Law of demand & supply, time value of money, present and future worth methods.

Decision Making: Decision making process, decision making under risk certainty, uncertainty and conflict.

Replacement and maintenance Analysis: Types of maintenance, determination of economic life of an asset, replacement of items that fail suddenly and that fail over a period of time.

Methods of depreciation: straight line method, sum-of-the year's digest method, declining balance method, sinking fund method and service output method of depreciation.

Inventory control: Introduction and objective of inventory control, purchase model with instantaneous replenishment, model with shortages, price break model, ABC analysis.

Forecasting: Demand forecasting by quantitative and qualitative techniques, applications of demand forecasting.

Make or Buy Decision: Criteria for make or buy, approaches for make or buy decision.

Value Engineering Analysis: Value analysis vs. value engineering function, aims and value engineering procedure, advantages & applications.

Linear Programming: Linear programming as a tool of decision making, graphical and Simplex Methods and applications in decision making.

Books Recommended

1. Panaeerselvam, R., (2001), "*Engineering Economics*" Prentice Hall of India: New Delhi
2. Smith G.W., (1973), "*Engineering Economics*", Iowa State Press: Iowa
3. Grant, E.L., Irevan, W.G. and Leanenworh, R.S., (1976), 'Principles of Engineering Economy'. Ronald Press: New York
4. Lee S.M. Moore and Taylor, (2005), "*Management Science*".
5. Jaha, H.A , (2005), "*Operations Research: An Introduction*", Prentice-Hall of India: New Delhi

4TH SEMESTER

IC-202 EMF Theory

[3 1 0 4]

Electrostatics: Review of the fundamental postulates of Electrostatics in free space, Coulomb's Law, Gauss's Law and applications, Electric potential, Conductors and Dielectrics in static Electric Field, Electric flux density, boundary conditions for electrostatic fields, Capacitance and capacitors, Electrostatic energy and Forces, Poisson's and Laplace's Equations, Uniqueness of Electrostatic solutions, method of images.

Magnetostatics: Review of the fundamental postulates of magnetostatics in free space, vector magnetic potential, Biot-Savart Law and applications, magnetic Dipole, Magnetic field intensity and relative permeability, boundary conditions for Magnetostatic fields, magnetic forces and torques.

Time varying fields and Maxwell's Equations: Introduction, Faraday's law of Electromagnetic Induction, Maxwell's Equations.

Plane Electromagnetic Waves: Introduction, Plane waves in lossless media, plane waves in lossy media, Group velocity, Flow of Electromagnetic Power and the Poynting Vector, Normal Incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary.

Transmission lines: Introduction, transmission line parameters, transmission line equations, input impedance, SWR, and Power, Smith chart, microstrip transmission lines.

Waveguides: Introduction, rectangular waveguides, TM and TE modes, wave propagation in the guide, power transmission and attenuation, waveguide current and mode excitation, waveguide resonators

Electromagnetic Interference and Compatibility: Introduction, source and characteristic of EMI, control techniques.

Books Recommended

1. Jordon E C and K G Balmain, "*Electromagnetic waves and radiating systems*", Prentice Hall, New Delhi (1995).
2. Kraus J D, "*Electromagnetics*", McGraw Hill New York (1999).
3. Hayt W H and J A Buck, "*Engineering Electromagnetics*", Tata McGraw Hill Publishing Co., New Delhi (2001).
4. Edminister J A, "*Schaum's outline of theory and problems of Electromagnetics*", Tata McGraw Hill Publishing Co., New Delhi (2002).
5. Sadiku M N O, "*Elements of Electromagnetics*", Oxford University Press (2004)

MA-202 Numerical Methods

[3 1 0 4]

Roots of algebraic and transcendental equations, Bisection Method, Regula – Falsi method, Newton –Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of simultaneous algebraic equations, matrix inversion and eigen-value problems, triangularisation method, Jacobi's and Gauss-Siedel iteration method, partition method for matrix inversion, power method for largest eigen-values and Jacobi's method for finding all eigen-values.

Finite differences, interpolation and numerical differentiation, forward, backward and central differences, Newton's forward, backward and divided difference interpolation formulas, Lagrange's interpolation formula, Stirling's and Bessel's central difference interpolation formulas, numerical differentiations using Newton's forward and backward difference formulas and Numerical differentiations using Stirling's and Bessel's central difference interpolation formulas.

Numerical integration, Trapezoidal rule, Simpson's one-third rule and numerical double integration using Trapezoidal rule and Simpson's one-third rule.

Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods for ordinary differential equations, simultaneous first order differential equations and second order differential equations.

Boundary value problems, finite difference methods for boundary value problems.

Partial differential equations, finite difference methods for elliptic, Parabolic and hyperbolic equations.

Books Recommended

1. S S Sastry, *Introductory Methods of Numerical Analysis*, 3rd Edition, Prentice Hall of India Pvt.Ltd., New India -1999
2. S C Chapra and R P Canale, *Numerical Methods for Engineers*, 2nd Edition, McGraw Hill Book Company, Singapore 1990.
3. Grewal, B S, "*Numerical Methods*", Khanna Publishers, Delhi.

Principle of Electromechanical Energy Conversion: Principle of energy conversion, Singly excited magnetic system, Dynamic equations.

D C Generators: EMF equation, classification of D.C. generators, various characteristics, parallel operation of D.C Generators, Tests on Generators, Losses and Efficiency.

D C Motors: Construction and principle of operation, armature winding, torque equation, characteristics of d. c. motors and their applications, Braking and speed control.

Transformers: Construction and working principle, type of single-phase transformer, concept of ideal transformer, emf equation, transformer on load, phasor diagram on no load and on load, equivalent circuit, O.C and S.C tests. Regulation and efficiency. Pulse transformer. Low, intermediate and high frequency response, Three Phase Transformers, Auto Transformer: Principle of operation, advantages, phasor diagram, equivalent circuit.

Three Phase Induction Motors: Construction and principle of operation, slip-torque equation, characteristics, phasor diagram at standstill and on load, equivalent circuit, No load and blocked rotor tests, methods of speed control, applications.

Single Phase Induction Motors: Construction and principle of operation, Double revolving field theory, types of single phase induction motor, equivalent circuit, phasor diagram, characteristics, hysteresis motor, reluctance motor, universal motor and their characteristics, applications

Introduction to synchronous machines and stepper motors.

Books Recommended

1. Fitzgerald A F, Kingsley C and Umans S D, *“Electrical Machinery”*, McGraw Hill (1983).
2. Puchstein A F, Lloyds T C and Conard A C, *“Alternating Current Machines”*, Asia Publishing House (1968).
3. Bimbhra P S, *“Electrical Machinery”*, Khanna Publishers, Delhi, 6th Ed. (2003)
4. Nagrath I J and Kothari D P, *“Electric Machines”*, Tata McGraw Hill (1985).
5. Gupta B R and Singhal V *“Fundamentals of Electric Machines”*, 2nd Ed., New Age International Pub. (2000).

1. To perform Ratio, Polarity and the Load Test on a Single Phase Transformer
2. To perform Open Circuit and Short Circuit Test on a Single Phase Transformer and hence determine its Equivalent Circuit Parameters
3. To perform Parallel Operation on two Single Phase Transformers
4. Speed Control of a DC Shunt Motor
5. To obtain Magnetization characteristics of
 - a) a separately excited DC Generator
 - b) a Shunt Generator
6. To obtain the load characteristics of
 - a) a DC Shunt Motor
 - b) a DC Cumulative Compound Generator
7. To perform no-load test and blocked rotor test on a three-phase induction motor and hence determine its equivalent circuit parameters
8. To perform load test on a three-phase induction motor and obtain its various performance characteristics
9. To perform the retardation test on a three phase induction motor and obtain its moments of inertia
10. To perform no-load and blocked-rotor test on a single phase induction motor and hence determine its equivalent circuit parameters
11. To study dc shunt motor starters.
12. To perform reversal and speed control of Induction motor.
13. Identification of different windings of a dc compound motor.

Note: At least 8 experiments are to be performed

Introduction to Semiconductors: Semiconductors, Conductor and Insulators, Intrinsic and extrinsic silicon, p-n junction, Current-Voltage characteristics of a p-n junction, the Diode, Rectifiers-half wave and full wave, Special purpose diodes - Zener diode, Tunnel diode and Varactor diode, Photo diode, clippers-single and two level, clampers, their analysis with ideal and practical diodes.

Bipolar Junction Transistor: Transistors-construction, operation, characteristics, parameters, Transistor as an amplifier at low frequency, Hybrid model and re model of BJT, Analysis of amplifier using Hybrid model and re model, Amplifier types-CE,CB,CC. DC operating point, DC Biasing circuits-fixed bias, emitter bias, voltage divider bias, bias stabilization.

Field-Effect Transistor: The junction FET - construction, operation, characteristics, parameters, JFET as an amplifier, FET as a VVR and MOSFET- construction, operation, characteristics, parameters.

Power and Multistage Amplifiers: Power Amplifiers, Types, analysis of Class A, B,C,AB; Multistage Amplifiers, Types of multistage couplings.

Feedback Amplifier and Oscillators: Feedback concept, Analysis of various configurations of feedback in amplifiers, Criterion for oscillation and Oscillator based on RC and LC feedback circuits, crystal oscillator.

Introduction to op-amps: Op-amp- analysis, Ideal op-amp building blocks, Open loop op-amp configurations, Practical op-amp- Offset voltage, Input bias and offset current, CMRR, Block diagram representations and analysis of configurations using negative feedback. Applications of op-amp.

Specialized ICs: 555 Timer-Monostable multivibrator, astable multivibrator, PLL.

Books Recommended:

1. Millman, Jacob, Halkias Christos C and Satyabrata jit, "*Electronic Devices and Circuits*" Tata McGraw- Hill, New Delhi.
2. Boylestad Nashelsky, "*Electronic Devices and Circuit Theory*", 8th Ed., Pearson Education, 7th Indian Reprint (2004)
3. Gayakwad Ramakant A, "*Op-amps and Linear Integrated Circuits*", Pearson Education, 4th Ed., New Delhi (2002)
4. Sedra, Adel S and Smith, Kenneth C, "*Microelectronic Circuits*", Oxford University Press, New York, Fourth Edition, (1997)
5. Streetman Ben J, Sanjay Banerjee, "*Solid State Electronic Devices*", 5th Ed. PHI (2004)

EC-272 Electronic Devices and Analog Integrated Circuits Laboratory [0 0 2 1]

1. To study bipolar transistor as a switch.
2. To plot a load line for a CE amplifier and show effect of input signal on Q-point.
3. To demonstrate use of a BJT in a CE amplifier circuit configuration and study its frequency response.
4. To demonstrate use of a BJT in a CC amplifier circuit configuration and study its frequency response.
5. To demonstrate and study a two stage RC coupled amplifier.
6. To demonstrate working of a JFET and study its V-I characteristics.
7. To demonstrate working of a Wein Bridge Oscillator.
8. To demonstrate working of an op-amp as a voltage level detector.
9. To demonstrate working of an op-amp as a square wave generator.
10. To demonstrate the operation of a 555 timer as monostable multivibrator.
11. To demonstrate the operation of a 555 timer as astable multivibrator

This is only the suggested list of practicals. Instructor may frame additional practicals relevant to the course contents

CS-207 Object Oriented Programming

[3 0 0 3]

Object oriented thinking: Need for oop paradigm, A way of viewing world – Agents, responsibility, messages, methods, classes and instances, class hierarchies (Inheritance), method binding, overriding and exceptions, summary of oop concepts, coping with complexity, abstraction mechanisms.

Java Basics: History of Java, Java buzzwords, datatypes, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and casting, simple java program, classes and objects – concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, string handling.

Inheritance: Hierarchical abstractions, Base class object, subclass, subtype, substitutability, forms of inheritance- specialization, specification, construction, extension, limitation, combination, benefits of inheritance,

costs of inheritance. Member access rules, super uses, using final with inheritance, polymorphism- method overriding, abstract classes.

Packages and Interfaces: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces. Exploring packages – Java.io, java.util.

Exception handling and multithreading: Concepts of exception handling, benefits of exception handling, Termination or resumptive models, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. Differences between multi threading and multitasking, thread life cycle, creating threads, synchronizing threads, daemon threads, thread groups.

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes. The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, dialogs, menubar, graphics, layout manager – layout manager types – boarder, grid, flow, card and grib bag.

Applets: Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets.

Swing: Introduction, limitations of AWT, MVC architecture, components, containers, exploring swing-JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons – The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables.

Networking: Basics of network programming, addresses, ports, sockets, simple client server program, multiple clients, Java .net package Packages – java.util,

Books Recommended

1. An Introduction to programming and OO design using Java, J.Nino and F.A. Hosch, John wiley & sons.
2. An Introduction to OOP, second edition, T. Budd, pearson education.
3. Introduction to Java programming 6th edition, Y. Daniel Liang, pearson education.
4. An introduction to Java programming and object oriented application development, R.A. Johnson-Thomson.
5. Core Java 2, Vol 1, Fundamentals, Cay.S.Horstmann and Gary Cornell, seventh Edition, Pearson Education.

Objectives:

- To make the student learn a object oriented way of solving problems.
 - To teach the student to write programs in Java to solve the problems
1. a) Write a Java program that prints all real solutions to the quadratic equation $ax^2 + bx + c = 0$. Read in a, b, c and use the quadratic formula. If the discriminant $b^2 - 4ac$ is negative, display a message stating that there are no real solutions.
b) The Fibonacci sequence is defined by the following rule:
The first two values in the sequence are 1 and 1. Every subsequent value is the sum of the two values preceding it. Write a Java program that uses both recursive and non recursive functions to print the nth value in the Fibonacci sequence.
 2. a) Write a Java program that prompts the user for an integer and then prints out all prime numbers up to that integer.
b) Write a Java program to multiply two given matrices.
c) Write a Java Program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use StringTokenizer class of java.util)
 3. a) Write a Java program that checks whether a given string is a palindrome or not. Ex: MADAM is a palindrome.
b) Write a Java program for sorting a given list of names in ascending order.
c) Write a Java program to make frequency count of words in a given text.
 4. a) Write a Java program that reads a file name from the user, then displays information about whether the file exists, whether the file is readable, whether the file is writable, the type of file and the length of the file in bytes.
b) Write a Java program that reads a file and displays the file on the screen, with a line number before each line.
c) Write a Java program that displays the number of characters, lines and words in a text file.
 5. a) Write a Java program that:
 - i) Implements stack ADT.
 - ii) Converts infix expression into Postfix form
 - iii) Evaluates the postfix expression
 6. a) Develop an applet that displays a simple message.
b) Develop an applet that receives an integer in one text field, and computes its factorial Value and returns it in another text field, when the button named "Compute" is clicked.
 7. Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -, *, % operations. Add a text field to display the result.
 8. Write a Java program for handling mouse events.
 9. a) Write a Java program that creates three threads. First thread displays "Good Morning" every one second, the second thread displays "Hello" every two seconds and the third thread displays "Welcome" every three seconds.
b) Write a Java program that correctly implements producer consumer problem using the concept of inter thread communication.
 10. Write a program that creates a user interface to perform integer divisions. The user enters two numbers in the textfields, Num1 and Num2. The division of Num1 and Num2 is displayed in the Result field when the Divide button is clicked. If Num1 or Num2 were not an integer, the program would throw a Number Format Exception. If Num2 were Zero, the program would throw an Arithmetic Exception Display the exception in a message dialog box.
 11. Write a Java program that implements a simple client/server application. The client sends data to a server. The server receives the data, uses it to produce a result, and then sends the result back to the client. The client displays the result on the console. For ex: The data sent from the client is the radius of a circle, and the result produced by the server is the area of the circle. (Use java.net)
 12. a) Write a java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time No light is on when the program starts.
b) Write a Java program that allows the user to draw lines, rectangles and ovals.
 13. a) Write a java program to create an abstract class named Shape that contains an empty method named number Of Sides (). Provide three classes named Trapezoid, Triangle and Hexagon such

that each one of the classes extends the class Shape. Each one of the classes contains only the method number Of Sides () that shows the number of sides in the given geometrical figures.

- b) Suppose that a table named Table.txt is stored in a text file. The first line in the file is the header, and the remaining lines correspond to rows in the table. The elements are separated by commas. Write a java program to display the table using JTable component.

Books Recommended

1. Java How to Program, Sixth Edition, H.M.Dietel and P.J.Dietel, Pearson Education/PHI
2. Introduction to Java programming, Sixth edition, Y.Daniel Liang, Pearson Education
3. Big Java, 2nd edition, Cay Horstmann, Wiley Student Edition, Wiley India Private Limited.

HM-202 Entrepreneurial Development and Management

[3 0 0 3]

Entrepreneurship Development: Meaning, objectives, scope & philosophy, type of entrepreneurs, factors affecting entrepreneurship, entrepreneurial qualities, need for promotion of entrepreneurship & small business, linkage between entrepreneurship and economic development, problem of increasing unemployment, creativity & entrepreneurship, harnessing locally available resources.

Entrepreneurship Support System: SIDBI, SISIs, SSIEC, SFCs, DICs, NSIC, EDI (Ahmedabad), NRDC, NIESBUD, PSIEC and Technical Consultancy Organisations.

Project Report Preparation: Planning a small scale industry, identifying business opportunities, project report & its importance, various contents of project report: managerial & entrepreneurial capabilities, socio-economic benefits, demand analysis, technical feasibility and financial viability.

Introduction to Marketing Management: Brief introduction to various types of product strategies, pricing strategies, channel strategies and promotional strategies.

Introduction to Production Management: Types of production systems, production planning and control, functions of production manager & materials management.

Introduction to Human Resource Management: Manpower planning, recruitment, selection, placement & induction, training & development, compensation.

Introduction to Financial Management: Sources of finance and working capital management.

Books Recommended:

1. Prasanna Chandra, "*Projects : Planning, Analysis, Selection, Implementation & Review*", Tata McGraw Hill
2. Kenneth R., Van Voorthis, Entrepreneurship and Small Business Management.
3. B. Gupta & N.P. Srinivasan, "*Entrepreneurial Development*".
4. Gopala Krishnan & V.E Rama Moorthy, "*Project Management*", Macmillan India Ltd.
5. Jose Paul and Kumar Ajith N, "*Entrepreneurship Development and Management*", Himalaya Publishers, New Delhi (2000).

5TH SEMESTER

IC-301 Microprocessors and Applications

[3 1 0 4]

Introduction to 8-Bit Microprocessor: General 8-bit Microprocessor and its architecture – Intel 8085 Microprocessor, Pin Configuration, CPU Architecture, Registers, ALU Control Unit, Stack.

Microprocessor Instruction Set (INTEL 8085): Complete instruction set of INTEL 8085, instruction format, types of instructions, various addressing modes, Timing diagrams – T-states, machine cycles, instruction cycle.

Assembly Language Programming: Programming of Microprocessors using 8085 instructions, use of Arithmetic, logical, Data transfer, stack and I/O instructions in programming, Interrupt in 8085.

Peripherals and Interfacing for 8085 Microprocessors: Memory interfacing, I/O interfacing – memory mapped and peripheral mapped I/O, Data transfer schemes – Programmed, Interrupt driven and Direct memory Access (DMA) data transfers, Block diagram representation, Control word formats, modes and Simple programming of 8255A PPI, 8254 Programmable Interval Timer, 8259A programmable Interrupt Controller, 8237 DMA Controller, Key board / display controller, Interfacing of Data converters (A/D & D/A), Serial I/O and data communication

Introduction to 8086 Microprocessors: Architecture of 8086, block diagram, register set, flags, Queuing, concept of segmentation, Pin description, operating modes, addressing modes and interrupts.

Applications of Microprocessors: Applications of microprocessors in temperature, pressure, flow and level control in processes.

Books Recommended

1. Gaonkar R S, “*Microprocessor architecture, programming and application with 8085*”, Wiley (2003).
2. B. Ram, “*Fundamentals of Microprocessors and Microcomputers*”, Dhanpat Rai and Sons, N. Delhi., 4th Ed. (1993).
3. Liu Yu-Cheng, “*Microcomputer Systems*”, The 8086/8088 family, 2nd Ed. PHI, New Delhi (1986)
4. Mathur A P, “*Introduction to Microprocessors*”, 3rd Ed., TMH, New Delhi (1996).
5. Ray A.K. and Bhurchandi K.M. “*Advanced Microprocessor and peripherals: Architecture programming and interfacing*” 1st Ed. TMH New Delhi (2001)

IC-303 Microprocessor and Applications Laboratory

[0 0 2 1]

- 1 a) Familiarization with the 8085 kit (trainer kit)
b) To execute at least 8 programs on the above kit.
- 2 a) Familiarization with the 8085 kit (trainer-cum-development)
b) To execute at least 5 program on the above kit.
3. Study of 8155 card
4. Study of 8212 card
5. Study of 8255 card
6. Study of 8253 card
7. Study of 8251 card
8. Study of latch, buffer, decade, RAM study card.
9. Study of 8257/8237 DMA control study card.
10. Study of DC motor study card.
11. Study of traffic control study card.
12. Study of A to D and D/A converter.
13. Familiarization with 8086 trainer kit

Note: At least 8 experiments are to be performed

IC-305 Control Engineering-I

[3 1 0 4]

Introductory Concepts: Plant, Systems, Servomechanism, regulating systems, disturbances, Open loop control system, closed loop control systems, linear and non-linear systems, time variant and invariant, continuous and sampled-data control systems, Block diagrams, some illustrative examples.

Modeling: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical, mechanical analogies. Use of Laplace transforms, Transfer function, concepts of state variable modeling. Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

Time Domain Analysis: Typical test – input signals, Transient response of the first and second order systems. Time domain specifications, Dominant closed loop poles of higher order systems. Steady state error and coefficients, pole-zero location and stability, Routh-Hurwitz Criterion.

Root Locus Technique :The extreme points of the root loci for positive gain. Asymptotes to the loci, Breakaway points, intersection with imaginary axis, location of roots with given gain and sketch of the root locus plot.

Frequency Domain Analysis: Closed loop frequency response, Bode plots, stability and loop transfer function. Frequency response specifications, Relative stability, Relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Compensation: Necessity of compensation, series and parallel compensation, compensating networks, applications of lag and lead-compensation.

Control Components: Error detectors – potentiometers and synchros, servo motors, a.c. and d.c. techno generators, Magnetic amplifiers.

Books Recommended

1. Ogata K, “*Modern Control Engineering*”, Prentice Hall, 4th Ed., N. Delhi (2002)
2. Kuo B C, “*Automatic Control System*”, Prentice Hall, 3rd Ed. (1978)
3. Nagrath I J and Gopal M, “*Control System Engineering*”, Wiley Eastern Ltd. N. Delhi (1998)
4. Dorf Richard C and Bishop Robert H, “*Modern Control System*”, Addison –Wesley, Pearson New Delhi (1998).
5. Stephanopoulos G, “*Chemical Process Control – An Introduction to Theory and Practice*”, 1st Ed., Prentice Hall of India Pvt. Ltd., New Delhi (1998)

IC-307 Control Engineering-I Laboratory

[0 0 2 1]

1. To study the characteristics of potentiometer and to use it as an error detector in a control system
2. To study the synchro Transmitter-Receiver set and to use it as an error detector
3. To study the Speed – Torque characteristics of an AC Servo Motor
4. To study the Speed – Torque characteristics of an DC Servo Motor
5. To study the various electro-mechanical transducers i.e. resistance, capacitance, inductive transducers
6. To study a LVDT (AC-AC, DC-DC) as a transducer and its processing circuits
7. To study the characteristics of a thermocouple, a thermistor and a RTD
8. To study photo-conductive cell, semi-conductor photodiode and a silicon photo voltaic cell
9. To study a silicon phototransistor and obtain response of photo conductive cell
10. To study the variations of time lag by changing the time constant using control engineering trainer
11. To simulate a third order differential equations using an analog computer and calculate time response specifications
12. To obtain the transfer function of a D.C. motor – D.C. Generator set using Transfer Function Trainer
13. To study the speed control of an A.C. Servo Motor using a closed loop and an open loop systems
14. (i) To study the operation of a position sensor and study the conversion of position in to voltage
(ii) To study the PI control action and show its usefulness for minimizing steady state error
15. To measure Force / Displacement using Strain Gauge in a wheat stone bridge

Note: At least 8 Experiments are to be performed

IC-309 Transducers and Signal Conditioning

[3 1 0 4]

Introduction: Measurement systems, Basic electronic measuring system, Transduction principles, Classification of transducers, General transducers characteristics, Criteria for transducer selection.

Resistive Transducers: Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.

Inductive Transducers: Types of Inductive transducer, Principles of operation, construction, Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT (Linear variable differential transformer).

Capacitive Transducers: Types of capacitive transducer, Principles of operation, construction, theory, advantages and disadvantages and applications, of capacitive transducers based upon familiar equation of capacitance.

Elastic Transducers: Spring bellows, diaphragm, bourdon tube – their special features and application.

Active Transducers: Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: Thermocouple, Piezo-electric transducer, Magneto-strictive transducer, Hall effect transducer, Photo-voltaic transducer and Electrochemical transducer.

Other Transducers: Optical transducers: photo-emissive, photo-conductive and Photo-voltaic cells, Digital Transducers: Optical encoder, Shaft encoder. Feedback fundamentals, introduction to Inverse transducer.

Signal Conditioning: Concept of signal conditioning, Introduction to AC/DC Bridges. Op-amp circuits used in instrumentation, Instrumentation amplifiers, analogue-digital sampling, introduction to A/D and D/A conversion, signal filtering, averaging, correlation, Interference, grounding, and shielding.

Books Recommended

1. Murty D V S, "*Transducers & Instrumentation*", PHI, New Delhi (2000)
2. Sawhney A K, "*Electrical and Electronics Measurements and Instrumentation*", Dhanpat Rai and Sons, New Delhi (2000).
3. Kalsi H S, "*Electronic Instrumentation*" Tata McGraw Hill, New Delhi, 4th Ed. (2001).
4. Patranabis D, "*Sensors and Transducers*", PHI, New Delhi (2003).
5. Doebelin Ernest O, "*Measurement Systems: Application and Design*", Tata McGraw Hill Ltd., New Delhi (2004).

IC-311 Transducers and Signal Conditioning Laboratory [0 0 2 1]

1. To measure displacement using an LVDT (linear variable differential transformer)
2. To measure the temperature using thermocouple and to plot variation of temperature with the voltage
3. To measure the force using a full bridge strain gauge based transducer
4. To measure the strain of a deflecting beam with the help of a strain gauge
5. To measure speed-using a proximity type sensor
6. To measure temperature using a thermistor and to plot variation of resistance with temperature
7. To study the recording of different signals from sensors on a magnetic tape recorders
8. To study the acquisition data from strain gauge transducer using a data acquisition system
9. To study the acquisition of data from inductive transducer using a data acquisition system
10. To measure the vibrations of system using a piezoelectric crystal
11. To study the performance of an LCD, LED, BCD to 7-segment display
12. To measure a load using a load cell
13. To study the characteristics of a given bourdon tube

Note: At least 8 Experiments are to be performed

PH-206 Material Science (Nano Science) [3 1 0 4]

Crystal Structure: Fundamental concepts, Crystal systems, Closed packed structures, Crystallographic planes and directions, Miller indices, Crystal defects.

Electrical Properties: Classical free electron theory of metals, Quantum theory – Particle in a box, Wave function and energy states, Finite potential barrier, Tunneling, Fermi-Dirac distribution law, Density of energy states, Classification of solids into conductors, Semiconductors and insulators, Hall effect and its applications.

Semiconductor Materials: Intrinsic and extrinsic materials, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations, Conductivity and mobility.

Magnetic Properties: Basic concepts, Soft and hard magnetic materials, Ferrites, Selection techniques for applications, Magnetic recording, Magnetic memories.

Superconductivity: Properties of superconductors, London equations, Quantum explanation of superconductivity, Applications of superconductors.

Dielectric & Optical Properties: Dielectric materials, Polarization mechanisms, Dipole moment, Dielectric strength, Methods for producing polarization, Application of dielectric materials, Index of refraction, Damping constant, Characteristic penetration depth and absorbance, Reflectivity and transmissivity, Optical storage devices.

Nanomaterials: Introduction to nanotechnology, Nanowire and nanotube, Carbon nanotubes, Single wall carbon nanotubes, Multiwall carbon nanotubes, Fabrications, Properties and applications.

Books Recommended

1. Hummel R E, "*Electronic Properties of Materials*", Narosa Publishing House, New Delhi (1997).

2. William D Callister, Jr, "*Materials Science and Engineering*", John Wiley and Sons, Inc. New York (2002).
3. Dekker A J, "*Solid State Physics*", MacMillan, India Limited, Madras (2000).
4. Pillai S O, "*Solid State Physics*", New Age International Publishers, New Delhi (1999).
5. Van Vlack L H, "*Elements of Material Science and Engineering*", Addison Wesley Publishers (1980).
6. Poole C.P. and Owens F.J., "*Introduction to Nanotechnology*", Wiley Edition (2003)

IC-302 Process Dynamics and Control**[3 1 0 4]**

Basic Considerations: Introduction, Basic components, diagrammatic representation, symbol and Terminology, changes at arbitrary points in the loop, offset and its analysis.

Process Characteristics: Process variables, mathematical modeling of liquid, gas, thermal, mechanical and chemical systems. Linearizing techniques, Liquid level control in a tank. Dynamics of manometer, response of non-interacting and interacting first-order elements in series, Mixing process, Heat transfer process, Distillation column.

Controller Characteristics: Control modes, characteristics and comparison of on-off, proportional, integral, derivative modes and their combinations (PI, PD and PID), Introduction to Digital controllers.

Automatic Control: Single and combined modes in closed loop, static error, velocity error. Dynamic behaviour of feedback control processes for different modes, IAE, ISE, IATE criteria, Tuning of controllers, process reaction curve.

Controller Hardware: Electronic pneumatic and hydraulic controller's implementation, single and composite modes of controllers.

Final Control Elements: Control valves, types, functions, Electrical, Pneumatic hydraulic-actuators, Solenoid, E-P converters, stepper motors.

Introduction to Computerized Process Controls: Control algorithm, PID Control action with Dead time.

Books Recommended

1. Coughanowr R Donald, "*Process Systems Analysis & Control*", McGraw Hill, New Delhi (1991).
2. Patranabis.D, "*Principles of Process Control*", TMH, New Delhi (1994).
3. Stephanopoulos G, "*Chemical Process Control: An Introduction to Theory and Practice*", PHI New Delhi (1995).
4. Johnson Curtin, "*Process Control Instrumentation Technology*", PHI, New Delhi (1999).
5. Harriott P, "*Process Control*" 10th Reprint, TMH, New Delhi (1992).

IC-304 Signal Processing**[3 1 0 4]**

Introduction: Signals, Digital Signal Processing, Filters, Limitations of Analog Signal Processing, Advantages and Applications of Digital Signal Processing.

Discrete Signals and Systems: Discrete Signals, Operations on Discrete Signals, Decimation and Interpolation, Common Discrete Signals, Discrete-Time Harmonics and Sinusoids, The Sampling Theorem, Discrete-Time Systems, Solving Difference Equations, Zero-Input Response and Zero-State Response, The Impulse Response, System Representation in Various Forms, Discrete Convolution, Stability and Causality of LTI Systems, System Response to Periodic Inputs, Periodic or Circular Convolution, Deconvolution, Discrete Correlation.

Frequency Domain Analysis: Discrete-Time Fourier Transform (DTFT) from the z-Transform, Properties of DTFT, DTFT of Discrete-Time Periodic Signals, Inverse DTFT, System Analysis using the DTFT.

Filter Terminology and Characterization: Filter Response and Filter Characteristics (Gain, Phase Delay and Group Delay, Minimum-Phase), FIR Filters and Linear Phase, IIR Filters.

Digital Processing of Analog Signals: Ideal Sampling, Sampling, Interpolation and Signal Recovery, Sampling Rate Conversion, Quantization, Digital Processing of Analog Signals (Practical ADC Considerations, Anti-Aliasing Filter Considerations, Anti-Imaging Filter Considerations), Compact Disc Digital Audio, Dynamic Range Processors, Audio Equalizers, Digital Audio Effects, Digital Oscillators and DTMF Receivers.

The Discrete Fourier Transform and Its Applications: The DFT and its Properties, The DTFT and the DFT, The DFT of Periodic Signals and the DFS, The DFT of Nonperiodic Signals, Spectral Smoothing by Time Windows, Applications in Signal Processing, Spectrum Estimation, The Cepstrum and Homomorphic Filtering, Optimal Filtering, Matrix Formulation of the DFT and IDFT, Fast Fourier Transform Algorithms, Concept of Decimation-in-Time and Decimation-in-Frequency, Fixed Point and Floating Point Representations, Effects of Coefficient Quantization, Effect of Round-off Noise in Digital Filters.

Books Recommended

1. Ambardar A, "*Digital Signal Processing - A Modern Introduction*", Cengage Learning India, Delhi (2007).
2. Lyons R G, "*Understanding Digital Signal Processing*", Pearson Education India, New Delhi, 2nd Ed. (2004).

3. Proakis J G and Manolakis D G, "Digital Signal Processing", Pearson Education India, New Delhi (2003).
4. Ifeacher E C and Jerris B W, "Digital Signal Processing: A practical approach", 2nd Ed., Pearson Education, New Delhi (2002).
5. Bose ,Tamal "Digital signal and Image Processing " Wiley JW and Sons (Asia) Pvt. Ltd. (2004).

IC-306 Signal Processing Laboratory

[0 0 2 1]

1. Plotting discrete signals: Plot $\delta[n-3]$, $u[n-3]$, $r[n-3]$, $\text{sinc}(n/4)$ and $4(0.8)^n \cos(0.2\pi n)u[n]$ over the range $-10 \leq n \leq 10$.
2. Signal measures: Let $x[n] = r[n] - r[n-5] - 5u[n-10]$.
 - (a) Sketch $x[n]$, $x[n+2]$, $x[-n]$, $x_e[n]$, and $x_o[n]$.
 - (b) Find the signal energy in $x[n]$.
 - (c) Is $x[n]$ absolutely summable? Square summable?
 - (d) Sketch the periodic extension of $x[n]$ with period $N = 7$ and find its signal power.
3. Random distributions: Generate about 500 points each of a uniform and Gaussian random signal.
 - (a) Plot their first 100 values.
 - (b) Plot their histograms using 20 bins.
 - (c) Compute their mean and variance.
4. The central limit theorem: Demonstrate the central limit theorem by generating five realizations of a uniformly distributed random signal and plotting the histogram of the individual signals and their sum.
5. Signal-to-Noise Ratio: For a noisy signal $x(t) = s(t) + An(t)$ with a signal component $s(t)$ and noise component $An(t)$, the signal to noise ratio (SNR) is the ratio of signal power σ_s^2 and noise power $A^2\sigma_n^2$ and defined as $SNR = 10 \log \frac{\sigma_s^2}{A^2\sigma_n^2}$ dB. We can adjust the SNR by varying the noise amplitude A. Use the result to generate the noisy sinusoid with SNR of 18 dB.
6. Signal Averaging: Using coherent signal averaging extract the signals from the noise given below.
 - (a) Sample $x = \sin(40\pi t)$ at 1000Hz for 0.2s to obtain the discrete signal $x[n]$.
 - (b) Generate 16 runs (realizations) of a noisy signal by adding uniformly distributed random noise (with zero mean) to $x[n]$ and average the results.
 - (c) Repeat part (b) for 64 runs and compare results.
 - (d) Does averaging improve the quality of the noisy signal?
7. Discrete system response: Consider the second order system $y[n] - 0.64y[n-2] = x[n] + 2x[n-1]$ with zero initial conditions and $x[n] = 20(0.8)^n u[n]$.
 - (a) Find its response using **dsim** and filter and compare the results.
 - (b) Is this system BIBO stable?
8. Smoothing effects of a moving average filter: Consider a 20-point *moving average filter* $y[n] = 1/20\{x[n] + x[n-1] + \dots + x[n-19]\}$. It is also called a smoothing filter because it tends to smooth out the rapid variations in a signal, To confirm this try the following;
 - (a) Generate 200 samples of 1Hz sine wave sampled at 40 Hz.
 - (b) Add some noise to generate a noisy signal.
 - (c) Filter the noisy signal through the 20-point MA filter.
 - (d) Plot each signal to display the effects of noise and smoothing.
9. Convolution and convolution indices: An input $x[n] = \{2, -1, 3\}$ is applied to an FIR filter whose impulse response is given by $h[n] = \{1, 2, 2, 3\}$. Find the response $y[n]$ and sketch all three signals using the same axis limits.
10. Approximating analytical convolution: The impulse response of a digital filter is described by $h[n] = (0.4)^n u[n]$. Evaluate and plot the response $y[n]$ of this filter to the input $x[n] = (0.8)^n u[n]$ over the range $0 \leq n \leq 20$.
11. System response to sinusoidal inputs: We claim that the response of LTI system to a sinusoidal input is a sinusoid at the input frequency. Justify the statement using an input $x[n] = \cos(0.2\pi n)$ to a digital filter whose impulse response is described by $h[n] = \{1, 2, 3, 4, 5, 6, 7, 8\}$.
12. Convolution and filtering: The difference equation describing the digital filter of the previous example may be written as $y[n] = x[n] + 2x[n-1] + \dots + 8x[n-7]$. Use this to find the response to $x[n] = \cos(0.2\pi n)$ and compare with the previous example.
13. Deconvolution: Given $y[n] = \{3, 9, 17, 21, 19, 13, 6, 2\}$ and $x[n] = \{3, 3, 2, 2\}$ identify $h[n]$.

14. Circular convolution: Consider two periodic signals described over one period by $x_p[n] = \{1, 2, -1, 0, 2, 3\}$ and $h_p[n] = \{2, 1, 0, -1, -2, -3\}$. Find their periodic convolutions.
15. Let $x_p[n] = \{1, 2, -1, 0, 2, 3\}$ and $h_p[n] = \{2, 1, 0, -1, -2, -3\}$.
- Find the periodic convolution $y_1[n]$ using one period of x and h .
 - Find the periodic convolution $y_5[n]$ using 5 periods of x and h .
 - How is the period of $y_5[n]$ related to that of $y_1[n]$?
 - How are the convolution values of $y_5[n]$ and $y_1[n]$ related?
16. Let $x_p[n] = \{1, 2, -1, 0, 2\}$ and $h_p[n] = \{2, 1, 0, -1, -2, -3\}$. Find their regular convolution using zero padding and periodic convolution.
17. Autocorrelation and cross-correlation: Consider the sequences $x[n] = n, 0 \leq n \leq 8$ and $h[n] = n, 0 \leq n \leq 3$.
- Evaluate and plot $r_{xx}[n]$ and $r_{hh}[n]$ and find where they attain their maximum.
 - Evaluate and plot $r_{xh}[n]$ and $r_{hx}[n]$.
 - Evaluate and plot the correlation of $h[n]$ and $h[n-4]$ and find where it attains a maximum.
18. Signals buried in noise: Generate two noisy signals by adding noise to a 20Hz sinusoid sampled at $t_s = 0.01s$ for 2s.
- Verify the presence of the signal by correlating the two noisy signals.
 - Estimate the frequency of the signal from the FFT spectrum of the correlation.
19. Convolution by FFT: Use FFT to find
- The periodic convolution of $x_p[n] = \{1, 2, -1, 0, 2, 3\}$ and $h_p[n] = \{2, 1, 0, -1, -2, -3\}$.
 - The regular convolution of $x_p[n] = \{1, 2, -1, 0, 2\}$ and $h_p[n] = \{2, 1, 0, -1, -2, -3\}$.

Note: At least 8-experiments are to be performed

IC-308 Data Acquisition and Transmission

[3 0 0 3]

Data Acquisition System: Definition and generalized block diagram of data acquisition system (DAS), Classification of DAS, working principle block diagram, construction and salient features of the following data acquisition systems: Analog data acquisition system using time division multiplexing, Analog data acquisition system using frequency division multiplexing, Digital data acquisition system with different configurations and Data logger.

Data Transmission Systems: Definition, generalized block diagram of Telemetry system, classification of Telemetry system the working principle, block diagram, construction, salient features and applications of the following Telemetry systems: DC voltage, current and position telemetry system (Landline Telemetry system), Radio frequency amplitude modulated and frequency modulated telemetry system – theory related to amplitude and frequency modulation techniques, Pulse telemetry system – pulse amplitude modulated (PAM) system, pulse width modulated system (PWM), pulse code modulated system (PCM) system, Modem based telemetry system, Satellite Telemetry system and Fiber optic Telemetry system.

Display Systems: Construction, principle of operation and salient features of various kinds of display devices such as LED, Nixie tube, LCD, segmental gas discharge type, single and multi digit LED 7-segmental display system (study of BCD to 7 segment code converter / decoder), Nixie tube based display system for numeric display (study of BCD to decimal decoder), to design LED Dot Matrix (3 x 5) numeric display system and LCD 7-segmental numeric display system

Digital Instruments: Digital voltmeters (DVMs): working principle, construction, operation, salient features, range selection– Ramp type, dual slope integrating type, successive approximation type, Digital Frequency Meter: working principle, construction (block diagram), range selection and operation of, time period meter, frequency ratio meter, Digital Clock: block diagram construction and working, Analog Storage Oscilloscope and Digital storage oscilloscope: working principle, construction, operation and salient features.

Recorders: The working principle, construction, operation and salient features of X-t strip chart recorder, X-Y strip chart recorder and Magnetic type recorder.

Books Recommended

- Sawhney A K, “*Electric and Electronic Measurement and Instrumentation*”, Dhanpat Rai and Sons, New Delhi (1993).
- Bell David A, “*Electronic Instrumentation and Measurement*”, PHI, Inc, New Delhi (1994).
- Tocci Ronald J, “*Digital Systems Principles and Applications*”, PHI, New Delhi (2002)

4. Doebelin E O, "*Measurement systems – Applications and Deign*", McGraw Hill, New Delhi (1990).
5. Mani and Rangan, "*Instrumentation Devices and Systems*", Tata McGraw Hill, New Delhi (1997).

IC-310 Minor Project (ISD)

[0 0 2 1]

This course is aimed at providing practical design skills to students. As a matter of fact, this study can be conducted under two following categories:

- i) Designing and synthesizing any circuit as per the given parameters
- ii) Analyzing any pre designed or fabricated circuited as per the technical knowledge imparted to the students during the course of UG study / programme.

This lab prepares the students for both the above categories.

Physiological Systems of the Body: Brief description of musculoskeletal, endocrine, gastrointestinal, nervous, circulatory and respiratory systems; the body as a control system; the nature of bioelectricity, action events of nerve; the origin of biopotentials.

Bio potential Electrodes: Signal acquisition; electrodes for biophysical sensing; electrode-electrolyte interface; skin preparation, electrode-skin interface and motion artifact; surface electrodes; microelectrodes; Internal electrodes; electrode arrays; electrodes for electric stimulation of tissues; electrode polarization, electrical interference problems in biopotential measurement; electrical safety.

The Heart System and Its Measurements: The heart; electro conduction system of the heart; the ECG waveform; the standard lead system; the ECG preamplifier; ECG machines; Cardiac monitors; Transient protection; common-mode and other interference-reduction circuits.

Physiological Pressure and other Cardiovascular Measurements and Devices: Physiological pressure; blood pressure measurements; sphygmomanometer; oscillometric and ultrasonic methods; practical problems in pressure monitoring; cardiac output measurement; plethysmography; blood flow measurements; phonocardiography; vectorcardiography; defibrillators; pacemakers; heart lung machines.

The Human Respiratory System and Its Measurement: Respiratory anatomy (lungs, conducting airways, alveoli, pulmonary circulation, respiratory muscles); lung volumes and gas exchange, mechanics of breathing; parameters of respiration; regulation of respiration; unbalanced and diseased states; environmental threats to the respiratory system; respiratory system measurements; respiratory transducers and instruments; spirometry, body plethysmography.

Measurement of Electrical activity in Neuromuscular System and Brain: Neuron potential; muscle potential; electromyography (EMG); electroencephalography (EEG); EEG electrodes and the 10-20 system; EEG amplitude and frequency bands; the EEG system – simplified block diagram; preamplifiers and EEG system specifications; EEG diagnostic uses and sleep patterns; visual and auditory evoked potential recordings; EEG system artifacts.

Books Recommended

1. Carr Joseph J. and Brown John M., "*Introduction to Biomedical Equipment Technology*", 4th Ed., New Delhi: Pearson Education India (2001) (ISBN 81-7808- 327-2)
2. Webster John G (Ed.), "*Medical Instrumentation, Application and Design*", 3rd ed., Singapore: John Wiley & Sons (Asia) Pte. Ltd. (2003). (ISBN 9971-51-270-X)
3. Webster J G (ed.), "*Encyclopedia of Medical Devices and Instrumentation*", Vols. 1-4, New York: Wiley (1988).
4. Bronzino J D (ed.), "*The Biomedical Engineering Handbook*". FL: CRC Press (1995).
5. Khandpur R S, "*Handbook on Biomedical Instrumentation*", TMH, 13th reprint, New Delhi (2000).

IC-403 Biomedical Instrumentation Laboratory

[0 0 2 1]

1. Data acquisition and analysis system
 - a). To become familiar with the format of data display in the BIOPAC Student Lab data window
 - b). To learn how to position data within the data window by using software tools and pull-down menus.
 - c). To learn how to select and use the correct measurement tools for extracting information from the data.
 - d). To learn how to use the journal to record measurements and write notes.
2. Electromyography-I: fundamentals of motor unit recruitment
 - a). To observe and record skeletal muscle tonus as reflected by a basal level of electrical activity associated with the muscle in a resting state.
 - b). To record maximum grip strength for right and left hands and compare differences between male and female.
 - c). To observe, record, and correlate motor unit recruitment with increased power of skeletal muscle contraction.
 - d). To listen to EMG "sounds" and correlate sound intensity with motor unit recruitment.
3. Electromyography-II: motor unit recruitment and fatigue
 - a). To determine the maximum grip strength for right and left hands and compare differences between male and female.

- b). To observe, record, and correlate motor unit recruitment with increased power of skeletal muscle contraction.
- c). To record the force produced by grip muscles, EMG, and integrated EMG when inducing fatigue.
4. Electroencephalography: Alpha, Beta, Delta and Theta rhythms
 - a). To record an EEG from an awake, resting subject with eyes open and eyes closed
 - b). To identify and examine alpha, beta, delta and theta components of the EEG complex.
5. Electrocardiography-I: elements of electrocardiogram
 - a). To become familiar with the electrocardiograph as a primary tool for evaluating electrical events within the heart.
 - b). To correlate electrical events as displayed on the electrocardiogram with the mechanical events that occur during the cardiac cycle.
 - c). To observe changes in the electrocardiogram associated with breathing, body position, exercise, body size and age.
 - d). To anticipate the nature of changes in the electrocardiogram associated with pathology of the heart.
6. Electrocardiography-II: the bipolar limb leads and frontal plane QRS axis
 - a). To record ECG from standard bipolar limb leads I and III when the subject is supine, sitting, and breathing deeply while sitting.
 - b). To observe an application of Einthoven's Law.
 - c). To determine the mean QRS axis of the ventricles using vectors derived from the amplitude and polarity of the QRS complex in two of the three bipolar limb leads.
 - d). To determine the mean QRS potential of the ventricles.
 - e). To observe how factors such as the position of the heart in the chest influence the mean QRS axis.
7. Systemic blood pressure
 - a). To use an auscultatory method for an indirect determination of systemic arterial systolic and diastolic blood pressures and to correlate the appearance and disappearance of vascular sound with systolic and diastolic pressures, respectively.
 - b). To measure, record, and compare systemic arterial blood pressure in the right arm and the left arm of the same subject under identical conditions.
 - c). To measure, record, and compare systemic arterial blood pressure in the same subject under different experimental conditions of rest and exercise.
 - d). To compute, record and compare pulse pressure and mean arterial pressure under different experimental conditions of rest and exercise.
 - e). To compute the pulse pressure wave velocity by measuring the time between the R-wave of the ECG and the first Korotkoff sound and the distance between the heart and the brachial cuff.
8. The cardiac cycle and heart sounds
 - a). To listen to human heart sounds and qualitatively describe them as to intensity or loudness, pitch, and duration.
 - b). To correlate the human heart sounds with the opening and closing of cardiac valves during the cardiac cycle and with systole and diastole of the ventricles.
 - c). To determine the nature of the change in the relationship between electrical and mechanical events of the cardiac cycle as the heart rate increases.
9. The electrocardiogram and the peripheral pressure pulse
 - a). To become familiar with the principle of plethysmography and its usefulness in qualitatively assessing peripheral changes in blood volume.
 - b). To observe and record changes in peripheral blood volume and pressure pulse under a variety of both experimental and physiologic conditions.
 - c). To determine the approximate speed of the pressure pulse wave traveling between the heart and the finger.
 - d). To illustrate the electrical activity associated with normal cardiac activity and how it relates to the flow of blood throughout the body.
10. The respiratory cycle
 - a). To observe and record normal respiratory rate and depth utilizing pneumograph and air temperature transducers.
 - b). To observe and record modifications in the rate and depth of the normal respiratory cycle due to cerebral influence and chemoreceptor influence on the medullary control centres.
11. Pulmonary function tests: volumes and capacities
 - a). To observe experimentally, record, and /or calculate selected pulmonary volumes and capacities.
 - b). To compare the observed values of volume and capacity with predicted normals.

- c). To compare the normal values of pulmonary volumes and capacities of subjects differing in sex, age, weight, and height.
12. Pulmonary function tests: forced expiratory capacity, maximum voluntary ventilation
- a). To observe experimentally, record, and/or calculate forced vital capacity (FVC), forced expiratory volume (FEV), and maximal voluntary ventilation (MVV).
 - b). To compare observed values of FVC, FEV, and MVV with predicted normals.
 - c). To compare normal values of pulmonary flow rates of persons differing in gender, age, and body surface area.

Note: At least 8-experiments are to be performed

8TH SEMESTER

IC-402 Analytical Instrumentation Laboratory

[0 0 2 1]

1. pH measurement of given sample on microprocessor based pH meter
2. To estimate the concentration of given sample in a solution (PPM) in on flame photometer
3. To measure the viscosity of given solution
4. To measure the strength of oxygen dissolved (PPM) in the given solution
5. To analyze a given gas using gas analyzer
6. To determine fluoride contents in a given sample using fluoride meter
7. To determine moisture contents in a given sample using Karl Fisher Titrator
8. To determine the turbidity of unknown sample
9. To measure the conductivity of given sample
10. To detect flaw using ultrasonic flaw detector
11. To measure the concentration sample of gases NO, SO₂, CO₂, CO and CH₄ by using infrared gas analyzer (type ZKJ).

Note: At least 8-experiments are to be performed

IC-404 Advanced Process Control Laboratory

[0 0 2 1]

1. To study the operation and characteristics of a pressure transmitter, I/P converter and Pneumatic control valve
2. To study the action of On-Off, proportional, PI, PD and PID control actions for a pressure process station using a software on PC
3. To study the ratio control on pressure process station
4. To study operational characteristics of a flow Transmitter and capacitive level transmitter
5. To study the action of ON-OFF, proportional, P.I, P.D., P.I.D control actions for a flow process station using FFCON software
6. To study the cascade control of flow and level on flow level process station
7. To study the ratio control of the flow using flow-level process station
8. To study the feed-forward control using flow-level process station
9. To control the level in a tank by controlling input and output flow rate using SCADA RS-View 32 and RS-Logix 500
10. To control the input flow rate in a control tank using PID-control action with SCADA RS View-32 and RS-Logix 500
11. To control the temperature in control tank to a defined limit by using heater and heat exchanger using RS-View 32 and Rs-Logix 500
12. To study the operation of single acting cylinder, double acting cylinder with 3-2 valve & 5-2 valve
13. To study the various control i.e. Manual, semi Automatic, Automatic and Sequential Control using Pneumatic Trainer
14. To study the Automatic Control using the time kit & Electro Pneumatic kit.

Note : At least 8-experiments are to be performed

ELECTIVE-I (5TH SEMESTER)

IC-321 Signals and Systems

[3 0 0 3]

Signals & Systems: Introduction, signals, Transformations of independent variable, Basic continuous time signals, Basic Discrete –Time Signals, system.

Linear Time – Invariant System: The Representation of signals in Terms of Impulses, Discrete-Time LTI systems, continuous time LTI system, properties of LTI systems, Signal Flow Graph, System Described by differential and Difference equations, Block Diagram representations of LTI system.

Fourier series and Fourier analysis for Continuous Time Signals and Systems: Introduction, Fourier series and periodic functions, Features of periodic functions, choice of origin, systems with periodic inputs, The response of continuous time LTI system, The continuous Time Fourier Series, Representation of a periodic signals: The continuous – Time Fourier Transform Periodic signals and continuous Time Fourier Transform, Convolution and correlation.

Laplace Transform: The Laplace Transform, the Region of convergence for Laplace Transforms, the inverse Laplace Transform, Geometric Evaluation of the Fourier transform from the pole-zero plot, Analysis and characterization of LTI-system, unilateral Laplace transform.

Z-Transform: Z-transform, Region of convergence for Z-transform, Inverse Z-transform, Geometric evaluation of the Fourier transform from the pole-zero plot, analysis and characterization of LTI systems using Z-transforms, Transformations between continuous Time and Discrete Time System, Unilateral Z-Transforms. Application of Z-transform to the analysis and characterization of discrete time system.

Books Recommended

1. Alan V Oppenheim, Alan S Willsky with Ian T Young, “*Signals and Systems*” Pearson Education India, New Delhi (2003).
2. Ziemier R E, Tranter W H and Fannin, “*Signals and Systems*”, 4th Ed., Pearson Education India, New Delhi (2000).
3. Phillips C L, Parr J M and Riskin E A, “*Signals, Systems and Transforms*”, Pearson Education India, New Delhi (2003).
4. Mitra S K, “*Digital Signal Processing (A computer Based Approach)*”, TMH New Delhi(1998).
5. Salivahanan S and Vallavaraj A, “*Digital Signal Processing*”, TMH New Delhi 10th Ed. (2004).

IC-323 Computer Networks

[3 0 0 3]

Introduction to Computer Networks: Use and types of Computer Networks, Network Hardware and Software and Reference Models.

Physical Layer: Transmission Media and Public Switched Telephone Network.

Data Link Layer: Design Issues, Error Detection and Correction, Data Link Protocols and Protocol Verification Methods.

Medium Access Control Sub layer: Channel Allocation Problem, Multiple Access Protocols, Ethernet and Wireless LANs.

Network Layer: Network layer design issues, Routing Algorithms, Congestion Control Algorithms and Quality of Service.

Transport Layer: The Transport Service, Elements of Transport Protocols, A Simple Transport Protocol, The Internet Transport Protocols and Performance Issues.

Application Layer: Domain Name System, Electronic Mail, World Wide Web and Multimedia.

Network Security: Cryptography, Symmetric-Key Algorithms, Public-Key Algorithms, Digital Signatures and Authentication Protocols

Books Recommended

1. Tanenbaum Andrew S “*Computer Networks*” Ed Pearson Education 4th Ed. (2003)
2. Kurose James F and Ross Keith W. “*Computer Networking*” Ed Pearson Education (2002)
3. Nance “*Introduction to Networking*” Ed PHI of India 4th Ed. (1998)
4. Jain S, “*Computer Networks*” Ed 1st Ed. (2000)
5. Stalling W, “*Data and Computer Communication*”, 7th Ed. Pearson Education, (2004).

Introduction: concept of power electronics, applications of power electronics, advantages and disadvantages of power electronics.

Diode Circuits and Rectifiers: diode circuits with DC source, freewheeling diodes, single phase diode rectifiers.

Thyristors: thermal characteristics of thyristors, thyristor turn-on methods, switching characteristics of thyristors, thyristor gate characteristics, two transistor model of a thyristor, thyristor ratings, thyristor protection, series and parallel operation of thyristors.

Thyristor Commutation Techniques: class A commutation: load commutation, class B commutation: resonant pulse commutation, class C commutation: complementary commutation, class D commutation: impulse commutation, class E commutation: external pulse commutation, class F commutation: line commutation.

Phase Controlled Rectifiers: principle of phase control, full-wave controlled converters, single phase full-wave converters, three-phase converter systems using diodes, three-phase thyristor converter circuits, effect of source impedance on the performance of converters.

Choppers: principle of chopper operation, control strategies, step-up choppers, types of chopper circuits, thyristor chopper circuits: voltage-commutated chopper, current-commutated chopper, load-commutated chopper.

Inverters: operating principle of single-phase voltage source inverters, force-commutated thyristor inverters, three-phase bridge inverters, voltage control in single phase inverters, PWM inverters, operating principle of current source inverters.

Books Recommended

1. Dr. P S Bimbhra, "*Power Electronics*", Khanna Publishers.
2. P C Sen, "*Power Electronics*", Tata McGraw Hill.
3. Muhammad H Rashid, "*Power Electronics*", Prentice Hall of India.
4. Harish C Rai, "*Industrial and Power Electronics*", Umesh Publications, Delhi.
5. G K Mithal, M Gupta, "*Industrial and Power electronics*", Khanna Publishers.

ELECTIVE-II (5TH SEMESTER)

IC-341 Electrical Power Systems

[3 0 0 3]

Introduction: Generation, Transmission and Distribution systems, various supply systems, Comparison based on Copper Efficiency.

Distribution System: Primary and Secondary Distribution systems, radial, ring-main and network distribution systems, Distribution voltage, Choice of conductor size for distributors, Distribution sub stations – types and location, main equipments in distribution sub-station, supporting structures for distribution lines, Voltage drop and power loss calculations.

Over Head Transmission Lines: Overhead and Underground – transmission, conductor materials, solid stranded, ACSR, hollow and bundle conductors, different types of supporting structures and tower for OH-lines, Transmission line parameters – calculation of inductance and capacitance of single and double circuit transmission lines, 3-phase with stranded and bundle conductors, Generalized ABCD – constants, Transposition of OH-conductors.

Performance of Transmission Lines: Short transmission lines – voltage drop, regulation and efficiency calculations. Medium transmission lines – Nominal-T and π -solution for voltage drop, regulation and efficiency. Long Transmission Lines – current and voltage relations, ABCD – constants, charging current and Ferranti Effect.

Mechanical Design of Overhead Lines: Sag and stress calculations, Wind and Ice loads, Stringing chart and Sag templates, elementary idea about conductor vibrations.

Insulators of Overhead Lines: Insulator materials, types of insulators, Voltage distribution over an insulator string, string efficiency, equalizing voltage drops across insulators of a string.

Underground Cables: Insulating materials, types of LV and HV – cables, 3-core solid, oil filled and gas pressure cables, grading of cables, sheath and dielectric loss in cables, elementary idea about cable breakdown, thermal considerations and current rating of cables, cable laying and jointing.

Tariff: Load curves, Load factor, Max demand factor, diversity factor, losses and their calculations, different types of tariffs – fixed and variable tariffs, economics of p.f. improvement.

Books Recommended

1. Nagrath I J and Kothari D P, “*Modern Power System Analysis*”, TMH New Delhi (1999)
2. Cotton H and Barber H, “*Transmission and Distribution of Electric Energy*”, B I Publishing, New Delhi (1970).
3. Wadhwa C L, “*Electric Power Systems*”, Wiley Eastern Ltd., New Delhi (1998).
4. Stevenson W D, “*Elements of Power System Analysis*”, McGraw Hill Ltd., 4th Ed (1975).
5. Elgerd O I, “*Electric Energy Systems – An Introduction*”, 2nd Ed., TMH New Delhi (1984).

IC-343 Electrical Drives

[3 0 0 3]

Load Characteristics and automatic starting methods: Concept of electrical drives, types of loads, speed-torque characteristics of loads and motors. Dynamics of motor load combination. Four-quadrant operation. Starting methods and auto contactors. Time and current limit acceleration.

Braking methods: Braking methods and automatic braking circuit with relay contactors for DC and Induction motors, Speed-torque characteristics under braking conditions; master controllers. Transient conditions in drives; Energy losses; rating and selection of motors; Review of conventional speed control methods for DC and AC motors.

Thyristorised DC motor drives: 1-phase and 3-phase controlled converters. Analysis with semi and full - converter for continuous and discontinuous current. Dual converter schemes closed loop control. Thyristor chopper-fed d.c. drives, Regenerative braking with DC series motor fed from chopper.

Thyristorised AC motor drives: Comparison with DC drives, Induction motor drives using thyristors for stator voltage control, Slip power recovery and rotor resistance, variable frequency operation of Induction motors with constant pulse and constant current. Inverter / Cycloconverter converter control of Induction and synchronous motor. Typical Industrial applications.

Books Recommended

1. Chilikin M, "Electro Drive", Mir Publishers, Moscow (1970).
2. Pillai S K, "A First Course on Electrical Drives", Wiley Eastern, New Delhi (1982).
3. Sen P C, "Thyristor D C Drives", Wiley Inter Science, New York (1981).
4. Murphy M D, "Thyristor Control of AC Motors", Pergamon Press (1973).
5. De N K and Sen P K, "Electric Drives", PHI, New Delhi (1999).

IC-345 Computer Aided Network Design

[3 0 0 3]

Introduction: Concept of network analysis and design, computer aided design philosophy for networks. Topological structures, examples.

Computer Aided Network Analysis: Computer methods for linear and non linear network analysis, sensitivity analysis, sensitivity models for computer aided design, optimization methods in design of networks.

Active Devices: Introduction, Analysis of linear and non linear networks with special reference to active devices.

Some Advances in Network Studies: Nonlinear D.C circuit analysis, steady state solution and frequency domain analysis, Frequency domain analysis of filters, Transient analysis of dynamic networks.

Books Recommended

1. Gupta S C, Bayless J W and Peikavi B, "Circuit Analysis with Computer Applications to Problem Solving", Scranton Pa (1972).
2. Kuo B C, "Network Analysis and Synthesis", John Wiley (1999).
3. Calahan D A, "Computer Aided Network Design", McGraw Hill (1972).
4. Kuo F F and Kaiser J F, "System Analysis by Digital Computer", John Wiley, NY (1966).
5. V Valkenburg M E, "Introduction to Modern Network Synthesis", Prentice Hall, New Delhi (1999).

ELECTIVE-III (6TH SEMESTER)

IC-322 Control Engineering-II

[3 0 0 3]

State Variable Representation of Control Systems: Concepts of state space and state variables. State space representation of systems described by scalar differential equations, solution of state equation; State transition matrix. State space representation of discrete systems.

Controllability and Observability: Controllability and observability of linear time invariant systems; conditions for complete controllability and complete observability.

Stability Analysis: Definition, first and second methods of Liapunov: stability analysis of linear system using Liapunov's second method. Stability analysis of Nonlinear system using second method of Liapunov – Liapunov's stability theorem, Generation of V-function using some formalized methods, Minimization of V-function, Computation of stability domain, Popov's stability criterion, Study of stability of Lur'e system using Liapunov – Popov method & exploiting the use of YKM – lemma.

Non-linear Systems: Introduction: Common physical non-linearities: Phase-plane method, system analysis by phase plane method: Describing functions: Stability analysis by describing function methods.

Sampled Data Systems: Sampling process: Impulse modulation: Mathematical analysis of sampling process; Z transform and its evaluation, theorems of Z-transform: Modified Z- transform: Mapping of S-Plane into Z plane, pulse transfer function: stability analysis in Z-plane using various methods.

Introduction to Adaptive Control and Parameter Identification

Books Recommended

1. Ogata K, "Modern Control Engineering", PHI 4th Ed., New Delhi (2002).
2. Gibson J E, "Non Linear automatic Control", MGH (Int.) (1966).
3. Lindorf D P, "Theory of sampled data control systems", JW (1967).
4. Atherton D P, "Non linear control engineering", Van Nostrand Reinhold, London (1975).
5. Kuo B C, "Analysis & Synthesis of S.D. Control Systems", PHI, New Delhi (1966).

IC-324 Computer Organization and Architecture

[3 0 0 3]

Introduction: Historical overview, economic trends, underlying technologies, Data Representation- Data Types, Complements, Fixed-Point Representation, Floating-Point Representation, Error detection and correction, Addition, subtraction, multiplication and division algorithms and hardware.

Computer Performance: The metrics of performance, popular performance metrics, Comparing and summarizing performance- Transaction Processing Benchmarks.

Arithmetic Logic Unit: Arithmetic, logic and shift micro operations, Constructing an arithmetic logic shift unit.

Basic Computer Architecture and Design: Computer registers, Computer Instructions-Instruction Set Completeness, Classifying Instruction Set Architecture, Basic steps of Instruction Execution, Hardwired control, Microprogrammed Control, Horizontal and Vertical Microprogramming, Interrupts.

Central Processing Unit: General Register Organization, Stack Organized CPU, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, RISC Vs CISC.

Pipelining: Parallel and pipeline Processing, Pipeline Control, Pipeline Implementations, Conflicts Resolution, and Pipeline Hazards. Vector Processing, and Array Processors.

Memory Organization: Memory Systems: principle of locality, principles of memory hierarchy Caches, associative memory, main memory, Virtual memory, Paging and Segmentation, Memory Interleaving.

Input Output Organization: I/O performance measures, types and characteristics of I/O devices, I/O Modes- Programmed I/O, Interrupt Initiated I/O and DMA. Buses: connecting I/O devices to processor and memory, interfacing I/O devices to memory, processor, and operating system.

Parallel Computers: Classification, SIMD, MIMD Organizations, Connection Networks, Data Flow Machines, and Multithreaded Architectures.

Books Recommended

1. M Moris Mano, "*Computer System Architecture*", Pearson Education, 3rd Edition (1993)
2. David A. Patterson and John L. Hennessy, "*Computer Organization & Design-The Hardware/Software Interface*", Morgan Kaufmann, 2nd Edition (1997)
3. William Stallings, "*Computer Organisation and Architecture, Designing for Performance*", Pearson Education Asia, 6th Edition (2003)
4. Harry F. Jordan and Gita Alaghband, "*Fundamentals of Parallel Processing*", Pearson Education, 1st Edition (2003)
5. Barry Wilkinson Michael Allen, "*Parallel Programming*", Prentice hall, (1999)

Concept of generalized measurement system (review); Static sensitivity, drifts, linearity, hysteresis, threshold and resolution; Generalized static stiffness and input-output impedances; Impedance loading and matching, Generalized mathematical model of measurement system; Transfer function and frequency response of zero, first and second order measurement systems; Environmental characteristics; System analysis using reduced-order model; Dynamic response for various inputs; Numerical correction of dynamic data; Experimental determination of system parameters; First order and second order system compensation; Types of errors and uncertainties; Standard deviation & standardized normal distribution; Confidence level; Central limit theorem; Significance test & chi-square test; Contingency table.

1. Considine D M and Considine G D, "*Process Instruments and Controls Handbook*", McGraw Hill, New York (1988)
2. Doebelin E A, "*Measurement Systems: Application and Design*", McGraw Hill, New York, 4th Edn., (1990)
3. Sawhney A K, "*A Course in Electrical and Electronics Measurement & Instrumentation*", Dhanpat Rai & Sons, Delhi (2007)
4. Cooper W D & Helfrick A D, "*Electronic Instrumentation & Measurement Techniques*", PHI Pvt Ltd, New Delhi (1996)
5. Murthy D V S, "*Transducers & Instrumentation*", PHI Pvt. Ltd., New Delhi, (2008)

ELECTIVE-IV (6TH SEMESTER)

Introduction: Introduction to Microcontrollers and embedded processors, comparison of Microcontrollers and Microprocessors, overview of the 8051 family.

The 8051 Architecture: Introduction, 8051 Microcontroller hardware, Input/Output pins, ports and circuits, external memory, counters and timers, serial data input/output, interrupts.

8051 Assembly language Programming: Introduction to 8051 assembly language programming, data types and directives, Jump, Loop and Call instructions, time delay for various 8051 chips, addressing modes, 8051 I/O programming and I/O bit manipulation programming.

Arithmetic and Logic Instructions and Programs: Arithmetic instructions, signed number concepts and arithmetic operations, logic and compare instructions, rotate instruction and data serialization, BCD, ASCII, and other application programs.

8051 Timer Programming: Programming 8051 timers, counter programming.

8051 Serial Port Programming: Basics of serial programming, 8051 connection to RS 232, 8051 serial port programming.

Interrupts Programming: 8051 interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupt, interrupt priority.

Applications: LCD interfacing, parallel and serial ADC, DAC interfacing, motor control applications.

Books Recommended

1. Kenneth J. Ayala, "The 8051 Microcontroller: Architecture, Programming and Applications", Penram International, 2nd edition.
2. Mazidi M.A. and Mazidi J.G., "The 8051 Microcontroller and embedded systems Using Assembly and C", Pearson Education, 2nd edition.
3. Deshmukh A.V. "Microcontrollers [Theory and Applications]", Tata McGraw-Hill.
4. Kamal Raj, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education.
5. Lewis D.W., "Fundamentals of Embedded Software: Where C & Assembly Meet", Pearson Education.

General: Introduction to properties of Nuclear systems and Radiation, Interaction of radiation with matter, Radioactive sources – choice of isotopes.

Radiation detectors: ionization chambers, Geiger Muller counters, Scintillation counters, Semi-conductor devices, Neutron detectors based on recoil measuring circuits including modulators; converters and stabilizers, Synchronous detectors.

Nuclear Power Plants: Selection of site for Nuclear power plant, Main components of reactors, Types of reactors, Fuel sources, Uranium as a source of energy, Safety of Nuclear power reactors, nuclear power programme in India.

Nuclear Reactor Instrumentation: Diffusion, moderation, absorption and delay processes, Neutron flux measurement, Control rod calibration, Nuclear fuel inspection and testing including poisoning, radiation energy measurement, Remote control instrumentation, Nuclear instrument maintenance.

Application in Industrial System: Radioactive Tracer technique: Gas and Liquid flow measurement, Leak detection, Residence time and its distribution, application to blending corrosion and wear studies. **Thickness and density measurement:** Beta rays, Gamma ray absorption technique, measurement of thickness of surface material by back scattering.

Safety: Hazards of ionization radiation, physiological effect of radiation, Dose and Risk, Radiological protection (alpha, beta and gamma, X, neutron) – shielding material and effectiveness. Operational safety instruments, emergency schemes, affluent disposal, Applications to medical diagnosis and treatment.

Books Recommended

1. Washlete C C H and Hewitt S G, "Nuclear Instrumentation", Newnes (1965).
2. Issue of National Research Control, "Digital Instrumentation and Control system in Nuclear Power Plant: Safety and Reliability issue", National Academy Press, (1997).
3. S N Singh "Electric Power Generation, Transmission and Distribution" PHI New Delhi (204).
4. Almenas K and Lee r, "Nuclear Engineering : An introduction", Spring Verlag Berlin, (1992).
5. Lamarsh J R and Baratta A J, "Introduction to Nuclear Engineering", 3rd Ed., PH (2001).

IC-346 Environmental Instrumentation and Safety

[3 0 0 3]

Introduction to Environmental Technology Field: An overview of environmental laws and regulations, toxicology, air pollution, water pollution, water treatment, solids and hazardous waste, occupational safety and health.

Nature of Pollution: Air pollution control devices, waste water treatment techniques, solid and hazardous waste materials management, Disposal, recycling and pollution prevention.

Techniques for measuring water quality: parameters like pH; alkalinity; dissolved oxygen, ammonia, anions, turbidity and solids.

Instrumentational methods for Environmental analysis: Theory and practice of modern instrumentational methods used in analysis of environmental samples; analysis of samples using UV – IR Spectrophotometry; Gas chromatography (GC); Liquid chromatography (LC) Ion chromatography (IC) and Atomic absorption spectrometer (AA)

Introduction to environmental measurement including temperature; flow rate; level and pressure, Emphasis on function, operation and maintenance of environmental devices.

Books Recommended

1. Peany Howard S, Donal R Rowe and George Tacho Banoylous, "Environmental Engineering", Teddy (1996)
2. Gilber M Masters, "Environmental Engineering and Science" (1997)
3. Holman JP, "Experimental method for Engineers", 7th Ed. TMH, New Delhi (2004).
4. Patranabis D, "Principles of industrial Instrumentation"
5. Rao C S, "Environment Pollution control Engineering" McGraw Hill

IC-348 Optical Instrumentation and Measurement

[3 0 0 3]

Introduction: Optical measurement terminology, Radiometry and photometry, Laws of illumination, Photometric / Radiometric measurement systems, Optical sources, optical transmitter and receiver measurements, Light modulating techniques, Amplifier gain and noise measurements, optical detectors, photoelectric techniques in optical measuring instruments, power meters.

Optical Spectrum Analysis and Instruments: Types of optical spectrum analyzers, operation of grating based optical spectrum analysis, Monochromator, Calorimeter, spectrometer, Interferometer (Michelson, Fabray-Rerot, Twyman-Creen type).

Lasers and its applications: Introduction to lasers, general properties, types of lasers and their operating characteristics, study of laser based instruments for metrology and holography.

Fiber Optic Systems: Introduction to fiber optics, principle, optical fiber characteristics, Step index and graded index fibers, Fiber optic sensors, propagation of light through optical fiber, fiber optic telemetry.

Books Recommended

1. Kingslake, "*Lens Design*", Academic Press (1987)
2. Chai Yeh, "*Handbook of fibre optics*" (1990)
3. Ghatak A K and Thyagrajan, India, "*Laser theory and applications*", Macmillan (1988)
4. Sawhney A K, "*A course in Electrical and Electronics Measurement Instrumentation*", Dhanpat Rai and Sons, New Delhi (1993)
5. Silvano D. "*Electro optical Instrumentation: Sensing and measuring with LASER*", PHI, New Delhi (2004).

ELECTIVE-V (6TH SEMESTER)

IC-362 Instrumentation System Design

[3 0 0 3]

Instrumentation System Design: Introduction, Transducer terminology, General transducer characteristics, design characteristics, performance characteristics, reliability characteristics, criterion for transducer selections.

Basic principles of designing transducers: Resistive, inductive, capacitive, bimetallic strips, RTD, thermocouples, diaphragm, bellow, capsule, bourdon tube etc.

Signal Conditioning: Bridges, instrumentation amplifier, modulators & demodulators, S/H circuit, active and passive filters, and various types of ADC and DAC circuits.

Display system design: 7 segment LED display, Dot Matrix LED display, Bar Graph LED display, 7 segment LCDs, CRT Displays

Microprocessor based system design: Design considerations.

Some case studies in instrumentation

Books Recommended

1. Norton H N, "*Handbook of Transducers*" Prentice Hall, Englewood Cliffs, NJ (1989).
2. Neubert H K P, "*Instrument Transducers - An introduction to their performance and design*" Clarendon Press, Oxford (1975).
3. Andreeva L E, "*Elastic elements of instruments*" Israel programme for scientific translation – Jerusalem (1966).
4. Sondhi B S, "*Introduction to System Design using Integrated Circuit*", New Age International (P) Limited publishers, New Delhi (1995).
5. Slater Michael, "*Microprocessor Based Design*", Prentice Hall of India Pvt Ltd. New Delhi (1999).

IC-364 Industrial Measurement

[3 0 0 3]

Metrology: Line and length standards, gauge, gauge block, mechanical, optical, pneumatic and electrical comparators, interferometry and flats, sine bar, review of displacement, velocity, acceleration and seismic pickups.

Pressure Measurement: Standards and calibration, Deadweight piston gauges and manometers, elastic transducers, bourdon tube, bellows and diaphragm, high pressure measurement, vacuum measurement-McLeod gauge, Knudsen gauge, thermal conductivity gauges, Pirani and Ionization gauge.

Temperature Measurement: Measurement: Standards and calibrations, thermal expansion methods, bimetallic thermometers, filled in systems, their errors, thermoelectric sensors electric resistance sensors, junction semiconductor sensors, radiation pyrometry.

Flow Measurement: Head type, area type, positive displacement type, mass flow meters vortex type, electrical type, Turbo magnetic, Electro magnetic, ultrasonic Hot wire anemometer, flow marker, open channel flow metering, their working principle and applications.

Other Variable measurements: Mass, weight, force, torque and shaft power measurement, level measurement, Humidity and moisture measurement.

Books Recommended

1. Doebelin E O, "*Measurement System: Application & Design*", McGraw Hill Book Co., New Delhi (2004).
2. Rangan, Mani Sharma, "*Instrumentation Devices & Systems*", Tata McGraw Hill Book Co., 16th Reprint, New Delhi (1996).
3. Sawhney A K, "*A course in Mechanical Measurement & Instrumentation*", Dhanpat Rai & Sons Book Co., New Delhi (2003).
4. Patranabis D "*Principles of Industrial Instrumentation*" TMGH ,(1993).
5. Beckwith T G, Lienhard J H and Marangoni R D, "*Mechanical Measurements*" Addison –Wesley (Pearson Edu Asia), (2000).

IC-366 Advanced Sensors

[3 0 0 3]

Micro mechanical sensing and actuating structures: SAW micro sensors, Resonant micro sensors, micro accelerometers, Pressure micro sensors, micro actuators and micro motors, semiconductor strain gauges, Piezo resistive elements.

Temperature and Light Sensitive Microstructures: Solid state temperature sensors – silicon resistive temperature sensors, Transistor based sensors, Integrated thermocouple, Photo detectors, Pneumatic detectors, Pyro electric detectors, Photo emissive, photo conductive, Schottky, CCDs, Radiation detectors, Fibre optic sensors: Pressure, Temperature and Phase modulated, Gyroscopes.

Miscellaneous Miniature Sensors: Magnetic sensors, solid-state, chemical sensors: silicon based, Metal oxide based, Catalyst.

Sensor Fusion: Introduction to sensor fusion and sensor selection. Bayesian theory of sensor fusion and its applications.

Books Recommended

1. Khazan Alexander D, "*Transducers and their elements – Design and Applications*", PTR Prentice Hall, Englewood Cliff, NJ07632 (1994)
2. Middlehoek S and Audet S A, "*Silicon Sensors*", Academic Press, London (1989)
3. Edmonds T E, "*Chemical Sensors*", Blackie, London (1988)

4. "Sensors and Actuators", No 8, 1985 (pp 227-233); No 10, 1986 (pp 65-82); No 12, (1987), pp 129-144.
5. Sloman Sabrie " sensor and control system in manufacturing "TMH ,India (1994).

IC-368 Power Plant Instrumentation

[3 0 0 3]

Introduction: Various types of power plants, energy policy of India, priority for sources for power generation, selection of sites and unit size.

Steam Power Plant: Operation of steam power plant, choice of steam pressure and temperatures. Rankine cycle and its analysis, Reheat and regenerative cycle, classification of steam turbines and their working, velocity diagrams, Governing of steam turbines, layout of steam power plant. Steam condensers, vacuum efficiency, and performance of cooling towers. Fuel handling, combustion equipment, Ash handling, Heat exchangers, reheaters, feed water reheaters and evaporators.

Nuclear Power Plant: Advantages and disadvantages, Generation of nuclear energy by fission, Nuclear reactor, nuclear reactions, types and applications, Layout of Nuclear plant.

Hydro Power Plant: Advantages and disadvantages, hydrological cycle, hydro-graph, flow duration curve, mass curve, selection of site, essential features of a hydro plant, selection of water turbines for a given hydro power plant, layout of a hydro power plant.

Instrumentation: Instrumentation needed in steam power plants for plant supervision, safety and plant performance, Governing and controls needed for water flow, drum level, air/gas flow, coal flow, combustion control, control for furnaces, controls for turbine, condenser safety.

Books Recommended

1. "Modern power station practice (1-8 volumes)", CEGB (1967)
2. Loftness D Van Nostrand, "Nuclear Power", McGraw Hill, New Delhi (1990)
3. Lish, "Nuclear Power Plant System and Equipment", Industrial press (1992)
4. Varma, "Power Plant Engineering", Metroplitan Publication (1988)
5. Soni M L, Gupta P V and Chakraborty A, "A Text Book on Power System Engineering", Dhanpat Rai and Co, New Delhi (1998)

ELECTIVE-VI (7TH SEMESTER)

IC-421 Robotics and Automation

[3 0 0 3]

Robotics: Introduction to robots, classification of robots, and anatomy of robots, degree of freedom, robot joints, and robot coordinates various applications of robots

Actuators: introduction to various actuators, comparison of various actuators, selection of actuators.

Introduction to Automation: Fully automatic systems, semi automatic systems and manual control systems, tele-operated systems, measurement system, control system, microprocessor based controller, introduction to PLC & DCS.

Sensors and signal conditioning: introduction to transducers, various transducers used for the measurement of displacement, position, velocity, temperature, selection of sensor, signal conditioning, data presentation and data logging system

Books Recommended

1. Tsunco Yoshikawa, "Foundations of Robotics, Analysis and Control", prentice Hall of India, 2001.
2. Craig J J, "Introduction to Robotics: Mechanics and Control", 2nd Edition, Boston, Addison –Wesley, 1989.
3. Mittal R K and Nagrath I J, "Robotics and Control", TMH Pub., New Delhi, 2003
4. An C H, Atkeson C G & Hollerbach J M, "Model based control of a Robot manipulator", MIT Press, Mass., 1988
5. W. Bolton, "Mechatronics Electronic Control System in Mechanical and Electric Engineering", Pearson education Ltd. 2009

IC-423 PLC and SCADA

[3 0 0 3]

PLC Basics: An Overall looks at PLCs, General PLC Programming Procedures, Devices to which PLC Inputs and Outputs are connected.

Basic PLC Programming : Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Timers and Counters, PLC Arithmetic functions, Number comparison functions, Data handling Functions, PLC functions with BITS.

Advanced PLC Functions: Analog PLC Operation, PID control of Continuous Processes, Networking PLCs, Motor Controls, System Integrity and safety

Introduction to SCADA: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked, SCADA Protocols- IEC 60870-5-101, DNP-3

Implementation of SCADA: Deploying SCADA systems, Security and Vulnerability of SCADA Systems, SCADA Standards Organizations.

Books Recommended

1. John R Hackworth, Frederick D Hackworth, Jr, “ *Programmable Logic controllers- Programming Methods and Applications*”, Pearson Education
2. John W Webb, Ronald A . Reis, “*Programmable Logic Controllers- Principles and applications*”, PHI , ND, 2006
3. Liptak Bela G,”
4. Ian G Warnock, “PLC”,

IC-425 Mechatronics

[3 0 0 3]

Introduction to Mechatronics: what is Mechatronics, main components of Mechatronics, measurement system, control system, microprocessor based controller, the Mechatronics approach problem

Sensors and signal conditioning: introduction to transducers, various transducers used for the measurement of displacement, position, velocity, temperature, selection of sensor, signal conditioning, data presentation and data logging system

Robotics: Introduction to robots, classification of robots, and anatomy of robots, degree of freedom, robot joints, and robot coordinates various applications of robots

Actuators: introduction to various actuators, comparison of various actuators, selection of actuators.

Books Recommended

1. Tsunco Yoshikawa, "*Foundations of Robotics, Analysis and Control*", prentice Hall of India, 2001.
2. Craig J J, "*Introduction to Robotics: Mechanics and Control*", 2nd Edition, Boston, Addison –Wesley, 1989.
3. Mittal R K and Nagrath I J, "*Robotics and Control*", TMH Pub., New Delhi, 2003
4. An C H, Atkeson C G & Hollerbach J M, "*Model based control of a Robot manipulator*", MIT Press, Mass., 1988
5. W. Bolton, "*Mechatronics Electronic Control System in Mechanical and Electric Engineering*", Pearson education Ltd. 2009

IC-427 Intelligent Instrumentation

[3 0 0 3]

Virtual Instrumentation: Historical perspective, advantages etc., block diagram and architecture of a virtual instrument

Data-Flow Techniques: Graphical programming in data flow; comparison with conventional programming.

VI Programming Techniques: VI and Sub-VI, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

Common instrumentation interfaces: - RS232C/RS485, GPIB.

Use of Analysis Tools: Some tools from the advanced analysis tools relevant to the discipline may be included e.g., Fourier transformer, power spectrum, convolution and correlation methods, windowing and filtering techniques.

Applications of VI: VI Application in digital signal processing.

Books Recommended

1. Gary Johnson, "*Lab VIEW Graphical Programming Application in instrumentation and control* ", McGraw Hill, New York, 2001
2. Lisa K Wells and Jertrey Travis, "*Lab VIEW for Everyone*", Prentice Hall, 1997
3. Sokoloff, "*Basic concepts of Lab VIEW 4*", Prentice Hall, 2002
4. S. Gupta, JP Gupta, "*PC Interfacing for Data Acquisition and Process Control*", Instrument Society of America, 2003
5. Mahesh L Chgani and Abhay R . Samant "*Labbview signal processing*" Prentice Hall, 1998

ELECTIVE-VII (7TH SEMESTER)

IC-441 Optimal Control Theory

[3 0 0 3]

Introduction: Basic Mathematical concepts, State variable descriptions, Conditions for optimality, Formulation of optimal control problems, Classification of optimal control problems, Review of controllability and observability, Performance criteria and constraints of optimization.

Calculus of Variations: Definitions and minimization of functionals; Euler Lagrange's equation for scalar case and its generalization to vector case, Lagrange Multiplier method, Fixed and free end problems, Transversality conditions, Dynamic optimization with equality and inequality constraints.

Pontryagin's Maximum (Minimal) Principle: Statement of Pontryagin's maximum principle and Hamilton-Jocabi-Bellman Equation, Application to optimization problems with constraints.

Dynamic Programming: Multistage decision processes, principles of causality, invariant imbedding and optimality, Discrete dynamic programming, Optimization using Gradient methods, Steepest Descent, Newton Raphson and Fletcher Powell methods.

Optimal Feedback Control: Introduction, Linear regulator and servomechanism problems, Matrix Reccati equation, solution and implementation, Sub optimal linear regulators, Minimum time control of linear time invariant (LTIV) – systems.

Introduction to optimal control to Distributed parameter systems

Books Recommended

1. Gopal M, "*Modern Control System Theory*", Wiley Eastern Ltd., New Delhi (1995)
2. Sage A P, "*Optimal System Control*", PHI, New Jersey (1968)
3. Anderson B D O and Moore B, "*Linear Optimal Control*", PHI-Pub, New Delhi (1990)
4. Kirk D E, "*Optimal Control Theory: An Introduction*", Englewood Cliffs, NJ, PH (1970)

5. Kwakenack H and Sivan R, "*Linear Optimal Control Systems*", Wiley, New York (1972).

IC-443 Control System Design

[3 0 0 3]

Introduction: The feedback concept and modelling, T.F. and stability, concept of Block diagram representation and reduction, SF-graph, Types of control system design.

Root Locus Analysis and Design: Root locus for feedback control systems, root locus construction, Design concepts, relation between root locus and time domain, compensation, Pole placement, Frequency response and forced sinusoidal response, Bode plots, Nyquist plot, gain margin and phase margin, Frequency response Design, PID – compensation.

State Space Modelling and Design: State feedback and pole placement, Limitations of state feedback, tracking problems, Observer design, control law using observer, Observer T.F., Reduced order observer design, Trade-offs in state feedback and observers.

Advanced State Space Methods: Design via optimal control techniques, the linear quadratic regulator problem, properties of LQR design, optimal observer – Kalman Filter, Robustness, robust stability, root T.F. recovery (LTR), uncertainty modelling.

Digital Control: Preview, computer processing, A/D and D/A conversion, Discrete time signals, Sample and hold circuits, Z-transformation and properties, inverse Z-transform, sampling, reconstruction of signals from samples, stability and Bilinear transformation, state space description of discrete – time systems, response and stability, controllability and observability, Direct digital design, some examples, Decoupling.

Books Recommended

1. Stefani R T, Savant C J, Shahian Balram and Hostetter G H, "*Design of feedback controls systems*", International Edition, 3rd Ed. (2002).
2. Goodwin C G, Graebe S F and Salgado M E, "*Control System Design*", Pearson Education, First Indian Print – (2003).
3. Gopal M, "*Control Systems: Principles and Design*", TMG Hill Pub. Co., New Delhi (1998).
4. Chen C T, "*Linear System Theory and Design*", New York, Holt, Rinehart and Winston (1984).
5. Ogata K, "*Discrete Time Control Systems*", Englewood Cliff, New Jersey, PH-(1995).

IC-445 Digital Control Systems

[3 0 0 3]

Discrete Data and Digital Control Systems: Introduction, basic elements of Discrete-data control systems, signal conversion and processing, data conversion and quantization.

Sampling and Data Reconstruction of Sampled Signals: mathematical modeling of ideal & actual samplers, sampling theorem, Hold circuits and comparison between hold circuits based on step response and frequency domain characteristics.

Transform Analysis of Digital Control System: Introduction, Linear Difference equations, the pulse TF and pulse response, z-transform, relationship between the s-plane and the z-plane, Limitation of z-transform, the delayed & modified z-transforms.

The State Variable Technique for Digital Systems: Introduction, state equations and solutions of continuous and digital systems, Development of state formulation of Discrete-data system with S/hold-devices, relationship between state equation and T.F., diagonalization of system-matrix, Jordon Canonical form, state diagrams, state variable analysis of response between sampling instants.

Controllability, Observability and Stability: Concept of controllability for LTIV-discrete data systems, observability & TF, stability of Linear digital control systems, various methods of stability test, the second method of Liapunov & its applications to LTIV – discrete data system for stability analysis.

Design of Discrete-Data Control Systems: Concept of cascade compensation, Digital controllers including PID-controller, Design of digital control systems with digital controllers, Introduction to design of robust control systems, Pole-placement design by state and output – feedback, DSP control – digital signal processors.

Digital Control Systems using MATLAB.

Books Recommended

1. Kuo B C, "*Digital Control Systems*", Oxford Univ. Press, Noida, New Delhi, 2nd Edition (2004)
2. Gopal M, "*Digital Control Engg*", WE Ltd. New Delhi – (1993)
3. Jury E I, "*Theory and application of Z-transform methods*" John Wiley (1964).
4. Medich K, "*State Estimation*", McGraw Hill International, 1963
5. Lindorff D P, "*Theory of SD-control systems*", John Wiley, (1966)

System Models and Studies: Concept of a system, system Environment, stochastic Activities, continuous and discrete systems, systems modeling, types of models, Principles used in Modeling, system Analysis & design.

System Representation: Introduction, Block diagram presentation, Standard Block – Diagram, Signal flow graphs, Determination of overall system response using Block diagram and Signal flow for the various inputs.

System Equations: Introduction, Electric circuits and components, Basic linear algebra, state concept, Mechanical Translation system, analogous circuits, Mechanical rotational system.

Probability concepts in simulation: Stochastic variables, discrete probability functions, continuous probability functions, Measures of probability. Functions numerical evaluation of continuous probability functions, Estimation of mean variances, and Correlation, Random number generator and Properties of Random Numbers.

System Simulation: Step in simulation study, techniques of simulation, comparison of simulation and analytical methods, Experimental Nature of simulation, types of system simulation, Numerical computation Technique for continuous models, Numerical computation technique for Discrete models, Distributed lag models, Real Time Simulation, Selection of Simulation Software, Simulations Packages, Trends in simulation software.

Introduction to system Reliability: Reliability, MTTF, MTBF, failure data analysis, hazard rate, System reliability using: - series configuration, parallel configuration, mixed configuration, Markov model, fault tree analysis. Reliability improvement and maintainability.

Books Recommended

1. Geoffrey Gorden, "*System Simulation*", PHI, New Delhi(1996).
2. Averill M Law and W David Kelton, "*Simulation Modeling and Analysis*", TMH International Editions (2003)
3. Nagrath I J and Gopal M, "*System Modeling and Analysis*", TMH, New Delhi (1982).
4. L S Srinath, "Reliability Engineering", Third edition, East West Press Pvt Ltd. New Delhi(2000).
5. Banks, et al "*Discrete Event System Simulation*" 3rd Ed. PHI (2005).

ELECTIVE-VIII (8TH SEMESTER)

Introduction: Difference between analytical and other instruments, sampling, sampling system for liquids and gases, sampling components, automatic and faithful sampling.

Gas Analysis: Gas Chromatography – principles & components, Thermal conductivity gas analyzers, Heat of reaction method, Estimation of Oxygen, Hydrogen, Methane, CO₂, Carbon monoxide etc. in binary or complex gas mixtures, paramagnetic oxygen analyzer, Electro chemical reaction method, Polarography, Density measurement.

Humidity and Moisture Measurements: Humidity measurement: definitions – absolute, specific, relative humidity and dew point, Dry and wet bulb psychrometer, Hair hygrometer, dew point meter. Moisture Measurement: definitions, electrical methods, NMR method, IR method.

Chemical Composition Measurements: Newtonian and Non Newtonian flow, Measurement of viscosity and consistency, Laboratory and on line methods, Measurement of pH:- definition and methods, redox potential, electrical conductivity, conductivity cell and applications, density measurement: solids, liquids, gases.

Spectrochemical Analysis: Classification of techniques, Principles and components, emission spectrometry:- flame emission, atomic absorption type, Dispersive techniques, scheme for UV, IR and near IR analysis, comparison of methods, X-ray analyzers NMR spectrometry, ESR spectroscopy, Mass spectrometry.

Analytical Electron Microscope

Books Recommended

1. Patranbis D, "*Principles of Industrial Instrumentation*", Tata McGraw Hill Pub., New Delhi (1991)
2. Jones E B, "*Instrument Technology vol II*", Butterworths Scientific Publication, London (1985)
3. Khare R P, "*Analytical Instrumentation an Introduction*" C.B.S. Publication, Delhi (1993)
4. Khandpur R S, "*Handbook of Analytical Instruments (7th reprint)*", Tata McGraw Hill Pub, New Delhi (2000)
5. Considine D M, "*Process Instruments and Control*" Hand Book, 3rd (1985).

Embedded Processing Systems – Introduction, Components of Embedded Systems
Embedded Processors: Microprocessors, Microcontrollers, DSP and ASICs, Comparative Assessment of Embedded Processors
Memory Devices: ROM family, RAM family, Interfacing memory
Embedded Programming - C and C++
Input-output Ports and Interfacing, I/O Programming
Interrupts and Their Servicing, timing devices and interfacing, Analog I/O techniques
Embedded Communications: Serial Bus, Parallel Bus, Networking and Wireless Standards
 Introduction to Real-time operating system (RTOS), RTOS: memory management, I/O **Management and Device Drivers,** scheduling
Software Engineering Practices: Embedded Software Development Process
Hardware-Software Co-design in an embedded system
Tools and Trends in Embedded systems design

Books Recommended

1. Raj Kumar, *“Embedded Systems: Architecture, Programming and Design”*, Tata McGraw Hill, Third Reprint, (2003).
2. John Catsoulis, O’Reilly, *“Designing Embedded Hardware”*, First Indian Reprint, (2003).
3. David E. Simon, *“An Embedded Software Primer”*, Pearson Education Asia, Fifth Indian Reprint, (2002).
4. Michael Barr, O’Reilly, *“Programming Embedded Systems in C and C ++”*, (1999).
5. Vahid and Givargis, *“Embedded System Design”*, A Unified Hardware/Software Introduction, John Wiley and Sons, (2002).

IC-426 Neural Network and Fuzzy Logic

[3 0 0 3]

Introduction: History of development in neural networks, neural network characteristics, Artificial neural network technology, Model of a neuron, topology, learning, types of learning, supervised, unsupervised and reinforcement learning.

Supervised Learning: Basic hop field model, the perceptron, linear reparability, Basic learning laws, Hebb’s rule, Delta rule, Widroff and Huff LMS learning rule, correlation learning rule, In star and out star learning rules. Unsupervised learning, competitive learning, K mean clustering algorithm, Kolwner’s feature maps.

Radial Basis Function: Basic learning laws in RBF network, recurrent networks, recurrent back propagation, Real time recurrent learning algorithm.

Counter Propagation Networks: Introduction to counter propagation networks, CMAC networks, ART networks, Application of neural networks, pattern recognition, optimization, associative memories, vector quantization, control.

Fuzzy Logic: Basic concepts of fuzzy logic, Fuzzy logic crisp set, Linguistic variable, Membership functions, Operation of fuzzy set, Fuzzy IF THEN rules, Variable inference techniques, Defuzzification techniques, Basic fuzzy inference algorithm, Application of fuzzy logic, Fuzzy system design, Implementation of fuzzy system, Useful tools supporting design.

Neural and Fuzzy Control: Basic terms, Control Plant, Controler, Classification of Control Systems, Neural Networks in direct and indirect control, Fuzzy Controller design.

Books Recommended

1. Riza Berkin and Trubatch, *“Fuzzy System Design Principles”*, PHI (2000).
2. Yegna Narayanan, *“Artificial Neural Networks”*, MGH (1999).
3. Bart Kosko, *“Nueral Networks and Fuzzy Logic”*, PHI, New Delhi (1998).
4. Simon Haykin, *“Neural Networks”*, Pearson Education (2002).
5. Anderson J A *“An Introduction to Neural Networks”*, PHI , New Delhi (1998).

IC-428 Virtual Instrumentation

[3 0 0 3]

Introduction to Virtual Instrumentation: Historical perspective, Classification of different instruments / instrumentation system. Definition and architecture of virtual instrumentation system, salient features and application area of virtual instrumentation.

Data Flow Programming Techniques: Graphical programming in data flow, comparison with conventional programming, popular data flow and VI software packages. Building a VI front panel and block diagram, sub VI, for and while loops, case and sequence structure, formula nodes, local and global, string and file I/O, array and clusters, charts and graphs, attributes nodes.

Data Acquisition Basics: ADC, DAC, D/O, counters and timer, PC hardware structure, timing, interrupts, DMA, software and hardware installation, Configuring data acquisition hardware using the drives in application software, use of DAQ library functions for different analog and digital input/output operations.

Common Instrument Interfaces: Current loop, RS 232, RS485, GBIP. Use of library functions to communicate with different instruments.

Use of Measurement Analysis Tools: Measurement of Max, Min, Peak-Peak voltage, Mathematical tools, time period of a signal, power spectrum and logging Fourier transform, Correlation methods, windowing and filtering.

Building a web based virtual instrument: Networking basics for office and industry application.

Books Recommended

1. Wells Lisa K and Travis Jeffrey, "LabVIEW for everyone", Prentice Hall (1997).
2. Gupta S and Gupta J P, "PC Interfacing for data acquisition of process control", Instrument Society of America (1994)
3. Johnsons Gary W, "LabVIEW Graphical programming", 2nd Ed., McGraw Hill, 1997.
4. Johnson G. and Jennings R, "Labview graphical programming" 3rd ed. MGH (2002).
5. James K "PC interfacing and data acquisition", 2002.

ELECTIVE-IX (8TH SEMESTER)

IC-432 Advanced Process Control

[3 0 0 3]

Introduction: Review and limitations of single-loop control, need for multiloop systems.

Advanced Process Control Techniques: Concept of multiloop process controls, analysis and applications of cascade, ratio, Feed forward, override, split-range, selective and Auctioneering Control Systems with multiple loops, Dead time compensation, Adaptive control, inferential control.

Introduction to Computer Control systems in Process Control: DCS Configuration, control console equipment, communication between components, local control units, DCS flow sheet symbols, DCS I/O hardware and setpoint stations. Supervisory control and data acquisition system (SCADA).

Programmable Logic Control: Introduction, relative merits over DCS and relays, programming languages, Hardware and system sizing, PLC installation, Maintenance and trouble shooting.

Design of control systems for multivariable process: Multivariable control system, interaction in multiple loops, RGA method for minimizing interactions e.g. distillation column, absorbers, Heat Exchangers, Furnaces and Reactors.

P-I diagrams, standard instrumentation symbols for devices, signal types, representation and reading of instrumentation scheme using PI diagrams.

Some Case Studies in Process Control: Ammonia plant control, Process control and safety, Control aspects of Fertilizer plant and Process control in Cement industry

Books Recommended

1. Coughanowr R Donald, "Process System Analysis and Control", McGraw Hill International Edition (1991).
2. Eckman D P, "Industrial Instrumentation" Wiley Eastern Pvt. Ltd., New Delhi (1976).
3. George Stephanopoulos, "Chemical Process Control – An introduction to Theory & Practice", Prentice Hall of India, New Delhi (1995).
4. Liptak B G, "Handbook of Process Control", 3rd Ed., Chilton Press (1995).
5. Johnson Curtis D, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi (1997).

IC-434 Identification and Adaptive Control

[3 0 0 3]

Introduction: Problems of identification and control estimation problem and classification, Estimation problems for continuous and Discrete case, Linear and non linear estimation problems.

Adaptive Control Problem: Introduction, types of representation, Models and mode classifications, Transfer function and impulse response.

Method of Identification: Impulse response identification methods, Least square identification method, method of maximum likelihood, Recursive identification using Least square methods.

Kalman Filtering: Introduction to smoothing, filtering and prediction, Kalman Filter, Application of Kalman filtering algorithm to identification and adaptive controls.

Advances in Adaptive Control: Adaptive control using model reference techniques, self tuning control and self tracking control.

Applications: Application of state estimation in electromechanical systems, Maximum likelihood estimation for electromechanical systems. Some case studies.

Books Recommended

1. Desai R C, "*Identification and Control*", TMH New Delhi (1967)
2. Nagrath I J and Gopal M, "*Control System Engineering*", New Age International Pub (1999)
3. Landan I D, "*System Identification and Control Design*", Englewood Cliffs, NJ, PH (1990)
4. Goodwin G C and Sin K S, "*Adaptive Filtering Prediction and Control*", Englewood Cliffs, NJ, PH (1984).
5. Sanchez M, Juan M and Jose R, "*Adaptive Predictive Control for concept to Plant optimization*" PH, Eagle Wood Cliff, NJ (1996).

IC-436 Computer Control of Industrial Processes

[3 0 0 3]

Computers: Algorithm, languages, programmes, analog and hybrid simulation, software, hardware for process control, concept of real time operating system, Data and symbols for operating systems.

Computers – Hierarchical Control: Early computer control system, centralized control, Distributed control, Hierarchical control, Tasks of Digital control systems, Low level and high level tasks.

Man-machine interface: Introduction, operator system communication, Recognition of process states, operator process interaction, operator role, Engineering work station.

System Design: Feasibility study, communication design, data transmission unit, designing control and dispatching centres.

Field-Buses, Communication and Network Protocols: Communications hierarchy, ISO reference model, Industrial communication systems, MAP/TOP protocol, types of bus:- Field Bus, Rack Bus, Profi bus, Fip bus, Comparison of buses, HART protocol.

Books Recommended

1. Eran V Zivic, "Computers in Process Control" (1992)
2. Liptak B G, "Instrument Engineers Handbook", Chilton Book Co. Philadelphia 3rd Ed., (1995).
3. Blokeslee T R, "Digital design with standard MSI and LSI", JW and sons, NY (1986).
4. Kant Krishna "Computer Based Industrial Control " PHI ,New Delhi (1997).
5. Singh S K, "Industrial Instrumentation and Control " 2nd Ed. TMH ,New Delhi,(2003)

IC-438 Adaptive Signal Processing

[3 0 0 3]

Introduction: Limitations of analog signal processing, Advantages of digital signal processing, Laplace Transform, Z-Transform, Convolution, Correlation

Discrete time Signals and Systems: Some elementary discrete time sequences and systems; Concepts of stability, causality, linearity, linear time invariant systems and their properties; linear constant coefficient difference equations.

Structure for Discrete Time Systems: Block diagram representation, Signal flow graph representation, Direct form, cascade form, parallel form.

Discrete Fourier Transform and FFT: DFT and its properties; Linear, Periodic and Circular convolution; Correlation, Fast Fourier Transform algorithms, Concept of decimation in time and frequency.

Design of Digital Filters: Linear phase FIR filters; Design methods for FIR filters by windowing, IIR filter design by Impulse Invariance, Bilinear Transformation.

Adaptive Signal Processing: - Adaptive system, Adaptive linear combiner, Theory of adaptation with stationary signals, Adaptive algorithms and structures,

Application of ASP in Biomedical Signal analysis.

Books Recommended

1. Proakis J G and Manolakis D G, "Digital Signal Processing", Pearson Education India, New Delhi, 2003
2. Ifeather E C and Jerris B W, "Digital Signal Processing: A practical approach (2nd edition)", "Pearson Education, New Delhi, 2002
3. Jhon R. Thrichlen,C. Richards and M.G. Larimore , "Theory and design of Adaptive filter", PHI, New Delhi, 2002
4. Bernad Windrow and Samuel Stearn, "Introduction to Adaptive Signal Processing and application First", PHI, New Delhi, 2001
5. Bose ,Tamal "Digital signal and Image Processing", Wiely JW and Sons (asia) Pvt. Ltd., 2004

ELECTIVE-X (8TH SEMESTER)

IC-442 Advanced Networks

[3 0 0 3]

Introduction: Use and types of Computer Networks, Network Hardware and Software, OSI, TCP/IP Reference Models, Networking Terminology, Internet Evolution

Asynchronous Transfer Mode (ATM) Networks: Introduction, Cell-switching Physical, ATM, and AAL Layers, Routing and Addressing, ATM Signaling, ATM Switching Overview, ATM Traffic Management & Congestion Control, Quality of Service, Connection Admission Control performance issues

Wireless Networks: Introduction, Wireless Local Area Networks (WLANs), IEEE 802.11 standard, Bluetooth, Hiperlan,

Wireless adhoc networks: Introduction, Routing protocols, performance issues- Quality of Service (QoS),
Introduction to Sensor Networks

Books Recommended

1. Andrew S. Tanenbaum "Computer Networks" Ed Pearson Education 4th Edition, (2003)
2. James F. Kurose and Keith W. Ross "Computer Networking" Pearson Education, (2002)
3. William Stalling, "Wireless communication and networks", Pearson Education, 7th Edition, 5th Indian Reprint (2004)
4. Douglas E Comer, "Computer Networks and Internets", Pearson Education 2nd Edition, 5th Indian Reprint (2001)

5. W Stallings, "High Speed Networks and Internets-Performance and Quality of Service", second Edition 2003.

IC-444 Soft Computing

[3 0 0 3]

Neural Networks Characteristics- History of development of NN, ANN terminology, Types of learning- Supervised and Unsupervised. Basic learning rules-Hebb's rule, delta rule, widrow and hoff learning rule, instar and outstar learning rules. Unsupervised learning- competitive learning, K-means clustering algorithm.

Radial basis function neural networks – recurrent networks, Real time recurrent and learning algorithm.

Introduction to counter Propagation Networks- CMAC network, ART Networks, Application of NN in pattern recognition, optimization, control, speech and decision making.

Fuzzy logic- Basic concepts of Fuzzy logic, Fuzzy Vs Crisp set, Linguistic variables, membership functions, operations of Fuzzy sets, Fuzzy If-then rules, Variable inference techniques, defuzification techniques, applications, fuzzy system design, implementation of fuzzy system.

Natural Optimization methods- evolutionary algorithms (GAs, EP, GP etc.), a simple evolutionary selection schemes, cross over, Mutation, Applications.

Support Vector Machines- Introduction to SVM, Applications of SVM.

Books Recommended

1. David a coley, "An Introduction to genetic algorithms for Scientists and engineers", World scientific publishing Company(1997)
2. Berkin Riza C and trubatch, "Fuzzy system design principles", building a fuzzy IF-THEN rule bases, IEEE Press ISBN 0-7803-1151-5
3. Yegna Narayanan, "Artificial Neural Networks". 8th Printing. PHI(2003)
4. Yen and Langari, "Fuzzy Logic: Intelligence, control and information", Pearson Education.
5. Haykin simon, "Neural Networks" Pearson education.

IC-446 Image Processing

[3 0 0 3]

Introduction: Background, Digital image representation, fundamental steps in image processing, elements of digital image processing systems.

Digital Image Fundamentals: Elements of visual perception, image model, sampling and quantization, pixels, imaging geometry.

Image Transformation: Fourier transform, DFT, properties of two dimensional Fourier transform, FFT, some other transforms.

Image Enhancement: Spatial domain methods, frequency domain methods, Enhancement by point processing, Spatial filtering, Enhancement in frequency domain.

Image Restoration: Degradation model, algebraic approach to restoration, inverse filtering, Least mean square filter.

Image Compression and Segmentation: Image compression method, error free compression, Lossy compression, Detection of discontinuities, Thresholding, region oriented segmentation.

Introduction to image reconstruction algorithm for medical imaging

Books Recommended

1. Rafael C Gonzalez and Richard E Wood, "Digital Image Processing", Addison Wesley Publishing Company (1986)
2. Bernd Jahne, "Digital Image Processing Concepts, Algorithms and Scientific Applications" 2nd Ed., Spranjer Verlay (1991)
3. Jain A K, "Fundamental of Image Processing ", PH Eaglewood Cliff ,NJ (989)
4. Fangeras O,"Three Dimensional computer vision –A geometric view point ", MIT Press Cambridge MA(1993).
5. E Woods Richard and Eddins L Steven "Digital Image Processing ", 2nd Ed. Pearson Education, India (2005).

IC-448 MATLAB

[3 0 0 3]

Introduction to Matlab: Introduction, Matlab environment, types of files, Constants, Variables and Expressions, Operators, Hierarchy of operations, Vectors and Matrices, Multi dimensional Matrices and arrays, Matrix manipulations, Polynomials, Operations on polynomials, Input-output statements.

Matlab Graphics, control structures: 2D Plots, Multi dimensional Plots, Loops, Branched Control structures. Writing Programs and Functions in MATLAB

ODE, Symbolic Mathematics and SIMULINK Basics: ODE solvers and symbolic Mathematics, Simulink Modeling, Solvers, Simulating a model, Data import/ Export, state space modeling and simulation, simulation of non linear systems.

MATLAB Applications in Control systems: Laplace transforms, Transfer function to State Space representation and vice versa, time response of Control systems, Steady state errors, stability of CS, Root Locus, Frequency Domain analysis, Bode Plots, GM and PM, Nyquist Plots.

MATLAB applications in NN and Fuzzy Logic: Transfer functions, ANN architecture, using GUI, ANN based Control, implementation of ANN Controller, Linguistic variables and Membership functions, Rule Matrix, Fuzzy inference system, building system using GUI, Fuzzy controller example.

MATLAB applications in DSP: Signals and systems classification, Operation on Discrete time signals, Multirate Signal Processing functions, Convolution, Z Transforms, DTFT, DFT, FFT, Digital filter design, FDA tool Window, FIR and IIR filter design using FDA Tool.

MATLAB applications in DIP: Fundamentals, Intensity Transformations and Spatial filtering, frequency domain Processing, Image Restoration, Compression and Segmentation, Object Recognition

Books Recommended

1. Amos Gilat, "MatLab: An Introduction with applications", John Wiley and Sons.
2. Chapman Stephen J., "Matlab Programming for Engineers", Thomson Learning, 2004
3. Raj Kumar Bansal, Ashok Kumar goel, Manoj K Sharma, "Matlab and its applications in engineering", Pearson Education, 2009
4. Delores M. Etter, David C. Kuncicky, Doug Hall, "Introduction to Matlab 6", Pearson Education
5. Vinay K. Ingle, John J Proakis "Digital Signal Processing using MATLAB", Brooks/ Cole Thomson Learning,

OPEN ELECTIVE-I

IC-01 Elements of Control Engineering

[3 0 0 3]

Introductory Concepts: Functional elements of an instrumentation system. Some examples of instrumentation system; Potentiometers, Synchros, Techogenerators and Gyroscopes – functioning and their applications.

Transducers: Classifications of transducers, resistive transducers, inductive transducers & capacitive transducers, LVDT, Piezoelectric transducers and Biomedical transducers.

Mathematical Models of Systems: Different types of control systems, Mathematical models of Linear (LTIV & LTV – cases), Nonlinear and digital control system. Use of Laplace transform, T.F. of linear systems, Block diagram and SF-graph models, introduction to state variable modeling, S.V. models of some physical systems.

Time Domain Analysis: Standard inputs and response of various inputs, time domain response of a second order system, time domain specifications, steady state errors and coefficients, controllers.

Frequency Domain Analysis: Frequency domain specifications, correlation between time domain and frequency domain specifications, Bode' plots & Nyquist plots. Concept of stability and relative stability, Routh Hurwitz stability criterion, Limitation of RH-criterion.

State Variable Analysis: introduction, advantages of S.V. technique, state variable models for LTIV – analog and digital control systems, relation of state model with T.F. Diagonalization of system matrix & solution of state equations.

Books Recommended

1. Dorf Richard C and Bishop Robert H, "Modern Control System", Addison –Wesley, Pearson New delhi(1998).
2. Kuo C Benjamin, "Automatic control system" 7th Ed. PHI New delhi(1995).
3. Johnson C, "Process control instrumentation technology" 4th Ed., PHI, New Delhi(1993).
4. Ogata K, "Modern Control Engineering", 4th Edition, PHI, New Delhi (2004).
5. Murthy D V S, "Transducer and Instrumentation", PHI, New Delhi (2003).

Introduction: Measurement systems, Basic electronic measuring system, Transduction principles, Classification of transducers, General transducers characteristics, Criteria for transducer selection.

Resistive Transducers: Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.

Inductive Transducers: Types of Inductive transducer, Principles of operation, construction, Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT (Linear variable differential transformer).

Capacitive Transducers: Types of capacitive transducer, Principles of operation, construction, theory, advantages and disadvantages and applications, of capacitive transducers based upon familiar equation of capacitance.

Elastic Transducers: Spring bellows, diaphragm, bourdon tube – their special features and application.

Other Transducers: Optical transducers: photo-emissive, photo-conductive and Photo-voltaic cells, Digital Transducers, Encoder., Hall effect transducer, Photo-voltaic transducer

Books Recommended

1. Murty D V S, "*Transducers & Instrumentation*", PHI, New Delhi (2000)
2. Sawhney A K, "*Electrical and Electronics Measurements and Instrumentation*", Dhanpat Rai and Sons, New Delhi (2000).
3. Kalsi H S, "*Electronic Instrumentation*" Tata McGraw Hill, New Delhi, 4th Ed. (2001).
4. Patranabis D, "*Sensors and Transducers*", PHI, New Delhi (2003).
5. Doebelin Ernest O, "*Measurement Systems: Application and Design*", Tata McGraw Hill Ltd., New Delhi (2004).

IC-05 Optimization Techniques

[3 0 0 3]

Introduction: Definition, formulation of optimization problem, Classification of optimization problems, Objective function, Concept of optimization, direct approach, indirect methods, Optimization with constraints.

Indirect Methods: Maxima and Minima for functions of several variables, necessary and sufficient conditions, equality constraints, solutions using Lagrange – Multipliers.

Direct Optimum Search: Unimodal functions, resolution, implicit and explicit functions, simultaneous search using even and odd number of experiments, sequential search, Fibonacci and Golden section search, searches using quadratic and cubic interpolation.

Multivariable Optimization: Direct search methods – evolutionary simplex, concept of Hill climbing, methods of steepest ascent, Newton – Raphson and D F P. Direct search method programming.

Calculus of Variations: Various types of problems, The problem of Lagrange – Scalar case.

Constrained Optimization: Kuhn Tucker condition, transformation method, Penalty function, sensitivity analysis, interior point optimization.

Dynamic Programming: Introduction, multistage decision processes, solution for simple multistage problems, Discrete dynamic programming.

Some more Topics in Optimization: Multiobjective optimization, Genetic algorithms, Simulated annealing, optimization of Fuzzy systems.

Books Recommended

1. Rao S S, "*Engineering Optimization (Theory & Practice)*", 3rd Ed., New Age International (P) Ltd., New Delhi (2001)
2. Pierre D A, "*Optimization theory with applications*", (1970)
3. Deb Kalyanmoy, "*Optimization for engineering design algorithms and examples*", PHI, New Delhi (1978)
4. Deb Kalyanmoy, "*Multiobjective Optimization using Evolutionary Algorithm*", Wiley, Chi Chester, UK (1982)
5. Song Yong Hna, "*Modern Optimization Techniques in Power Systems*", Kluwer Academic Publisher (1987)

OPEN ELECTIVE-II

Introduction to Virtual Instrumentation: Historical perspective, Classification of different instruments / instrumentation system. Definition and architecture of virtual instrumentation system, salient features and application area of virtual instrumentation.

Data Flow Programming Techniques: Graphical programming in data flow, comparison with conventional programming, popular data flow and VI software packages. Building a VI front panel and block diagram, sub VI, for and while loops, case and sequence structure, formula nodes, local and global, string and file I/O, array and clusters, charts and graphs, attributes nodes.

Data Acquisition Basics: ADC, DAC, D/O, counters and timer, PC hardware structure, timing, interrupts, DMA, software and hardware installation, Configuring data acquisition hardware using the drives in application software, use of DAQ library functions for different analog and digital input/output operations.

Common Instrument Interfaces: Current loop, RS 232, RS485, GBIP. Use of library functions to communicate with different instruments.

Use of Measurement Analysis Tools: Measurement of Max, Min, Peak-Peak voltage, Mathematical tools, time period of a signal, power spectrum and logging Fourier transform, Correlation methods, windowing and filtering.

Building a web based virtual instrument: Networking basics for office and industry application.

Books Recommended

1. Lisa K Wells and Jeffrey Travis, "*LabVIEW for everyone*", Prentice Hall (1997).
2. Gupta S and Gupta J P, "*PC Interfacing for data acquisition of process control*", Instrument Society of America (1994)
3. Johnsons Gary W, "*LabVIEW Graphical programming*", 2nd Ed., McGraw Hill, 1997.
4. Johnson G and Jennings R, "*Labview graphical programming*", 3rd ed. MGH (2002).
5. James K "*PC Interfacing and Data Acquisition*" (2002).

Introduction to Energy Sources: World energy futures, Conventional energy sources, Non-conventional energy sources, Prospects of Renewable energy sources.

Solar Energy: Introduction to solar radiation and its measurement, Introduction to Solar energy Collectors and Storage, Application of solar energy: Solar thermal electric conversion, Thermal electric conversion systems, Solar electric power generation, Solar photo-voltatics, Solar Cell principle, Semiconductor junctions, Conversion efficiency and power output, Basic photo-voltaic system for power generation.

Wind Energy: Introduction to wind energy conversion, the nature of the wind, Power in the wind, Wind Energy Conversion: Wind data and energy estimation, Site Selection considerations, basic Components of a Wind energy conversion system, Classification of WEC Systems, Schemes for electric generation using synchronous generator and induction generator, wind energy storage.

Direct Energy Conversion Processes: Magneto Hydro Dynamic Power Generation: Principles of MHD power generation, Open cycle systems, Closed cycle systems, Voltage and power output, Materials for MHD generators. Thermo-Electric Generation: Basic principles of thermo-electric power generation, Seebeck, Peltier, Thomson effects, Thermo-Electric power generator, Analysis materials. Thermionic Generation: Thermionic emission and work function, Basic thermionic generator. Fuel Cells: H₂, O₂ cells, classification of fuel cells, types, Advantages, Electrodes, Polarization. Thermo Nuclear Fusion Energy: The basic Nuclear Fusion and Reactions Plasma confinement, Thermo Nuclear function reactors.

Energy from Biomass: Introduction: Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-gas plants Biomass as a Source of Energy: Methods for obtaining energy from Bio-mass, Biological conversion of Solar energy.

Books Recommended

1. Rai G D, "*Non Conventional Sources of Energy*", Khanna Publishers, New Delhi (1992)
2. Bansal N K, Kleemann M, Heliss M, "*Renewable energy sources and conversion technology*", Tata McGraw Hill, New Delhi (1990).
3. Jain H C, "*Non Conventional Source of Energy*", Advent Books Division, (1987).
4. Sorensen Bent "*Renewable Energy*", Academic Press, 3rd Ed. (2004).
5. Godfery Boyle "*Renewable Energy :Power for a Sustainable Future*", Oxford University (1996).

Signals & Systems: Introduction, signals, Transformations of independent variable, Basic continuous time signals, Basic Discrete –Time Signals, system.

Linear Time – Invariant System: The Representation of signals in Terms of Impulses, Discrete-Time LTI systems, continuous time LTI system, properties of LTI systems, Signal Flow Graph, System Described by differential and Difference equations, Block Diagram representations of LTI system.

Fourier series and Fourier analysis for Continuous Time Signals and Systems: Introduction, Fourier series and periodic functions, Features of periodic functions, choice of origin, systems with periodic inputs, The response of continuous time LTI system, The continuous Time Fourier Series, Representation of a periodic signals: The continuous – Time Fourier Transform Periodic signals and continuous Time Fourier Transform, Convolution and correlation.

Laplace Transform: The Laplace Transform, the Region of convergence for Laplace Transforms, the inverse Laplace Transform, Geometric Evaluation of the Fourier transform from the pole-zero plot, Analysis and characterization of LTI-system, unilateral Laplace transform.

Z-Transform: Z-transform, Region of convergence for Z-transform, Inverse Z-transform, Geometric evaluation of the Fourier transform from the pole-zero plot, analysis and characterization of LTI systems using Z-transforms, Transformations between continuous Time and Discrete Time System, Unilateral Z-Transforms. Application of Z-transform to the analysis and characterization of discrete time system.

Books Recommended

1. Alan V Oppenheim, Alan S Willsky with Ian T Young, “*Signals and Systems*” Pearson Education India, New Delhi (2003).
2. Ziemier R E, Tranter W H and Fannin, “*Signals and Systems*”, 4th Ed., Pearson Education India, New Delhi (2000).
3. Phillips C L, Parr J M and Riskin E A, “*Signals, Systems and Transforms*”, Pearson Education India, New Delhi (2003).
4. Mitra S K, “*Digital Signal Processing (A computer Based Approach)*”, TMH New Delhi(1998).
5. Salivahanan S and Vallavaraj A, “*Digital Signal Processing*”, TMH New Delhi 10th Ed. (2004).

OPEN ELECTIVE-III

Introduction: Energy requirement, types of electricity generation, connected loads, maximum demand, Demand factor, Diversity factor, variation in demand and chronological load curve, Load distribution curve, energy load curve, Load factor, capacity factor, utilization factor.

Power Plant Economics: Capital cost of plants, annual fixed costs, operating costs, Depreciation, effect of load factor on cost of energy.

Selection of Plant: Plant location and size, economic comparison of alternatives.

Loading of Alternators: Alternator connected to an infinite bus, phasor diagram and load diagram of salient and cylindrical pole machines.

Station Auxiliaries: General idea about station auxiliaries and equipments in hydro, steam plants, station batteries – size and maintenance.

Economic Operation of Steam Plants: Methods of loading turbo alternators, generator scheduling, elementary treatment of transmission loss and its effects on optimum scheduling.

Hydro – Thermal Coordination: Advantages of combined working of steam and hydro plants, base load and peak load plants, short term coordination of hydro-thermal plants neglecting transmission loss.

Tariff and Power Factor Improvements: Principles and objectives of tariff making, different types of tariff, need for p.f. improvement, use of capacitors for p.f. improvement.

Reactive Control of Generators: Methods of supplying reactive power from machines, synchronous condensers, series and shunt capacitors, shunt reactors, effect of reactive power on voltage.

Optimal Power Flow: Cost criteria, decoupling of p-f and Q-V loops, basic principles of power scheduling.

Basic Controls of Synchronous Generators: Excitation systems and its representation, Speed governing system, Dynamic stability with AVR-gain effect.

Load Frequency Control: Basic requirements to control system frequency, Load frequency characteristics, Two area control.

SCADA and computer control of power systems

Books Recommended

1. Nagrath I J and Kothari D P, “*Modern Power System Analysis*”, TMH, New Delhi (1980).
2. Anderson P M and Fouad A A, “*Power System Control and Stability*”, Iowa University Press, Ames, Iowa (1997).
3. Singh L P, “*Advanced Power System Analysis and Dynamics*”, Wiles Eastern Ltd. (1982).
4. Stevenson W D, “*Elements of Power System Analysis*”, 4th Ed. TMH New Delhi (1962).
5. Wadhawa C L, “*Electrical Power Systems*”, New Age International (P) Ltd., 3rd Ed., New Delhi (2000).

IC-04 Intellectual Property Rights

[3 0 0 3]

Fundamental aspects of intellectual property: introduction to copyright, related rights and trademarks, geographical indications, industrial design, patents, new plant varieties, unfair competition and emerging issues in intellectual property. Filing of IPR's in India.

International agreements on IPR's: agreement between WIPO and WTO, TRIPS agreement and GATT

PCT: Introduction to PCT, International application and International search, international preliminary examination

Books Recommended

1. WIPO publication No 274(E) Patent cooperation treaty (PCT) WIPO, 2006
2. WIPO publication No 223 (E) Agreements between world intellectual property organization and the world trade organization (1995), WIPO, 2006

IC-06 Experimental Methods for Engineers

[3 0 0 3]

Basic Concepts: Introduction, definition of terms: calibration, standards, the generalized measurement system, basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

Analysis of Experimental Data: Introduction, causes and types of experimental errors, error analysis on a commonsense basis, uncertainty analysis, evaluation of uncertainties for complicated data reduction, statistical analysis of experimental data, probability distributions, choice of graph formats, general considerations in data analysis.

Basic Electrical Measurements and Sensing Devices: Forces of electromagnetic origin, waveform measures, basic analog meters, basic digital meters, basic input circuits, amplifiers, differential amplifiers, transformers, power supplies, signal conditioning, the electronic voltmeter, digital voltmeter, the oscilloscope, oscilloscope selection, output recorders, counters – time and frequency measurements, transducers, comparison of analog and digital instruments.

Displacement and Area Measurements: Dimensional measurements, gage blocks, optical methods, pneumatic displacement gage, area measurements, the planimeter, graphical and numerical methods for area measurement, surface areas.

Pressure and Flow Measurement: Dynamic response considerations, mechanical pressure-measurement devices, practical considerations for obstruction meters, the sonic nozzle, flow measurement by drag effects, hot-wire and hot-film anemometers, magnetic flowmeters, Smoke methods, pressure probes, impact pressure in supersonic flow.

The Measurement of Temperature: Temperature measurement by mechanical effects, temperature measurement by electrical effects, temperature measurement by radiation, effect of heat transfer on temperature measurement, transient response of thermal systems, thermocouple compensation, temperature measurements in high-speed flow.

Force, Torque, and Strain Measurements: Elastic elements for force measurements, torque measurements, stress and strain, strain measurements, electrical resistance strain gages, temperature compensation, strain-gage rosettes, the unbonded resistance strain gage.

Data Acquisition and Processing: Introduction, the general data acquisition system, signal conditioning revisited, data transmission, analog-to-digital and digital-to-analog conversion, data storage and display.

Books Recommended

1. Holman J P, “*Experimental Methods for Engineers*”, 7th ed., Tata McGraw-Hill, 2004.
2. Doebelin E O, “*Measurement System: Application & Design*”, McGraw Hill Book Co., New Delhi (2004).

3. Rangan, Mani Sharma, "*Instrumentation Devices & Systems*", Tata McGraw Hill Book Co., 16th Reprint, New Delhi (1996).
4. Sawhney A K, "*A course in Mechanical Measurement & Instrumentation*", Dhanpat Rai & Sons Book Co., New Delhi (2003).
5. Patranabis D "*Principles of Industrial Instrumentation* " TMGH ,(1993).

ELECTIVE-IV

IC-08 Industrial Instrumentation

[3 0 0 3]

Basic concepts of measurement: Introduction to transducers, Measurement and its aim, functional elements of an instrument, performance characteristics.

Pressure and vacuum measurement: Manometers, Bourdon tubes, bellows, diaphragms, Pirani gauges, thermal conductivity gauges.

Flow measurement: Various types e.g. Head type, Area, some electrical methods of flow measurement.

Temperature Measurement: Temperature scales, Mercury in glass thermometers, filled in systems, thermocouple, RTD's and bimetallic type, Radiation pyrometers.

Composition Analysis: Spectroscopic analysis, analysis of moisture in gases, pH in concentration measurement.

Metrology: Line and length standards, Comparators, interferometry, Measurement of displacement, velocity and acceleration.

Miscellaneous Measurements: Measurement of humidity, moisture and level

Books Recommended

1. Doebelin E O, "*Measurement Systems – Application and Design*", McGraw Hill, New Delhi (1975)
2. Patranabis D, "*Problems of Industrial Instrumentation*", Tata McGraw Hill, New Delhi, 14th Reprint (1993)
3. Cooper W D, "*Electronic Instrumentation and Measurement Techniques*", PHI Pvt Ltd., New Delhi (1982)
4. Nakra B C and Chaudhary A K, "*Instrumentation, Measurement and Analysis*", TMH, New Delhi (1985).
5. Mani and Rangan, "*Instrumentation devices and systems*", Tata McGraw Hill, New Delhi (1997).

IC-10 Biomedical Instrumentation

[3 0 0 3]

Introduction: Cells and their structure, action events of nerve; the origin of biopotentials, Introduction to the physiology of cardiac, nervous and muscular and respiratory systems. Different types of transducers and their selection for biomedical applications.

Biopotential Electrodes: Signal acquisition; electrode theory, electrodes for biophysical sensing; electrode-electrolyte interface; electrode-skin interface and motion artifact; Different types of electrodes Hydrogen Calomel, Ag-AgCl, pH, Disposable electrodes, selection criteria of electrodes surface electrodes; electrical safety.

Measurement of Bioelectrical Activities: The electro-conduction system of the heart; the ECG waveform; the standard lead system; Electrocardiography, Electromyography, Electroencephalograph and their interpretation.

Non-electrical Measurements: Measurement of Blood Pressure, Blood flow, Cardiac output and Cardiac rate, Heart Sounds, Respiratory System Measurements, Measurement of pH value of blood, ESR measurements.

Therapeutic Aids: Stimulators, Defibrillators, Cardiac Pacemakers, Diathermy

Advances in Radiological Imaging: Introduction to Computed Tomography, Magnetic Resonance Imaging, Angiography, Nuclear Medicine, Ultrasound.

1. Rao C R and Guha S K, "Principles of Medical Electronics and Biomedical Instrumentation", Universities Press (India) Limited (2001).
2. Cromwell L, Weibell F J and Pfeiffer E A, "Biomedical Instrumentation and Measurements", 2nd ed., New Delhi: Pearson Education India (2003).
3. Carr Joseph J. and Brown John M., "*Introduction to Biomedical Equipment Technology*", 4th Ed., New Delhi: Pearson Education India (2001).
4. Webster John G (Ed.), "*Medical Instrumentation, Application and Design*", 3rd ed., Singapore: John Wiley & Sons (Asia) Pte. Ltd. (2003).
5. Khandpur R S, "*Handbook on Biomedical Instrumentation*", TMH, 13th reprint, New Delhi (2000).

IC-12 Physiological Control Systems

[3 0 0 3]

Brief introduction to human Anatomy and physiology: Basic human anatomy and physiology of the cardiovascular, nervous, muscular, and respiratory systems and their interactions;

Transport mechanisms: Emphasis on the physical and engineering principles governing the systems, various transport mechanisms of ions and molecules, concept of action potential.

Mathematical Modeling: Generalized system properties, Linear model of physiological systems, Laplace transform and concept of T.F., impulse response and convolution concept, computer analysis and simulation, differences between engineering and physiological control systems.

Static Analysis of Physiological Systems: Open loop Vs closed loop systems, steady-state operating point, and regulation of cardiac output.

Time Domain Analysis of Linearized Physiological Systems: Open loop and closed loop – transient responses, Descriptions of impulse and step responses for a generalized second order systems, Transient response, Effect of external disturbances and parameter variation,

Frequency Domain Analysis: Steady state response to sinusoidal inputs, graphical representation of frequency response, frequency response of a model of circulatory system, frequency response of general human body.

Stability Analysis: Stability and transient response, various approaches of linear system stability analysis, Root locus plots, RH – stability criterion, Nyquist criterion for stability.

Books Recommended

1. Khoo, Michael C K, "*Physiological Control Systems – Analysis, Simulation and Estimation*", EMB, IEE Press Series in Biomedical Engineering, Metin Akay, PHI Publishers, New Delhi, 2001
2. Graff K M VanDe and Rhees R Ward, "*Scham's Outlines*", TMH Publishing Co. Ltd., New Delhi, 2nd Ed, 1997
3. Ogata K, "*Modern Control Engineering*", 4th Ed., PHI, New Delhi, 2002
4. Nagrath I J and Gopal M, "*Control System Engineering*", Wiley Eastern Ltd., New Delhi, 1998
5. Friendland B, "*Advanced Control System Design*", PH-NY, 1996