CURRICULUM

B. TECH. Instrumentation and Control Engineering

3rd to 8th Semester

July 2018 admissions onwards

DEPARTMENT OF INSTRUEMNTATION AND CONTROL ENGINEERING

DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY, JALANDHAR

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About NITJ

Dr B. R. Ambedkar National Institute of Technology Jalandhar was established in the year 1987 as Regional Engineering College and was given the status of National Institute of Technology (Deemed University) by the Government of India on October 17, 2002 under the aegis of Ministry of Human Resource Development, New Delhi. Now the Ministry of Human Resource Development, Government of India has declared the Institute as —Institute of National Importance under the act of Parliament-2007.

Institute Vision

To build a rich intellectual potential embedded with interdisciplinary knowledge, human values and professional ethics among the youth, aspirant of becoming engineers and technologists, so that they contribute to society and create a niche for a successful career.

Institute Mission

To become a leading and unique institution of higher learning, offering state-of-the-art education, research and training in engineering and technology to students who are able and eager to become change agents for the industrial and economic progress of the nation. To nurture and sustain an academic ambience conducive to the development and growth of committed professionals for sustainable development of the nation and to accomplish its integration into the global economy.

About Department of Instrumentation and Control Engineering

The Department of Instrumentation and Control Engineering commenced its Bachelor of Technology (B. Tech) degree programme in 1990. Initially, the degrees were awarded by Guru Nanak Dev University Amritsar, subsequently, the Institute was affiliated to the newly set-up Punjab Technical University for the period July 1997 through October 2002. The Institute was accorded Deemed University Status w.e.f. October 17, 2002 under the aegis of Ministry of Human Resource Development, New Delhi. Now the Ministry of Human Resource Development, Government of India has declared the Institute as “Institute of National Importance” under the act of Parliament-2007. Instrumentation and Control Engineering is a well-diversified discipline. Many areas of specialization namely Process Instrumentation, Control Systems, Biomedical Engineering, Robotic, Wireless Networking etc. have grown by leaps and bounds and have emerged as full-fledged disciplines in themselves. Training students in all these areas is an uphill and challenging task. Therefore, every effort has been made while developing curricula to ensure full cognizance of all value elements among students. The teaching scheme has been enriched by the valuable inputs of experts of respective fields from prestigious institutions / organizations such as IIT Roorkee and IIT Delhi, R&D organizations like CSIO and leading industries of the region. The Department has commenced M Tech (Full Time) Degree Programme in Control & Instrumentation Engineering w.e.f. July, 2006 and M Tech (Part-Time) Programme w.e.f. July, 2010. The Department has also started Ph D Programme in 2005 in the areas of Instrumentation and Control Engineering, Biomedical Engineering, Robotics and Wireless Networking etc. The Department is consolidating its efforts to promote industrial research and consultancy in appropriate areas of Instrumentation and Control Engineering. The Department has many IPR’s to its credit.

Department Vision

To excel in the field of Instrumentation and Control Engineering education, research and innovation with interdisciplinary approach responsive to the needs of industry and sustainable development of society while emphasizing on human values and professional ethics.

Department Mission

- To create and disseminate knowledge through research, quality education and creative inquiry.
- To orient the education and research towards latest developments through close interaction with industry, other institutions of higher learning and research organizations.
- To train the students in problem solving and soft skills, inculcating leadership and team-work qualities, human values and ethical professionalism.

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 revolutionized. 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 proposed flexible curriculum as per directions of NIT council stipulated under the credit based system. 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 many years, the task of development of a flexible curriculum could be possible. The suggested curriculum is based credit based system in which students will be able to attain minor degree on completing the courses of other departments. 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. Core subjects have been selected to cover all those, which are essential in training of ICE graduates. The above features have been achieved by offering a number of electives courses both departmental and open in nature. I take this opportunity to express my deep appreciation to members of the Board for their valuable suggestions and critical comments in finalizing the curriculum. It is hoped that the curriculum complied 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.

Dr Kuldeep Singh Nagla
Head
Dept of Instrumentation and Control Engineering

Program Outcomes (POs) of BTech Programme

1) Ability to apply knowledge of mathematics, science and Instrumentation and Control engineering to the solution of complex problems.
2) Ability to conduct experiments and researches, perform analysis and interpret data for complex engineering problems.
3) Ability to identify, formulate, investigate and synthesis of information to solve complex engineering problems.
4) Ability to design solutions for complex system, component or process within a defined specification that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
5) Ability to use appropriate techniques, skills and modern engineering tools, instrumentation, software and hardware necessary for complex engineering practice with an understanding of their limitations.
6) Ability to articulate ideas, communicate effectively, in writing and verbally, on complex engineering activities with the engineering community and with society at large.
7) Ability to analyze the impact of global and contemporary issues, the role of engineers on society, including, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering.
8) Ability to execute responsibility professionally and ethically.
9) Ability to function effectively as an individual, and as a member or leader in diverse teams.

10) Ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need of sustainable development.
11) Ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
12) Ability to demonstrate knowledge and understanding of engineering and management principles to manage projects in multidisciplinary environments.

Programme Educational Objectives (PEO)

The Programme Educational Objectives of this Programme are:

i. The graduate should become as good professional (Teacher/ Researcher/ Engineer/ Entrepreneur) by acquiring strong knowledge in the principles and practices of instrumentation and control engineering.
ii. The graduate will continue to learn and to adapt in the world of constantly evolving technology.
iii. The complete engineer with professional and social ethics in-line with human values and work with values that meet the diversified needs of industry, academia and research.

Course Outcomes of BTech Programme

After completing the course the students:

i. Will be having good engineering knowledge and problem analysis skills of various courses related to Instrumentation and Control Engineering.
ii. Will be having exposure of various practical issues related to Instrumentation and Control Engineering.
iii. Will be having good knowledge of soft skills to analyze the performance of various Instrumentation and Control systems.
iv. Will learn to make and deliver presentations through seminar activity and will be passing through a process of project/thesis work where they will make design, fabrication and test of the project work and then write a report.
v. Will learn to work ethically which is beneficial to the society.

Development of curriculum: Overview

As per the NIT council (9th meeting) the following choices may be made available to the students at the end of the first year

- **Normal pace** – total 4 years (8 semesters): One major degree.
- **Major +Minor Degree-** Total 04 years, 06 minor courses (18 credits) in addition to essential Major Program Credits

Basic Structure of Flexible Curriculum Proposed by ICE Department

Sl. No	Course Category	Number of Courses	Number of Credits
1	Common Institute Core Courses (CIC)		63
2	Programme Core(PC)- Theory & Lab.	35	90
3	Programme Elective (PE)	06	18
	Total credits for PC & PE limited to 100		
4	Open Electives (OE) (from other dept.)	03	09
5	Minor Electives (MI) (For Minor Degree)	06	18
	Total		**180 (Excluding MI)**

First Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Category
1.	**CICI-102**	Applied Chemistry-B	3	1	0	**4**	4	**CIC**
2.	**MACI-101**	Applied Mathematics-I	3	1	0	**4**	4	**CIC**
3.	**ECCI-101**	Basic Electronics	3	1	0	**4**	4	**CIC**
4.	**HMCI-102**	English Communication & Report Writing	3	0	0	**3**	3	**CIC**
5.	**IPCI-101**	Introduction to Manufacturing	2	0	0	**2**	2	**CIC**
6.	**IPCI-103**	*Product Realization through Manufacturing Laboratory*	0	0	4	**2**	4	**CIC**
7.	**HMCI-103**	*English Communication Lab*	0	0	2	**1**	2	**CIC**
8.	**CYCI-103**	*Applied Chemistry-B*	0	0	2	**1**	2	**CIC**
9.	**CYCI-104**	*Environmental Science and Technology*	3	0	0	**3**	3	**CIC**
10.		*Induction programme*				**-**		
		TOTAL				**24**	**28**	

Second Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Category
1.	**PHCI-103**	Applied Physics-B	3	1	0	**4**	4	**CIC**
2.	**MECI-101**	Elements of Mechanical Engineering	3	1	0	**4**	4	**CIC**
3.	**CSCI-101**	Computer Programming	3	0	0	**3**	3	**CIC**
4.	**MACI-102**	Applied Mathematics-II	3	1	0	**4**	4	**CIC**
5.	**HMCI-101**	Management, Principles & Practices	3	0	0	**3**	3	**CIC**
6.	**MECI-102**	Engineering Graphics & CADD	1	0	4	**3**	5	**CIC**
7.	**PHCI-104**	*Applied Physics-B Laboratory*	0	0	2	**1**	2	**CIC**
8.	**CSCI-102**	*Computer Programming Lab*	0	0	2	**1**	2	**CIC**
9.		*NCC/NSO/NSS*				**-**		
		TOTAL				**23**	**27**	

Third Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Category
1.	**ICPC-201**	Circuit Theory	3	1	0	**4**	4	**PC**
2.	**ICPC-203**	Electrical Measurements and Measuring Instruments	3	1	0	**4**	3	**PC**
3.	**ECPC-251**	Electronic Devices and Analog Integrated Circuits	3	0	0	**3**	3	**PC**
4.	**ICPC-205**	EMF Theory	3	1	0	**4**	4	**PC**
5.	**MACI-206**	Numerical Methods	3	1	0	**4**	4	**CIC**
6.	**ICPC-221**	*Circuits Theory Laboratory*	**0**	**0**	**2**	**1**	**2**	**PC**
7.	**ICPC-223**	*Electrical Measurements and Measuring Instruments Laboratory*	**0**	**0**	**2**	**1**	**2**	**PC**
		TOTAL				**21**	**22**	

Fourth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Category
1.	**ICPC-202**	Electrical Machines	3	1	0	**4**	4	**PC**
2.	**ICPC204**	Transducers and Signal Conditioning	3	1	0	**4**	4	**PC**
3.	**ICPC-206**	Electrical Power System	3	1	0	**4**	4	**PC**
4.	**ECPC-252**	Digital Electronics	**3**	0	0	**3**	3	**PC**
5.	**HMCI-201**	Economics for Engineers	3	0	0	**3**	3	**CIC**
6.	**CSPC-213**	Data Structure and Algorithms	3	0	0	**3**	3	**PC**
7.	**ICXX-207**	**Professional Ethics & Holistic Wellbeing**	**2**	**0**	**0**	**Non credit**	**2**	
8.	**ICPC-222**	*Electrical Machines Laboratory*	0	0	2	**1**	2	**PC**
9.	**ICPC-224**	*Transducers and Signal Conditioning Laboratory*	0	0	2	**1**	2	**PC**
10.	**ECPC-272**	*Electronics devices and Digital Electronics Laboratory*	0	0	2	**1**	2	**PC**
		TOTAL				**24**	26	

Fifth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Type
1.	**ICPC-301**	Microprocessors and Interfacing	3	1	0	**4**	4	**PC**
2.	**ICPC-303**	Control System Engineering	3	1	0	**4**	4	**PC**
3.	**ICPC-305**	Signal Processing	3	1	0	**4**	4	**PC**
4.	**ICPC-307**	Industrial Measurement Systems	3	0	0	**3**	3	**PC**
5.	**ICPC-309**	Data Acquisition and Telemetry	3	0	0	**3**	3	**PC**
6.	**ICPE-3XX**	Program Elective-I	3	0	0	**3**	3	**PE1**
7.	**ICPC-325**	*Signal Processing Laboratory*	0	0	2	**1**	2	**PC**
8.	**ICPC-321**	*Microprocessors and interfacing Laboratory*	0	0	2	**1**	2	**PC**
9.	**ICPC-323**	*Control System Engineering Laboratory*	0	0	2	**1**	2	**PC**
10.	**ICCI-300**	*Minor Project*	0	0	2	**-**	2	**CIC**
		TOTAL				**24**	**29**	

Sixth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Type
1.	**ICPC-302**	Process Dynamics and Control	3	1	0	**4**	4	**PC**
2.	**ICPC-304**	Analytical Instrumentation	3	0	0	**3**	3	**PC**
3.	**ICPC-306**	Modern Control System	3	1	0	**4**	4	**PC**
4.	**ICPE-3XX**	Program Elective-II	3	0	0	**3**	3	**PE2**
5.	**ICPE-3XX**	Program Elective -III	3	0	0	**3**	3	**PE3**
6.	**ICOE-37X**	Open Elective-I	3	0	0	**3**	3	**OE1**
7.	**ICPC- 322**	*Simulation Laboratory*	0	0	2	**1**	2	**PC**
8.	**ICPC-324**	*Analytical Instrumentation Laboratory*	0	0	2	**1**	2	**PC**
9.	**ICCI-300**	*Minor Project*	0	0	2	**2**	2	**CIC**
		TOTAL				**24**	**26**	

Seventh Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Type
1.	**ICPC-401**	PLC, DCS and SCADA	3	0	0	**3**	3	**PC**
2.	**ICPC-403**	Biomedical Instrumentation	3	0	0	**3**	3	**PC**
3.	**ICPE-4XX**	Program Elective -IV	3	0	0	**3**	3	**PE4**
4.	**ICPE-4XX**	Program Elective -V	3	0	0	**3**	3	**PE5**
5.	**ICOE-47X**	Open Elective -II	3	0	0	**3**	3	**OE2**
6.	**ICPC-423**	*Biomedical Instrumentation Laboratory*	0	0	2	**1**	2	**PC**
7.	**ICPC-421**	*PLC, DCS and SCADA Laboratory*	0	0	2	**1**	2	**PC**
8.	**ICCI-400**	*Major Project*	-	-	4	**-**	4	**CIC**
9.	**ICPC-350**	*Summer Training**				**2**		**CIC**
		TOTAL				**19**	23	

**Summer Training* at the end of 7th semester for minimum 06 Weeks

Eighth Semester

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Type
1.	**ICPC-402**	Advanced Process Control	3	0	0	**3**	3	**PC**
2.	**ICPC-404**	Virtual Instrumentation	2	1	0	**3**	3	**PC**
3.	**ICPC-406**	Industrial Automation and Robotics	3	0	0	**3**	3	**PC**
4.	**ICPE-4XX**	Program Elective -VI	3	0	0	**3**	3	**PE6**
5.	**ICOE-48X**	Open Elective -III	3	0	0	**3**	3	**OE3**
6.	**ICPC-426**	*Industrial Automation and Robotics Laboratory*	0	0	2	**1**	2	**PC**
7.	**ICCI-400**	*Major Project*	-	-	4	**4**	4	**CIC**
8.	**ICCI-420**	**Industrial Lectures***				**1**		**CIC**
		TOTAL				**21**	21	

***** The evaluation of the particular course titled "**Industrial Lectures**" of credit 1 should be based on 50 % attendance of the students and 50% student's participation. The participation will depend on seminar, group discussion, group task, conducting exam etc.

Semester-wise Credit Structure:

Semester	Course Category	Number	Credits	Total Credits
III	CIC	1	4	21
	PC	6	17	
	PE	-	-	
	OE	-	-	
IV	CIC	1	3	24
	PC	8	21	
	PE	-	-	
	OE	-	-	
V	CIC	1	-	24
	PC	8	21	
	PE	1	3	
	OE	-	-	
VI	CIC	2	4	26
	PC	5	13	
	PE	2	6	
	OE	1	3	
VII	CIC	1	0	17
	PC	4	8	
	PE	2	6	
	OE	1	3	
VIII	CIC	2	5	21
	PC	4	10	
	PE	1	3	
	OE	1	3	
Total Credits (III to VIII semester)				133
Credits of 1st Year				47
Total Credits				180

Total No of PC	35	90	133
Total No of PE	6	18	
Total No of OE	3	9	
Total Credits for CIC	8	16	
Credits of 1st Year		47	47
Total Credits			**180**

LIST OF PROGRAM ELECTIVES (PE)

S.No	Semester	Course code	Course Title	L-T-P-C
1.	5th Semester	ICPE-351	Fiber Optics and Laser Instrumentation	3-0-0-3
2.	5th Semester	ICPE-353	Power Electronics and Drives	3-0-0-3
3.	5th Semester	ICPE-355	Computer Organization & Architecture	3-0-0-3
4.	5th Semester	ICPE-357	Communication System	3-0-0-3
5.	5th Semester	ICPE-359	Mechatronics	3-0-0-3
6.	5th Semester	ICPE-361	Testing and Calibration	3-0-0-3
7.	6th Semester	ICPE-352	Computer Networks	3-0-0-3
8.	6th Semester	ICPE-354	Embedded Systems	3-0-0-3
9.	6th Semester	ICPE-356	Advanced Measurement Systems	3-0-0-3
10.	6th Semester	ICPE-358	System Modeling and Reliability	3-0-0-3
11.	6th Semester	ICPE-360	Smart Sensors and Sensor Networking	3-0-0-3
12.	6th Semester	ICPE-362	Discrete Control Systems	3-0-0-3
13.	6th Semester	ICPE-364	Renewable energy systems	3-0-0-3
14.	6th Semester	ICPE-368	Autonomous Mobile Robot	3-0-0-3
15.	6th Semester	ICPE-351	Switchgear and Protection	3-0-0-3
16.	6th Semester	ICPE-370	Power Plant Instrumentation	3-0-0-3
17.	7th Semester	ICPE-451	Artificial Intelligence	3-0-0-3
18.	7th Semester	ICPE-453	Physiological control system	3-0-0-3
19.	7th Semester	ICPE-455	Identification and Adaptive Control	3-0-0-3
20.	7th Semester	ICPE-457	Optimization Techniques	3-0-0-3
21.	7th Semester	ICPE-459	Digital Image Processing	3-0-0-3
22.	7th Semester	ICPE-461	Instrumentation System Design	3-0-0-3
23.	7th Semester	ICPE-463	Energy Audit and Management	3-0-0-3
24.	7th Semester	ICPE-465	Industrial Safety	3-0-0-3
25.	7th Semester	ICPE-467	Machine Vision	3-0-0-3
26.	8th Semester	ICPE-452	Control System Design	3-0-0-3
27.	8th Semester	ICPE-454	Brain Computer Interfacing	3-0-0-3
28.	8th Semester	ICPE-456	Soft Computing	3-0-0-3
29.	8th Semester	ICPE-458	Advanced Sensors	3-0-0-3
30.	8th Semester	ICPE-460	Operation Research	3-0-0-3

LIST OF OPEN ELECTIVES (OE)

S. No.	Course Code	Course Title	L-T-P-C
1.	ICOE-371	Computer Networks	3-0-0-3
2.	ICOE-372	Elements of Control Engineering	3-0-0-3
3.	ICOE-373	Sensors and Transducers	3-0-0-3
4.	ICOE-374	Electronic Instrumentation and Measurements	3-0-0-3
5.	ICOE-375	Virtual Instrumentation	3-0-0-3
6.	ICOE-376	Non-conventional Energy Sources	3-0-0-3
7.	ICOE-377	Digital Signal Processing	3-0-0-3
8.	ICOE-471	Smart Materials and Structures	3-0-0-3
9.	ICOE-472	Intellectual Property Rights	3-0-0-3
10.	ICOE-473	Industrial Automation and Robotics	3-0-0-3
11.	ICOE-474	Brain Computer Interface	3-0-0-3
12.	ICOE-475	Biomedical Measurements	3-0-0-3
13.	ICOE-476	Testing and Calibration	3-0-0-3
14.	ICOE-477	Optimization Techniques	3-0-0-3
15.	ICOE-481	Computer Control of Industrial Process	3-0-0-3
16.	ICOE-482	Machine Learning	3-0-0-3
17.	ICOE-483	Industrial Measurements	3-0-0-3
18.	ICOE-484	Smart Sensor and Wireless sensor Networks	3-0-0-3
19.	ICOE-485	Internet of Things System Design	3-0-0-3
20.	ICOE-486	Physiological Control Systems	3-0-0-3
21.	ICOE-487	Process Optimization	3-0-0-3

LIST OF MINOR ELECTIVES (MI)

S. No.	Semester	Course Code	Course Title
1.	3rd Semester	ICMI-201	Electrical Measurements
2.	4th Semester	ICMI-202	Transducers and Signal Conditioning
3.	5th Semester	ICMI-301	Microprocessors and Interfacing
4.	6th Semester	ICMI-302	Control System Engineering
5.	7th Semester	ICMI-401	PLC, DCS and SCADA
6.	8th Semester	ICMI-402	Industrial Automation and Robotics

MI Minor Elective
PC: Program Core
CIC: Common Institute Core
PE : Program Elective
OE: Open Elective

Sr. No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Category
1.	ICMI-201	Electrical Measurements	3	0	0	**3**	3	**MI**
2.	ICMI-202	Transducers and Signal Conditioning	3	0	0	**3**	3	**MI**
3.	ICMI-301	Microprocessors and Interfacing	3	0	0	**3**	3	**MI**
4.	ICMI-302	Control System Engineering	3	0	0	**3**	3	**MI**
5.	ICMI-401	PLC, DCS and SCADA	3	0	0	**3**	3	**MI**
6.	ICMI-402	Industrial Automation and Robotics	3	0	0	**3**	3	**MI**
		TOTAL				**18**	**18**	

Syllabus for 3rd and 4th Semester

BTech. (3RD Semester)

ICPC-201 **Circuit Theory** **[3 1 0 4]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2		✓										
CO3			✓									
CO4		✓										
CO5			✓			✓						
CO6				✓			✓					

Course Outcome:

On successful completion of this course the student will be able to:

1. Analyze AC electrical circuits using basic laws and theorems of electrical circuits
2. Obtain the transient response of RC, RL and RLC circuits using Laplace transform
3. Solve two-port networks
4. Apply graph theory
5. Design analog filter
6. Synthesize networks

Syllabus:

Single Phase and Three Phase A.C. Circuits: Single-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 EMF generation, Delta and star connection, Line and phase quantities and relations, Solution of 3-phase circuits – balanced voltage and balanced load, Phasor diagrams.

Network Analysis Techniques: Classification of network elements, Network Laws , Node voltage and mesh current methods, Delta-star and star-delta conversion, Principle of superposition, Thevenin's and Norton's Theorems. 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.

Applications of Laplace Transform: Introduction, solutions of Linear Differential Equations for electric network-problems, convolution Integral-evaluation. Application of Laplace Transform analysis of electrical circuits – Linear time invariant first and second order circuits and response for different inputs. Impulse response of first and second order circuits.

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.

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-, hand transmission parameters, Interrelationship between these parameters, Interconnection of 2-port networks, Image parameters.

Filters Networks: Introduction to Fourier Transform, 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, mderived filters.

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.

Recommended Books:

1. Van-Valkenburg ME, “Network Analysis,” Prentice Hall
2. Aatre VK, “Network Theory and Filter Design,” Wiley and Sons Reference Books:
3. Choudhury RD, “Networks and Systems,” New Age International Publishers
4. Van-Valkenburg ME, “Introduction to Modern Network Synthesis,” Wiley and Sons

ICPC-203 Electrical Measurements and Measuring Instruments [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓		✓	✓	

Course Outcome:

On successful completion of this course the student will be able to:

1. Understand working of general instrument system, types of error, calibration etc
2. Measurement of various electrical quantities and parameters
3. Understand the principle and working of various electrical instruments and devices

Syllabus:

Measurement Systems: Measurement system architecture, errors in measurements. Standard used in measurement: Electrical standards, time and frequency standards, physical standards.

AC/DC Bridge Measurements: Wheatstone bridge, Kelvin Bridge, Anderson Constant current loop; resistance ration bridge, Schering bridge, Parallel C bridge, De Sauty bridge, Wein bridge, Maxwell’s bridge, hay bridge, Owen bridge, Anderson bridge, Heaviside Mutual inductance bridge. Measurement of high resistance including loss of charge method and Mega Ohm bridge method.

Basic Electrical Measurements: DC voltage/current measurements, Static electric field and potential of charged surfaces measurement, Electromechanical and analog electronic

AC voltmeters, AC current measurements, Phase measurements, frequency and time measurements, Q-meter for capacitance and inductance measurements.

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 power factor, secondary burden and frequency. Steady-state performance of current transformers, Transient performance of current transformers, Special connections of current transformers, Voltage transformers, Coupling capacitor voltage transformers, Transient performance of CCVTs, Electronic voltage transformers.

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; Oscilloscope specifications and performance; special purpose oscilloscopes

Books Recommended:

1. Northrop RB., "Introduction to Instrumentation and Measurements," CRC Press
2. Bell DA, "Electronic Instrumentation and Measurements," Prentice Hall
3. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons
4. Carr JJ, "Elements of Electronic Instrumentation and Measurements," Pearson Education India

ECPC-251 Electronic Devices and Analog Integrated Circuits [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓		✓		✓	✓
CO2	✓	✓	✓		✓			✓	✓		✓	
CO3	✓	✓	✓			✓		✓		✓	✓	✓
CO4				✓	✓					✓		

Course Outcome:

On successful completion of this course the student will be able to:

1. Knowledge of various solid state devices e.g. diodes, BJTs, FETs and their applications in electronic circuits
2. Knowledge of various feedback configurations of power and multistage amplifiers and ability to analyze their performances
3. Knowledge of op-amps and their applications and ability to analyze op-amp based circuits
4. Familiarization with various specialized ICs such as 555 timer, PLL, etc and their applications.

Syllabus:

Semiconductors Diodes and Applications: Review of p-n junction diode and special purpose diodes - Zener diode, Tunnel diode, 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 r_e model of BJT, Analysis of amplifier using Hybrid model and *re* model, Amplifier types-CE,CB,CC. DC operating point, 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, introduction to CMOS.

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.

Op-amps and Applications: Op-amp- analysis, Ideal op-amp building blocks, Open loop op-amp configurations, Practical op-amp- Offset voltage, Input bias and offset current analysis and compensation, CMRR, Block diagram representations and analysis of configurations using negative feedback, Voltage-series and Voltage–shunt feedback amplifier, Applications of op-amp- Summing, Scaling and Averaging amplifiers, Differential amplifier, Instrumentation amplifiers, V to I and I to V converters, Differentiator and integrator, Sample and hold circuits, Schmitt trigger.
Specialized ICs: 555 Timer-Monostable multivibrator, astable multivibrator, PLLs

Recommended Books:

1. Jacob Millman, Christos C Halkias and Satyabratajit, “Electronic Devices and Circuits” Tata McGraw- Hill, New Delhi(2008).
2. BoylestadNashelsky, “Electronic Devices and Circuit Theory”, Pearson Education, 8th edition, 7thIndian Reprint (2004).
3. Ramakant A Gayakwad, “Op-amps and Linear Integrated Circuits”, Pearson Education, 4th edition, New Delhi(2002).
4. Adel S Sedra, and Kenneth C Smith, “Microelectronic Circuits”, Oxford University Press, New York, 4th edition (1997).
5. Ben J Streetman and Sanjay Banerjee, “Solid State Electronic Devices”, PHI 5th edition (2004).

ICPC-205 **EMF Theory** **[3 1 0 4]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	✓	✓			✓	✓			✓			✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓								✓
CO4	✓	✓	✓	✓	✓		✓					✓

Course Outcome:
On successful completion of this course the student will be able to:

1. A working knowledge of the mathematical concepts of gradient, divergence, curl, aid line, surface and volume integrals; as well as Gauss' and Stroke's theorems, as they relate to engineering.
2. The capability to calculate forces between change distributions, and obtain the expressions for the electric field of lines, surfaces, and volumes in rectangular, cylindrical, and spherical charged geometries.
3. The capability to compute the forces between current distributions, and obtain mathematical expressions for the magnetic field characteristics of lines, surfaces, and volume currents in rectangular, cylindrical, and spherical shapes.
4. The ability to compute the voltage, current impedance, and power along two-conductor transmission lines using the solution of the wave equation and with the Smith chart.

Syllabus:

Mathematical Foundation
Review of vector algebra and calculus, Co-ordinate systems and transformation, Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems.
Introduction to Vector calculus, DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields, Helmholtz's theorem, Solution of problems.

Electrostatics
Electrostatic field: Coulomb's law and applications, field intensity, Gauss's law, Electric potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field.
Boundary conditions: Dielectric-dielectric, Conductor –dielectric, Conductor-free space. Poisson's and Laplace's equation, General procedure for solving Poisson's and Laplace's equation, Capacitance and capacitors, Electrostatic energy, Uniqueness of Electrostatic solutions, method of images, Solution of problems.

Magnetostatics
Biot- savart law, Ampere's circuit law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Force due to Magnetic Fields, Magnetic torque and moments, A Magnetic Dipole, Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material.

Time varying fields and Maxwell's Equations
Faraday' Laws, Displacement Current, Maxwell's Equations in Final forms, Time Varying Potentials, Time Harmonic Fields, Solution of problems.

Electromagnetic wave propagation

Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Polarisation. Solution of problems.

Transmission line

Concept of lump & distributed parameters, Line parameters, Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation, input impedance, SWR, and Power, smith chart, microstrip transmission lines, Solution of problems.

Books Recommended:

1. Jordon EC and Balmain KG, "Electromagnetic waves and radiating systems," Prentice Hall
2. Kraus JD, "Electromagnetics," McGraw Hill
3. Hayt WH and Buck JA, "Engineering Electromagnetics," Tata McGraw Hill
4. Edminister JA, "Schaum's outline of theory and problems of Electromagnetics," Tata McGraw Hill
5. Sadiku MNO, "Elements of Electromagnetics," Oxford University Press
6. Bhag Guru & Hüseyin R. Hiziroglu, "Electromagnetic Field Theory Fundamentals," Cambridge University press (2005)

MACI-206 Numerical Methods [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓	✓			✓	✓
CO2	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓			✓	✓
CO5	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:

After completion of this course, the students would be able to:

1. To attain knowledge of finding the roots of algebraic and transcendental equations which is a problem of great importance in applied mathematics by various numerical methods.
2. To understand direct and iterative methods for solving linear system of equations.
3. To attain knowledge of eigen value problems and several methods of finding the inverse of matrix which require less of computational labour and can be easily extended to matrices of higher order.
4. To understand interpolation, numerical differentiation and integration using basic concepts of finite differences.
5. To apply various numerical methods for solving ordinary differential equations where solutions cannot be obtained using available analytical methods and even to solve ordinary differential equations which have analytical solutions with greater ease.

6. To understand finite difference methods for boundary value problems and for elliptic, parabolic and hyperbolic partial differential equations which arise in description of physical processes in applied sciences and engineering.

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.

Interpolation and Finite differences: 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.

Numerical Method for ODE and PDE: 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.

Recommended Books:

1. Sastry SS, "Introductionary Methods of Numerical Analysis," Prentice Hall
2. Chapra SC and Canale RP, "Numerical Methods for Engineers," Tata McGraw-Hill
3. Grewal BS, "Numerical Methods," Khanna Publishers

ICPC-221 Circuit Theory Laboratory [0 0 2 1]

Course Outcome:

On successful completion of this course the student will be able to:

- Understand various principles and theorems and practical application to analog circuits
- Fabricate basic forms of various filters and their configurations. Where after they get familiarized with basic frequency responses of these filters

Syllabus:

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

ICPC -223 Electrical Measurement and Measuring Instruments Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Understand the procedure to measure unknown resistance, inductance and capacitance using bridge circuits
- Gain knowledge to calibrate electrical instruments
- Implement and verify different measurement schemes for measuring of electrical and non electrical parameters

Syllabus:

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 Electrodynamometer 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

B.Tech. (4TH Semester)

ICPC-202 **Electrical Machines** **[3 1 0 4]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓				✓		
CO2	✓	✓	✓	✓		✓				✓		✓
CO3	✓	✓		✓			✓	✓		✓	✓	

Course Outcome:
On successful completion of this course the student will be able to:

1. Learn the fundamental principles of Magnetic Circuits, Electro-mechanical energy conversion
2. Learn about the construction and working principle of DC machines, AC Machines, transformers, synchronous machines and induction machines
3. Learn the procedure for selecting machines for different applications

Syllabus:

Magnetics and Energy Conversion: Magnetic circuit, Analogies between electric and magnetic circuits, Magnetic Hysteresis and Hysteresis loss, Interaction of magnetic fields, Motor action, Generator action, Eddy currents and eddy current losses, Multi-polar machines.

Transformers: Construction of power and distribution transformers, Principle of transformer action, Concept of ideal transformer, EMF equation, Transient behavior when loading and unloading, Phasor diagrams, Equivalent circuit, Determination of transformer parameters, Regulation and efficiency, Per-unit impedance of transformer windings, Auto transformer, Parallel operation of transformers, Transformer nameplates.

Three Phase Induction Motors: Construction and principle of operation, Slip-torque equation, characteristics, Phasor diagram at standstill and on load, Equivalent circuit,

Parasitic toques, No load and blocked rotor tests, Starting, Methods of speed control, Applications, Name plate data.

Speciality Motors: Single phase induction motor, Shaded-pole motors, Hysteresis motor, Reluctance motor, Universal motor, Stepper Motor and their characteristics, applications

DC Machines: Flux distribution and generated voltage in DC machines, Commutation, Dynamic behavior when loading and unloading a DC motor, Armature reaction, Dynamic behavior during speed adjustment, Mechanical power and developed torque, losses and efficiency, Starting a DC Motor, Series/Shunt/Compound machines, Dynamic braking, Plugging and Jogging, Standard terminal markings and connections of DC motors.

Synchronous Machines: Introduction to synchronous machines.

Books Recommended:

1. Hubert CI, "*Electric Machines: Theory, Operation, Applications, Adjustment, and Control,*" Pearson Education India
2. Sarma MS and Pathak M, *"Electrical Machines,"* Cengage Learning India
3. Bhatacharya S, "*Eletrical Machines,"* Tata McGraw Hill
4. Nagrath IJ and Kothari DP, "*Electric Machines,*" Tata McGraw Hill
5. Bimbhra PS, *"Electrical Machinery,"* Khanna Publishers

ICPC-204 Transducers and Signal Conditioning [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓		✓	✓				✓		✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓		✓	✓				✓		✓	✓	✓

Course Outcome:

On successful completion of this course the student will be able to:

1. Understand study about the concepts of measurement, error and uncertainty, transducer classification, terminology, static and dynamic characteristics of transducers
2. Gain knowledge on working principle construction, operation, characteristics and features of different transducers
3. Understand the concepts of signal conversion and signal conditioning methods for different transducers
4. Understand the selection criteria of transducer for particular application and use the same for developing the applications

Syllabus:

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, Applications of AC/DC Bridges, Application of Op-amp circuits used in instrumentation, Instrumentation amplifiers, Interference, grounding , and shielding.

Books Recommended:

1. Murty DVS, “Transducers & Instrumentation”, Prentice Hall of India
2. Sawhney AK, “Electrical and Electronics Measurements and Instrumentation,” Dhanpat Rai and Sons
3. Kalsi HS, “Electronic Instrumentation,” Tata McGraw Hill
4. Patranabis D, “Sensors and Transducers,” Prentice Hall of India
5. Doebelin EO, “Measurement Systems: Application and Design,” Tata McGraw Hill

ICPC-206 Electrical Power System [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓				✓	✓	✓
CO2	✓	✓	✓	✓	✓					✓	✓	✓
CO3	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Course Outcome:

On successful completion of this course the student will be able to:

1. Understand generation, transmission and distribution aspects of electrical power system

2. Know the mechanical design considerations and insulation of overhead transmission lines
3. Have an insight into tariff structure

Syllabus:

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.

Text Books

1. Nagrath IJ and Kothari DP, “Modern Power System Analysis,” Tata McGraw-Hill
2. Wadhwa CL, “Electric Power Systems,” New Age Science

Reference Books :

3. Kirtley, “Electric Power Principles,” Wiley India
4. Mohan N, “*Electric Power Systems,*” John Wiley & Sons

5. Faulkenberry LM and Coffer W, “Electrical Power Distribution and Transmission,” Pearson Education India
6. El-Hawary ME, “Introduction to Electrical Power Systems,” IEEE Press

ECPC-252 **Digital Electronics** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Course Outcome:
On successful completion of this course the student will be able to:
1. Knowledge of various number systems and ability to perform number conversions
2. Ability to identify, analyse and design combinational and sequential circuits
3. Knowledge of digital logic families
4. Knowledge about ADCs/DACs, memories and programmable logic devices.

Syllabus:

Number Systems And Boolean Algebra: Review of 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.

Combinational Circuits: 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 Circuits: 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.

Digital Logic Families: Introduction to bipolar Logic families: TTL, ECL and MOS Logic families: NMOS, PMOS, CMOS, Details of TTL logic family and its subfamilies.

D/A And A/D Converters: Weighted resistor type D/A Converter, Binary ladder D/A converter, 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.

Semiconductor Memories: Memory organization, characteristics of memories, Sequential memories, ROM, RAM and PLDs-PLA & PAL.

Recommended Books

1. Mano M. Morris, “Digital Design”, 3rd edition, Pearson Education 2006.
2. Jain R. P. “Modern Digital Electronics”, 3rd edition, Tata McGraw-Hill 2003.
3. Malvino and Leach “Digital principles and Applications”, 5th edition, Tata McGraw Hill, 2003.
4. James W. Bignell and Robert Donovan, “Digital Electronics”, 5th edition, Delmar Publishers, 2007.
5. Flecther “An Engineering Approach to Digital Design”, 1st edition, PHI, 2009.
6. Tocci Ronald J. “Digital Systems-Principles and Applications” 10th edition, PHI, 2009.

HMCI-201 Economics for Engineers [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓								✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Course Outcome:

On successful completion of this course the student will be able to:

1. The students will able to understand different terms and concepts of economics.
2. The students will gain proficiency in understanding the changes in economic environment and their impact both at micro and macro levels.

Syllabus:

Basic Economic concepts, Decision making under risk and uncertainty. Concept of utility, demand and supply, elasticity of demand and supply, Demand forecasting. Production function in short and long run: law of diminishing marginal returns, isoquant-isocost approach. Economies of scale. Shapes of different cost curves in short and long run. Price-output determination in perfect competition, monopoly, monopolistic competition and oligopoly. Macroeconomics: national income, business cycle, fiscal policy, monetary policy, price indices, inflation, theories of international trade.

Reference Books:

Carl E Case, Ray C Fair and Sharon E Oster (2017), Principles of Economics, Pearson

John Sloman, Dean Garratt and Alison Wride (2014), Economics, 9th edition, Pearson.

Christopher R Thomas, S Charles Maurice and Sumit Sarkar (2010), Managerial Economics, 9th edition, McGraw Hill Publication.

H L Ahuja (2017), Managerial Economics, 9th edition, S Chand Publishing.

CSPC-213 **Data Structure and Algorithms** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓			✓			
CO2		✓		✓						✓		
CO3		✓	✓	✓			✓					✓
CO4		✓	✓	✓	✓	✓	✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO6		✓	✓		✓	✓		✓		✓	✓	✓

Course Outcome:

On successful completion of this course the student will be able to:

1. Define basic static and dynamic data structures and relevant standard algorithms for them: stack, queue, dynamically linked lists, trees, graphs, heap, priority queue, hash tables, sorting algorithms, min-max algorithm,
2. Demonstrate advantages and disadvantages of specific algorithms and data structures,
3. Select basic data structures and algorithms for autonomous realization of simple programs or program parts
4. Determine and demonstrate bugs in program, recognize needed basic operations with data structures
5. Formulate new solutions for programing problems or improve existing code using learned algorithms and data structures
6. Evaluate algorithms and data structures in terms of time and memory complexity of basic operations.

Syllabus:

Introduction: Basic Terminology, Elementary Data Organization, Structure operations.

Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C++, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors.

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, and Application of stack: Conversion of Infix to prefix and Postfix Expressions, Evaluation of postfix expression using stack.

Recursion: Recursive definition and processes, recursion in C, example of recursion, Tower of Hanoi Problem, simulating recursion, Backtracking, recursive algorithms, principles of recursion, tail recursion, removal of recursion.

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D-queues and Priority Queues**.**

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, Doubly linked list, Linked

List in Array, Polynomial representation and addition, Generalized linked list, Garbage Collection and Compaction.
Trees: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees**.**

Searching and Hashing: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation.

Sorting: Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical consideration for Internal Sorting**.**

Graphs: Terminology & Representations, Graphs & Multi-graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees.

TEXT BOOKS, AND/OR REFERENCE MATERIAL

1. Horowitz and Sahani, “Fundamentals of data Structures”, Galgotia Publication Pvt. Ltd., New Delhi.
2. R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education Asia, Delhi-2002
3. A. M. Tenenbaum, “Data Structures using C & C++”, Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Bruno R Preiss, “Data Structures and Algorithms with Object Oriented Design Pattern in C++”, Jhon Wiley & Sons, Inc.
5. GilbergForozan , “Data Structure – A pseudo code approach with C++”, Cengage Learning, New Delhi.

ICXX-207 Professional Ethics & Holistic Wellbeing [2 0 0 2]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓	✓	✓	✓	✓		✓
CO2						✓	✓	✓	✓	✓		✓
CO3						✓	✓	✓	✓	✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.

3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature

Syllabus:

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education: Understanding the need, basic guidelines, content and process for Value Education, Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels

Understanding Harmony in the Human Being - Harmony in Myself!:
Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship: Understanding Harmony in the family – the basic unit of human interaction, Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tript; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sahasttva as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family! - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Understanding Harmony in the Nature and Existence - Whole existence as Co-existence: Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (Sah-asttva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of

people-friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

Books:

1. Code of Ethics and Professional Conduct, College of Occupational Therapists; Revised edition edition, **ISBN-10:** 1905944209
2. Richard D. Parsons , "The Ethics of Professional Practice," ISBN-13: 978-0205308781
3. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
6. Subhas Palekar, 2000, How to practce Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati. 7. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.

ICPC-222 Electrical Machines Laboratory [0 0 2 1]

Course Outcome:

On successful completion of this course the student will be able to:

- Perform various configuration test on electrical single phase AC transformer
- Understand the working of single phase and three phase electrical motors along with their construction
- Acquire knowledge about the functioning of DC motor and generator

Syllabus:

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

ICPC- 224 Transducer and Signal Conditioning Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the use of sensor(s) and its interface to the associated circuitry in the experimental setups for the measurement of different physical variables
2. Understand the procedure to perform the experiment and obtain the output- input experimental data
3. Plot the output-input characteristics of transducers / measurement system and analyze certain static/dynamic characteristics of various types of transducers

Syllabus:

At least 8 experiments are to be performed out of the following list:

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

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.
Course Outcome: After completion of this course, the students would be able to:

- Understand the use of sensor(s) and its interface to the associated circuitry in the experimental setups for the measurement of different physical variables
- Understand the procedure to perform the experiment and obtain the output- input experimental data

• Plot the output-input characteristics of transducers / measurement system and analyze certain static/dynamic characteristics of various types of transducers

ECPC-272 Electronic Devices and Digital Electronics Lab [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Understanding of the operation and performance parameters of diodes, transistors and op-amps
- Ability to design, construct and characterize electronic circuits according to specification and analyze the results
- Ability to operate with electronic test equipment and discrete components and software tools to characterize the behavior of electronic devices and circuits
- Ability to design and analyze analog IC based circuits
- Ability to design and analyze combinational and sequential circuits using discrete components
- Ability to test the digital circuits
- Capability to design and test DACs

Syllabus:

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 working of a JFET and study its V-I characteristics.
5. To demonstrate working of an op-amp as a voltage level detector and a square wave generator.
6. To demonstrate the operation of a 555 timer as monostable and astable multivibrator.
7. Design and verification of the truth tables of Half and Full adder circuits.
8. Design and verification of the truth tables of Half and Full subtractor circuits.
9. Design and implementation of code converters using logic gates (i) BCD to excess-3 code (ii) Binary to gray code.
10. Verification of the truth table of the Multiplexer using IC 74150 and De-Multiplexer using IC 74154.
11. Design and test of an SR flip-flop using NOR/NAND gates.
12. Verify the truth table of a D flip-flop (7474) and JK flip-flop (7476).
13. Design and implementation of 3-bit synchronous up/down counter.

5Th Semester

ICPC-301 **Microprocessors and Interfacing** **[3 1 0 4]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓			✓			✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the architecture of 8-bit, 16-bit & Pentium microprocessors
2. Program the 8085 microprocessor & comprehend the basic concepts about the peripherals and interfacing devices
3. Develop microprocessor based systems for real time applications

Syllabus:

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

Introduction to Pentium Microprocessors: Introduction, Real mode and protected mode operation, Software model of the Pentium, Functional description, Pentium processor registers, Pentium data organization, Instruction types, Addressing modes, Interrupts.

Recommended Books:

1. Gaonkar RS, “Microprocessor architecture, programming and application with 8085,” Penram International Publishing

2. Hall DV, “Microprocessors and interfacing,” Tata McGraw-Hill

Reference Books:

3. Shen JP, “Modern processor design: Fundamentals of superscalar processors,” Tata McGraw-Hill
4. Mathur AP, “Introduction to microprocessors,” Tata McGraw-Hill
5. Ray AK and Bhurchandi KM, “Advanced microprocessor and peripherals: Architecture programming and interfacing,” Tata McGraw-Hill

ICPC-303 Control System Engineering [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓	✓		✓	
CO2	✓	✓	✓	✓	✓		✓	✓	✓			
CO3	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓			✓	✓					✓
CO5	✓	✓		✓	✓	✓	✓	✓		✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Learn the representation of systems, their transfer function models
2. Find the time response of systems subjected to test inputs and the associated steady state/dynamic errors
3. Analyze the concept of stability in time domain and frequency domain
4. Learn basics of compensation
5. Use of various control components

Syllabus:

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 and 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, polar plot.

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

Control Components: Error detectors – Potentiometers and Synchros, ac and dc servo motors, tacho-generators.

Text Books

1. Ogata K, "Modern Control Engineering," Pearson Education
2. Nagrath IJ and Gopal M, "Control System Engineering," New Age International

Reference Books

3. Kilian, "Modern Control Technology," Cengage Learning
4. Dorf RC and Bishop RH, "Modern Control System," Pearson Education
5. Kuo BC, "Automatic Control System," Prentice Hall
6. DiStefano JJ, Stubberud AR and Williams IJ, "Schaum's Outline of Theory and Problems of Feedback and Control Systems," Tata McGraw-Hill

ICPC-305 **Signal Processing** **[3 1 0 4]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓								✓	
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
CO3	✓		✓	✓	✓	✓				✓		
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓		✓							✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Represent continuous and discrete systems
2. Apply Z-transform, FT, DFT, FFT and their computation
3. Learn the finite word length effects in signal processing
4. Design digital filters
5. Learn fundamentals of digital signal processors

Syllabus:

Introduction: Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy

and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

Discrete Time System Analysis: Z-transform and its properties, inverse Z-transforms; difference equation – Solution by Z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Fourier transform of discrete sequence – Discrete Fourier series.

Discrete Fourier Transform & Computation: DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure.

Design of Digital Filters: FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Pole-zero placement, Impulse-invariant, matched z-transform and bilinear transformation methods.

Digital Signal Processors: Introduction – Architecture – Features – Addressing Formats – Functional modes - Introduction to Commercial Processors.

Text Books

1. Proakis JG and Manolakis DG, “Digital signal processing,” Pearson Education India
2. Ifeacher EC and Jerris BW, “Digital signal processing - A practical approach,” Pearson Education

Reference Books

3. Chen C-T, “Digital signal processing - Spectral computation and filter design,” Oxford University Press
4. Ambardar A, “Digital signal processing - A modern introduction,” Cengage Learning India
5. Lyons RG, “Understanding Digital Signal Processing,” Pearson Education India

ICPC-307 Industrial Measurement Systems [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓		✓		✓		✓
CO2	✓	✓	✓	✓	✓			✓	✓	✓		✓
CO3	✓	✓	✓		✓	✓	✓	✓				✓
CO4	✓	✓	✓	✓	✓			✓			✓	
CO5	✓		✓	✓	✓	✓		✓	✓		✓	

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the basic concept of industrial measurement transducers classification and selection criteria

2. Understand the principle, construction and working of transducers for measuring industrial process variables
3. Gain knowledge on different sources of error, signal conversion and conditioning methods for measurement of industrial variables
4. Understand the concept of calibration of different sensor based industrial instruments
5. Understand the use of industrial transducers for different process, measurement and control applications.

Syllabus:

Introduction: Review of functional block diagram of sensor based measurement system, generalized performance characteristics of sensor based instruments, definition, terminology and classification, review of displacement, velocity and acceleration measurement.

Temperature Measurement: Definitions and standards, primary and secondary fixed points calibration of thermometers, study of filled in system thermometer, bimetallic thermometers, electrical method of temperature measurement, resistance temperature detectors, thermocouple radiation pyrometry.

Pressure Measurement: Classification of pressure sensor, units of pressure, manometers, elastic type pressure gauges (bourdon tube, diaphragm, bellows), electrical transducers for pressure measurement (elastic elements with strain gauges, capacitive type pressure transducer), measurement of vacuum (McLeod gauge, thermal conductivity and lonization gauge), calibration of pressure gauges, dead weight tester.

Flow Measurement: Construction details and theory of head flow meters (Orifice plate, venturitube, pitot tube), Inferential flow meter – turbine flow meter, electromagnetic flow meter, hot wire anemometer, ultrasonic flow meter.

Other Variable measurements: Level measurement (float type level indication, differential pressure method, electrical type level gauges using resistive and capacitive probes and ultrasonic level sensor), mass, weight, force, torque and shaft power measurement.

Text Books

1. Doebelin EO, “Measurement System: Application & Design,” Tata McGraw-Hill.
2. Rathakrishnan E, “Instrumentation, Measurements and Experiments in Fluids,” CRC Press

Reference Books

3. Rangan CS, Sharma GR and Mani VSV, “Instrumentation devices & Systems,” Tata McGraw-Hill
4. Patranabis D, “Principles of Industrial Instrumentation,” Tata McGraw-Hill
5. Beckwith TG, Lienhard JH and Marangoni RD, “Mechanical Measurements,” Pearson Education
6. Nakra BC and Chaudary KK, “Instrumentation Measurement and Analysis,” Tata McGraw-Hill

7. Liptak BG, “Instrument Engineer’s Handbook, Vol. 1: Process Measurement and Analysis,” CRC Press

ICPC-309 Data Acquisition and Telemetry [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓				✓		✓
CO2	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓	✓		✓	✓		✓				✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the functionality of different components and configuration of data acquisition system
2. Understand the working and functionality of the Data Logger
3. Gain knowledge on different telemetry systems working principle, design techniques, signal transmission method, media and salient features
4. Gain knowledge on digital communication techniques and applications of single and multiple channel digital telemetry systems

Syllabus:

Data Acquisition System: Definition and generalized block diagram of data acquisition system (DAQ), Classification of DAQ, 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.

Analog Communication Techniques: Analog communication techniques: analog modulation of AC carrier; amplitude modulation of AM wave and frequency spectrum, frequency modulation and frequency spectrum of FM wave, Phase modulation and frequency spectrum of PM wave. Analog modulation of pulse carrier; basis of PAM, PFM.

Digital Communication Techniques: Digital modulation of pulse carrier, basis of PCM, DCPM; Digital modulation of AC carrier, ASK, FSK, PSK, error detection and correction methods, error control techniques.

Telemetry: Introduction, signal formation, conversion and transmission, general block diagram of telemetry system , classification of telemetry system, signal transmission media: Wires and cables, Power line carrier communication, terrestrial and satellite radio links, optical fiber communication, Multiplexing – TDM, FDM and WDM.

Telemetry Systems: Direct voltage and current telemetry system, AM and FM telemetry system, Multi-channel PAM and PWM telemetry system, single and multi-channel digital telemetry system, modem based telemetry system, short range radio telemetry and satellite telemetry system, fibre optics telemetry system.

Text Books

1. Karp HR (Ed.), "Basics of Data Communication," McGraw-Hill
2. Tomasi W, "Fundamentals of Electronic Communication Systems," Prentice Hall

Reference Books

3. Gruenberg EL, "Handbook of Telemetry and Remote Control," McGraw-Hill
4. Ginzberg, Lekhtman and Malov, "Fundamentals of Automation and Remote Control," Mir Publishers
5. Rangan CS, Sharma GR and Mani VSV, "Instrumentation Devices and Systems," Tata McGraw-Hill

ICPC-325 Signal Processing Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Characterize sampled systems in time and frequency domain
- Design basic IIR digital filters (using the bilinear transformation)
- Program digital signal processing algorithms in C and MATLAB, including the design, implementation, and real-time operation of digital filters, and applications of the fast Fourier transform

Syllabus:

1. Plotting discrete signals: Plot $\delta[n-3]$, $u[n-3]$, $r[n-3]$, $sinc(n/4)$ and $4(0.8)^n cos(0.2n\pi)u[n]$ over the range $-10 \le n \le 10$.
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(40πt)* 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 oreder 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 **dlsim** 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]+.....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 $x[n]=\{2,\underset{\uparrow}{-1},3\}$ is applied to an FIR filter whose impulse response is given by $h[n]=\{\underset{\uparrow}{1},2,2,3\}$. 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 $0 \le n \le 20$.
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(0.2πn)* to a digital filter whose impulse response is described by $h[n]=\{\underset{\uparrow}{1},2,3,4,5,6,7,8\}$.
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]+.....+8x[n-7].*Use this to find the response to *x[n] = cos(0.2πn)* and compare with the previous example.
13. Deconvolution: Given $y[n]=\{\underset{\uparrow}{3},9,17,21,19,13,6,2\}$ and $x[n]=\{\underset{\uparrow}{3},3,2,2\}$ identify *h[n]*.
14. Circular convolution: Consider two periodic signals described over one period by $x_p[n]=\{\underset{\uparrow}{1},2,-1,0,2,3\}$ $h_p[n]=\{\underset{\uparrow}{2},1,0,-1,-2,-3\}$. Find their periodic convolutions.
15. Let $x_p[n]=\{\underset{\uparrow}{1},2,-1,0,2,3\}$ and $h_p[n]=\{\underset{\uparrow}{2},1,0,-1,-2,-3\}$.
   (a) Find the periodic convolution $y_1[n]$ using one period of *x* and *h*.
   (b) Find the periodic convolution $y_5[n]$ using 5 periods of *x* and *h*.
   (c) How is the period of $y_5[n]$ related to that of $y_1[n]$?
   (d) How are the convolution values of $y_5[n]$ and $y_1[n]$ related?

16. Let $x_p[n] = \{\underset{\uparrow}{1},2,-1,0,2\}$ and $h_p[n] = \{\underset{\uparrow}{2},1,0,-1,-2,-3\}$. Find their regular convolution using zero padding and periodic convolution.
17. Autocorrelation and cross-correlation: Consider the sequences x[n] = n, 0≤n≤8 and h[n] = n, 0≤n≤3.
    (a) Evaluate and plot $r_{xx}[n]$ and $r_{hh}[n]$ and find where they attain their maximum.
    (b) Evaluate and plot $r_{xh}[n]$ and $r_{hx}[n]$.
    (c) 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.
    (a) Verify the presence of the signal by correlating the two noisy signals.
    (b) Estimate the frequency of the signal from the FFT spectrum of the correlation.
19. Convolution by FFT: Use FFT to find
    (a) The periodic convolution of $x_p[n] = \{\underset{\uparrow}{1},2,-1,0,2,3\}$ and $h_p[n] = \{\underset{\uparrow}{2},1,0,-1,-2,-3\}$.
    (b) The regular convolution of $x_p[n] = \{\underset{\uparrow}{1},2,-1,0,2\}$ and $h_p[n] = \{\underset{\uparrow}{2},1,0,-1,-2,-3\}$.

ICPC-321 Microprocessor and Interfacing Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Program 8085 Microprocessors using assembly language
- Interface peripheral devices such as PPI, Timer, ADC/ DAC with microprocessor
- Learn implementation of microprocessor based applications such as of Stepper Motor Controller, Traffic Light Controller, PID controller and Data Acquisition System
- Analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring

Syllabus:

At least 8 experiments are to be performed out of the following list:

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 control card
11. Study of traffic control study card

12. Study of A/D and D/A converter
13. Familiarization with 8086 trainer kit

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

ICPC-323 Control System Engineering Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

6. Use potentiometer and syncro as error detectors
7. Characterize servo motors
8. Derive transfer function
9. Study the open loop and closed loop speed control of AC servo motor
10. Study of PID control action

Syllabus:

At least 8 experiments are to be performed out of the following list:

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 a DC Servo Motor
5. To study the variations of time lag by changing the time constant using control engineering trainer
6. To simulate a third order differential equations using an analog computer and calculate time response specifications
7. To obtain the transfer function of a D.C. motor – D.C. Generator set using Transfer Function Trainer
8. To study the speed control of an A.C. Servo Motor using a closed loop and an open loop systems
9. (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

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

ICCI-300 Minor Project (PART-A) [0 0 2 -]

Course Outcome:

After completion of this course, the students would be able to:

1. Identify projects relevant to Instrumentation and Control systems
2. Design, model, simulate and fabricate a prototype
3. Prepare the project report

The Minor Project is aimed at to introduce the training of students to analyze any problem in the field of Instrumentation and Control systems independently. The project may be analytical, computational and experimental or combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done and it may be extend for the next semester (minor project) and major project in Seventh and Eighth Semester.

All the students are required to implement a research paper already published. During the project period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

Detailed Course Content of Electives-1

ICPE-351 **Fiber Optics and Laser Instrumentation** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓			✓		✓	
CO2	✓	✓	✓		✓		✓	✓				✓
CO3	✓	✓	✓			✓	✓				✓	✓

Course Outcome:
After completion of this course, the students would be able to:

1. Study about the transmission characteristics of light and principles of TRI in optical Fibers.
2. Know about the fundamentals of laser system, its mode of operation and their classifications.
3. Understand the principles of Holography, its application in NDT and the use of laser in biomedical application

Syllabus:

Optical Fibres and Their Properties: Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Fibre termination – Optical sources – Optical detectors.
Industrial Application of Optical Fibres: Fibre optic sensors – Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.
Laser Fundamentals: Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.
Industrial Application of Lasers: Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.
Hologram and Medical Applications: Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.
Recommended Books:

1. Senior JM, “Optical Fibre Communication – Principles and Practice,” Prentice Hall
2. Wilson J and Hawkes JFB, “Introduction to Opto Electronics,” Prentice Hall

Reference Books:

3. Keiser G, “Optical Fibre Communication,” McGraw-Hill
4. Arumugam M, “Optical Fibre Communication and Sensors,” Anuradha Agencies
5. Read JF, “Industrial Applications of Lasers,” Academic Press
6. Monte R, “Laser Applications,” McGraw-Hill

ICPE-353 **Power Electronics and Drives** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓				✓		✓
CO2	✓	✓		✓		✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand the operation of controlled rectifiers, choppers, inverters and their applications
2. study about voltage source inverter, current source inverter and PWM
3. Learn about the applications of power semiconductor devices for the speed control of AC and DC motors

Review of Power Semiconductor Devices: Power diodes – Power transistors – Characteristics of SCR, TRIAC, Power MOSFET, IGBT, GTO, MCT, LASCR – Thyristor protection circuits – Thyristor triggering circuits – Commutation – Natural, forced commutation.

Converters: Single phase – Three phase – Half controlled – Full controlled rectifiers – Dual converters – Effect of source and load inductance – Cyclo converters - AC regulators.

Inverters and Choppers: Voltage Source inverters –bridge inverters, Current source inverters – voltage and waveform control of inverters. DC choppers – step up and step down – uninterrupted power supplies.

DC Drives: Basic characteristics of DC motor – Operating modes – quadrant operation of chopper – Closed loop control of DC drives.

AC Drives: Induction motor – Performance characteristics – Stator and rotor voltage control, frequency and voltage control – Current Control – Introduction to synchronous motor, stepper motor, switched reluctance motor drives – Basics of vector control.

Recommended Books:

1. Rashid MH, “Power Electronics – Circuits, Devices and Applications,” Pearson Education
2. Dubey GK, “Power Semiconductors and Drives,” Prentice Hall

Reference Books:

3. Bose BK , “Modern Power Electronics and AC Drives,” Pearson Education
4. Vithyathil J, “Power Electronics,” McGraw-Hill
5. Mohan N, Undeland TM and Robbins WP, “Power Electronics: Converters, Applications and Design,” Wiley India
6. Subramaniam V, “Thyristor control of Electrical Drives,” Tata McGraw-Hill

ICPE-355 **Computer Organization and Architecture** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓				✓		✓
CO2	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand the basic concepts and organization of computers
2. Understand CPU architecture and micro programming
3. Learn about concepts and importance of parallelism

Instruction Set Architecture: Introduction to computer architecture - Review of digital design – Instructions and addressing – procedures and data – assembly language programs – instruction set variations.

Arithmetic/Logic Unit: Number representation – design of adders – design of simple ALUs – design of Multipliers and dividers – design of floating point arithmetic unit.

Data Path and Control: Instruction execution steps – control unit synthesis – microprogramming – pipelining – pipeline performance.

Memory System: Main Memory concepts – types of memory – cache memory organization – secondary storage – virtual memory – paging.

I/O and Interfaces: I/O devices – I/O programming – polling – interrupts – DMA – buses – links – interfacing – context switching – threads and multithreading.

Recommended Books:

1. Murdocca, “Computer Architecture and Organization,” Wiley India
2. Mano MM, “Computer System Architecture,” Pearson Education India

Reference Books:

3. Parhami B, “Computer Architecture,” Oxford University Press
4. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization,” Tata McGraw-Hill
5. Patterson DA and Hennessy JL, “Computer Organization & Design-The Hardware/Software Interface,” Morgan Kaufmann Publishers/ Elsevier
6. Stallings W, “Computer Organisation and Architecture, Designing for Performance,” Pearson Education India
7. Jordan HF and Alaghband G, “Fundamentals of Parallel Processing,” Pearson Education India
8. Wilkinson B and Allen M, “Parallel Programming,” Prentice Hall

ICPE-357 **Communication System** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓		✓		✓		✓
CO2	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand different methods of analog communication and their significance
2. Understand the concepts of source and line coding techniques for enhancing rating of transmission of minimizing the errors in transmission
3. Familiarize with optical and cellular communication concepts

Syllabus:

AM System: Introduction - Amplitude modulation theory - Frequency Spectrum - Representation - Power relation - AM Generation - Plate Modulated class C Amplifier - Evolution & description of SSB - Balanced Modulator - Advantages of SSB Transmission - AM transmitter - AM receiver - AM envelope detector - Superhetrodyne receiver.

FM System: Frequency Modulation - Phase Modulation - Armstrong Method of FM Generation - Ratio Detector - FM Transmitter - FM broadcast Receiver - Comparison of Wideband and Narrow Band FM.

Television System: Requirements and standards - Need for scanning - Interlaced scanning - VSB modulation - Black & white and Color Transmission (PAL) - Black & White and Color Receivers (PAL).

Communication Over Power Line: Need for and Methods of Power System Communications - Mode of Coupling to Power Lines - Power Line Carrier Frequency - Frequency Assignment - Modulation Methods - System Description.

Digital Communication System: Advantages of Digital Data transmission - Sampling - Pulse Code Modulation - Channel coding - Line coding - Digital Modulation schemes: ASK, FSK, QPSK - Digital Communication Receiver - Synchronisation.

Fibre Optic System: History of fibre optics-optical fibres versus metallic cables-optical fibre communication system-light propagation through optical fibres-fibre configurations-acceptance angle and acceptance cone-losses in optical fibre cables, light sources, light detectors, lasers. **Advanced Communication Systems:** Introduction to cellular radio telephones - Introduction to ISDN and BISDN.

Recommended Books:

1. Kennedy G and Davis, "Electronic Communication System," Tata McGraw-Hill

2. Tomasi W, "Advanced Electronic Communication Systems," Pearson Education

3. Biswas NN, "Principle of carrier communication," Asia Publishing House

Reference Books:

4. William S, "Data and Computer Communications," Pearson Education

5. Gulati RR, "Color Television Principles and Practice," Wiley Eastern

ICPE-359 **Mechatronics** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓		✓		✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓		✓		✓	✓		✓	✓		

Course Outcome:

After completion of this course, the students would be able to:

1. Learn the basics of electronics
2. Learn various types of sensors and actuators used.
3. Various concepts of control systems
4. Applications of mechatronics in CNC machines and Robotics

Introduction: Mechatronics: What and Why?

Essential electronics and Boolean algebra:

Digital representation: Binary, Decimal, Hexadecimal, Conversion from Binary to Decimal and vice-versa,

Binary arithmetic: Addition, Subtraction: 2's complement, Multiplication and Division, Boolean algebra: AND, OR, NOT, NAND, NOR, XOR logic, Truth table, Realization of logic in physical systems: switches-LEDs, cylinders... Fundamental identities, De Morgan's theorems and relationship with sets, Simplification

Electronics fundamentals: Review of some semiconductor devices, Concepts of Digital and Analog systems, Digital output (DO) and input (DI), Using switches, transistors, pneumatic devices, etc. to realize DI & DO

Operational Amplifier: Principles, Configurations: Inverting; Summing; Integrating and Differentiating configurations, Digital to Analog conversion (DAC), The R-2R and summing OpAmp circuit, Analog to Digital conversion (ADC), Successive approximation method, Flash method, etc., Programs for DI, DO, DA and AD for PC based plug in cards

Microprocessor, Computers and Embedded systems: Introduction to the 8085 (8-bit microprocessor) and microcontroller: Architecture, programming, I/O, Computer interfacing, Programmable logic controller basics

Sensors and actuators :Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezo electric accelerometer, Hall effect sensor, Optical Encoder, Resolver, Inductosyn, Pneumatic and Hydraulic actuators, stepper motor, DC motor, AC motor

Control Systems: Mathematical modeling of Physical systems, System equations, Controllability and Observability, Pole placement, PID controller, Control of Hydraulic, Pneumatic, Mechanical and Electrical Systems

Integration and case studies: Integration of Mechatronics component subsystems into a complete Mechatronics system Applications to CNC machines and Robotics

Recommended Books

1. David G. Alciatore, and Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi (2007).

2. W.Bolton, "Mechatronics", 2nd Edition, Pearson Education Asia, New Delhi (2001).

3. Dan Necsulescu, "Mechatronics", Pearson Education Asia, New Delhi (2002).

4. N. P. Mahalik, "Mechatronics", Tata McGraw Hill Publishing Company Ltd., New Delhi (2003).

5. Wolfram Stadler, "Analytical Robotics and Mechatronics", McGraw-Hill Book Co., Singapore (1995).

6. Eronini Umez-Eronini, "System Dynamics & Control", Thomson Asia Pvt. Ltd., Singapore (1999).

7. Shetty Devdas and Richard A Kolk, "Mechatronics System Design", Thomson Learning, 18 Vikas Publishing House, New Delhi (2001).

8. IEEE Robotics & Automation Magazine, Special Issue on Mechatronics, June 2001

ICPE-361 **Testing and Calibration** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓		✓		✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓

Course Outcome:

After completion of this course, the students would be able to:

1. Learn various safety standards for electrical equipments
2. How to test and calibrate instruments

Syllabus:

Electricity Rules: Indian Electricity Rules, Indian Electricity Act, Electricity Supply Act.
Standards: Study of Various Indian Standards codes for various important electrical equipments.
Installation & Commissioning : Installation & Commissioning of out door Indoor electrical equipments like transformer, Motors, Switchgears, Panels, Relays, CT, PT, Earthing etc.
Testing: Testing of new & Old electrical installation as per IS of the following. Transformer, Cables, Insulating Oil, Protective relays, Circuit Breakers, CT, PT, Meters, Energy Meters, PVC insulated cables, High voltage Testing & Routing Test, Type test on above.
Calibration : Calibration of meters, Energy meters, Relays, Circuit breakers, & other equipments as per IS specification.
Recommended Books:

1. M. Subbarao, Installation Commissioning & testing of Electrical Engineering Equipments, Khanna pub. Jagdishlal, Hanbook of Electricity Laws, Delhi Law House.
2. I.S. Codes, Indian Standard codes, Indian Standard Institution, Nanak Bhavan, New Delhi.

Sixth Semester

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓		✓		✓
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Analyze the dynamic model of different processes
2. Analyze the different control action and their relative merits, demerits and applications
3. Learn about different controller hardware and FCE

Syllabus:

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

Process Characteristics: Closed loop feedback control, Servo and regulator problems, Process variables, mathematical modeling of liquid, gas, thermal, mechanical and chemical systems, Degrees of freedom, Linearzing techniques, Liquid level control in a tank., Introduction to non-minimum phase processes; Distributed parameter processes and MIMO processes; Response of first and second order processes; 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 behavior 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 and their characteristics. Electrical, Pneumatic, hydraulic-actuators, Solenoid, E-P converters, stepper motors.

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

Text Books

1. Johnson CD, "Process Control Instrumentation Technology," Prentice Hall
2. Patranabis D, "Principles of Process Control," Tata McGraw-Hill

Reference Books

3. Sundaram, "Process Dynamics and Control," Cengage Learning
4. Coughanowr DR, "Process Systems Analysis & Control," McGraw-Hill
5. Stephanopoulos G, "Chemical Process Control: An Introduction to Theory and Practice," Prentice Hall
6. Harriott P, "Process Control," Tata McGraw-Hill
7. Seborg DE, Mellichamp DA, Edgar TF and Doyle FJ, "Process Dynamics and Control," John Wiley & Sons

ICPC-304 Analytical Instrumentation [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓	✓					
CO2	✓	✓	✓	✓	✓	✓						
CO3	✓	✓	✓	✓	✓	✓						
CO4	✓	✓	✓		✓	✓						
CO5	✓	✓	✓		✓	✓						

Course Outcome:
On successful completion of this course the student will be able to:

1. Liquid and gas sampling systems
2. Principle and working of gas analysis instruments
3. Principle and working of humidity and moisture measuring instruments
4. Principle and working of chemical composition measuring instruments
5. Principle and working of spectro-chemical analytical instruments

Syllabus:

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, CO_2, 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, gages.

Spectrochemical Analysis: Classification of techniques, Principles and components, emission spectrometery:- 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 spectrometery.
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).

ICPC – 306 Modern Control System [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓				✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Design state variable systems and analyze non-linear systems
2. Analyze the stability of the non-linear systems
3. Understand the concepts on design of optimal controller
4. Analyze system by phase plane method

Syllabus:
State Space Analysis of Continuous System: Review of state variable representation of continuous system, conversion of state variable models to transfer function and vice-versa, solution of state equations and state transition matrix, controllability and observability, design of state observer and controller.

Analysis of Discrete System: Discrete system and discrete time signals, state variable model and transfer function model of discrete system, conversion of state variable model to transfer function model and vice-versa, modeling of sample-hold circuit, solution of state difference equations, steady state accuracy, stability on the z-plane and Jury stability criterion, bilinear transformation, RouthHurwitz criterion on rth planes.

Stability: Lyapunov's stability theorems for continuous and discrete systems, methods for generating Lyapunov function for continuous and discrete system, Popov's criterion.

Non linear System: Types of non linearities, phenomena related to non - linear systems. Analysis of non linear systems-Linearization method, second order non-linear system on the phase plane, types of phase portraits, singular points, system analysis by phase-plane method, describing function and its application to system analysis.

Optimal Control: Introduction, formation of optimal control problem, calculus of variations minimization of functions, constrained optimization. Pontryagin's Minimum Maximum Principle, Linear Quadratic Problem-Hamilton Jacobi equation, Riccati equation and its solution.

Adaptive Control: Introduction, modal reference adaptive control systems, controller structure, self tuning regulators.

Recommended Books:

4. Gopal M, "Digital Control and State Variable Methods," Tata McGraw-Hill
5. Kirk DE, "Optimal Control Theory: An Introduction," Prentice Hall
6. Khalil HK, "Non-linear Systems", Prentice Hall
7. Astron KJ, "Adaptive Control", Dover Publications
8. Kuo BC, "Digital Control Systems," Oxford University Press
9. Ogata K, "Modern Control Engineering," Prentice Hall
10. Houpis CH and Lamont GB, "Digital Control Systems: Theory,Hardware, Software," McGraw-Hill

ICPC - 322 Simulation Laboratory [0 0 2 1]

Course Outcome:

On successful completion of this course the student will be able to:

- Understand modeling of complex systems with hands on experience for a given process
- Understand signal transmission through linear systems, convolution and correlation of signals and sampling

Syllabus:

Note: At least 10 experiments are to be performed:

1. To determine node voltages and branch currents in a resistive network.
2. To obtain Thevenin's equivalent circuit of a resistive network.
3. To obtain transient response of a series R-L-C circuit for step voltage input.
4. To obtain transient response of a parallel R-L-C circuit for step current input.

5. To obtain transient response of a series R-L-C circuit for alternating square voltage waveform.
6. To obtain frequency response of a series R-L-C circuit for sinusoidal voltage input.
7. To determine line and load currents in a three phase delta circuit connected to a 3-phase balanced ac supply.
8. To plot magnitude, phase and step response of a network function.
9. To determine z,y,g,h and transmission parameters of a two part network.
10. To obtain transient response of output voltage in a single phase half wave rectifier circuit using capacitance filter.
11. To obtain output characteristics of CE NPN transistor.
12. To obtain frequency response of a R-C coupled CE amplifier.
13. To obtain frequency response of an op-Amp integrator circuit.
14. To verify truth tables of NOT, AND or OR gates implemented by NAND gates by plotting their digital input and output signals.

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

ICPC-324 Analytical Instrumentation Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Learn the usage of various types of analytical instruments such as pH, Conductivity, UV absorbance and transmittance
6. Learn principle and working of humidity and moisture measuring instruments
7. Learn principle and working of chemical composition measuring instruments

Syllabus:

Note: At least 8-experiments are to be performed

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, SO_2, CO_2, CO and CH_4 by using infrared gas analyzer (type ZKJ).

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

ICCI-300 **Minor Project (PART-B)** **[0 0 2 2]**

Course Outcome:

After completion of this course, the students would be able to:

1. Identify projects relevant to Instrumentation and Control systems
2. Design, model, simulate and fabricate a prototype
3. Prepare the project report

It is the continuation of Minor Project started in the previous semester. During this period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. The students are advised to extend it as their major project in Seventh and Eighth Semester. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

ICPC-350 **Summer Training** **[- - -]**

Course Outcome:

After completion of this course, the students would be able to:

1. Gain exposure to industrial environment and latest technology trends
2. Understand organizational hierarchy
3. Enhance technical and managerial skills

The main objective of the Industrial/Vocational Training is to experience and understand real life situations in industrial organizations and their related environments and accelerating the learning process of how student's knowledge could be used in a realistic way. In addition to that, industrial training also makes one understand the formal and informal relationships in an industrial organization so as to promote favorable human relations and teamwork. Besides, it provides the exposure to practice and apply the acquired knowledge "hands - on" in the working environment. Industrial training also provides a systematic introduction to the ways of industry and developing talent and attitudes, so that one can understand how Human Resource Development works. Moreover, students can gain hands-on experience that is related to the students majoring so that the student can relate to and widen the skills that have been learnt while being in university. Industrial training also exposes the students to the real career world and accustoms them to an organizational structure, business operation and administrative functions. Furthermore, students implement what they have learned and learn more throughout this training. Besides, students can also gain experience to select the optimal solution in handling a situation. During industrial training students can learn the accepted safety practices in the industry. Students can also develop a sense of responsibility towards society.

Detailed Course Content of Electives-2 & 3

ICPE-352 **Computer Networks** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓						
CO4	✓	✓		✓	✓			✓	✓			✓

Course Outcome:
After completion of this course, the students would be able to:

1. To introduce the concepts, terminologies and technologies used in modern days data communication and computer networking
2. Understand the functions of different layers
3. Learn IEEE standards employed in computer networking
4. Understand different protocols and network components

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 Ad hoc Networks: Introduction, Routing protocols, performance issues- Quality of Service (QoS),
Wireless Sensor Networks: Characteristics, applications and routing.
Recommended Books:
1. Tanenbaum AS, “Computer Networks,” Pearson Education
2. Kurose JF and Ross KW, “Computer Networking,” Pearson Education

Reference Books:
3. Swamy, “Wireless Sensor Networks,” Wiley India
4. Stallings W, “Wireless communication and networks,” Pearson Education
5. Comer DE, “Computer Networks and Internets,” Pearson Education
6. Stallings W, “High Speed Networks and Internets,” Prentice Hall

ICPE-354 Embedded System [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓						
CO4	✓	✓		✓	✓			✓	✓			✓

Course Outcome:
After completion of this course, the students would be able to:

1. Understand the architecture of 8051 microcontroller hardware
2. Learn to program the microcontroller in assembly language, and eventually learn the arithmetic and logic instructions followed by Timer, Serial Port and Interrupt programming
3. Get familiar with the PIC microcontrollers
4. Understand the applications of microcontrollers such as LCD interfacing, DAC interfacing, and motor control

Introduction: Introduction to Microcontrollers and embedded processors, comparison of Microcontrollers and Microprocessors, overview of the 8051 family.
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.
Introduction to PIC Microcontrollers: Overview and features, PIC 16C6X/7X, FSR, PIC Reset actions, Oscillator Connections, Memory organization, Instructions, Addressing modes, I/O ports, Interrupts in PIC 16C61/71.
Applications: LCD interfacing, parallel and serial ADC, DAC interfacing, motor control applications.
Recommended Books:
1. Kenneth JA, “The 8051 Microcontroller: Architecture, Programming and Applications,” Penram International

2. Mazidi MA and Mazidi JG, ”The 8051 Microcontroller and embedded systems Using Assembly and C,” Pearson Education

Reference Books:
3. Deshmukh AV, “Microcontrollers: Theory and Applications,” Tata McGraw-Hill

4. Kamal Raj, “Microcontrollers: Architecture, Programming, Interfacing and System Design,” Pearson Education
5. Lewis DW, “Fundamentals of Embedded Software: Where C & Assembly Meet,” Pearson Education
6. Morton J, “The PIC Microcontroller”, Newnes Press

ICPE-356 Advanced Measurement Systems [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓						
CO4	✓	✓		✓	✓			✓	✓			✓

Course Outcome: After completion of this course, the students would be able to:

1. Realize an advanced measurement system is discussed from the viewpoints of measurement principle, sensors and signal processing
2. Specialized in measurement systems, which are important in industrial applications such as flow measurement system for fluid mechanics, effects of heat transfer, ultrasonic measurement system are covered
3. Each topic has been developed in logical progression with the up-to-date information on this field of research
4. Number of selected problems will be worked out to illustrate different concepts clearly

Intrinsically Safe Measurement Systems: Pneumatic measurement systems: flapper-nozzle, relay, torque balance transmitters, transmission and data presentation, Intrinsically safe electronic systems: the Zener barrier, energy storage calculations.

Heat transfer effects in measurement systems: Introduction, Dynamic characteristics of thermal sensors, Constant-temperature anemometer system for fluid velocity measurements. Katharometer systems for gas thermal conductivity and composition measurement.

Optical measurement systems: Introduction: types of system, Sources: principles, hot body, LED and LASER sources, Transmission medium: principles, optical fibers, Geometry of coupling of detector to source, Detectors and signal conditioning elements: thermal and photon detectors, measurements systems: intensity and wavelength modulation, interferometers.

Ultrasonic measurement systems: Basic ultrasonic transmission link, piezoelectric ultrasonic transmitters and receivers, Principles of ultrasonic transmission: wave properties, acoustic impedance, attenuation, stationary waves, response, Doppler effect, Examples of ultrasonic measurement systems: pulse reflection, medical imaging, Doppler, cross-correlation and transit time flowmeters.

Gas Chromatography: Principles and basic theory, Typical gas chromatograph, Signal processing and operations sequencing.

Data acquisition and communications systems: Time division multiplexing, Typical data acquisition system, Parallel digital signals, Serial digital signals, Error detection and correction, Frequency shift keying, Communication systems for measurement.

Recommended Books:

1. Bentley JP, “Principles of Measurement Systems,” Pearson Education
2. Doebelin EO, “Measurement Systems – Application and Design,” Tata McGraw-Hill
Reference Books:
3. Nakra BC and Choudhary KK, “Instrumentation Measurements and Analysis,” Tata McGraw-Hill 4. Northrop RB, “Introduction to Instrumentation and Measurements,” CRC Press
5. Dally JW, Riley WF and McConnell KG, “Instrumentation for Engineering Measurements,” Wiley India
6. Beckwith TG, Marangoni RD and Lienhard JH, “Mechanical Measurements,” Pearson Education

ICPE-358 **System Modeling and Reliability** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓				✓		
CO2	✓	✓	✓	✓	✓			✓	✓			
CO3	✓	✓	✓		✓						✓	✓
CO4	✓	✓	✓			✓	✓				✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Know the needs and applications of computer simulation
2. Learn the concepts of mathematical modelling and its representation
3. Learn the computer simulation techniques
4. Learn the importance of reliability, maintainability and safety aspects

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, Simulation 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. Case studies using soft computing algorithm.
Recommended Books:
1. Nagrath IJ and Gopal M, “System Modeling and Analysis,” Tata McGraw-Hill
2. Srinath LS, “Reliability Engineering,” East West Press

Reference Books:
3. Gorden G, “System Simulation,” Prentice Hall
4. Law AM and Kelton WD, “Simulation Modeling and Analysis,” Tata McGraw-Hill
5. Banks J, Carson JS, Nelson BL and Nicol DM, “Discrete Event System Simulation,” Prentice Hall

ICPE-360 Smart Sensors and Sensor Networking [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the concept of smart sensor, intelligent sensor, network sensors, hardware schematics, level of integration, transduction principle, functional capabilities of smart and intelligent transducer
2. Gain knowledge on IEEE 1451 smart transducer interface for sensor and actuator
3. Understand the functionality and usage of different types of smart/intelligent sensors used extensively in industrial and home, vehicle automation
4. Gain knowledge on concept of networking of sensor, functions of different layers, wired sensor network protocols, components and tools to implement the sensor network

Review of Basic Concepts: Measurement system, transducers, sensors and actuators; signal conditioners; data communications and networking.
Basics of Smart Sensors: Definition and architecture of smart sensor; different levels of integration in small sensors, differences between smart, intelligent and network sensors ;advantages of smart sensors ;smart actuators and transmitters.
Smart Sensor Technologies: IC Technologies: thick film, thin film and monolithic IC technologies; Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface micromachining, other micro-machining techniques.
Examples of Smart Sensors: Principles, characteristics and constructional details of typical smart sensors for temperature, humidity, pressure and vibrations.
Basics of Sensor and Actuator Networking: Field-level, controller-level and enterprise-level networks; Sensor and actuator network (SAN): Network topologies; seven-layer OSI model of communication system.
Wired Network Protocols: RS-422, RS-485, HART and Foundation Fieldbus protocols, comparison with Ethernet (IEEE – 802.3) protocol.
Wireless Network Protocols: Need and advantages of wireless sensor and actuator network(WSAN); Zigbee (IEEE – 802.15.4) protocol, Merits of Zigbee over WiFi (IEEE – 802.11) and Bluetooth for sensor and actuator networking.
IEEE Standard 1451: Introduction to IEEE Standard 1451: “Smart Transducer Interface for Sensors and Actuators”; highlights of parts 1451.1, 1451.2, 1451.3, 1451.4 and 1451.5 of the Standard.
Recommended Books:
1. Patranabis D, “Sensors and Transducers,” Prentice Hall
2. Frank Randy, “Understanding Smart Sensors,” Artech House

Reference Books:
3. Callaway EH, “Wireless Sensor Networks : Architecture and Protocols,” CRC Press
4. Anand MMS, “Electronic Instruments and Instrumentation Techniques,” Prentice Hall
5. William S, “Data and Computer Communications,” Pearson Education

6. IEEE Standard 1451, “Smart Transducer Interface for Sensor and Actuators,” IEEE Press

ICPE-362 Discrete Control System [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓		✓	✓		
CO2	✓	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	

Course Outcome:
On successful completion of this course the student will be able to:

1. Model discrete/digital control systems using state space model
2. Design digital control systems
3. Analyze discrete control systems for their Stability

Computer Controlled System: Configuration of the basic digital control scheme, general sampled data system variables, signal classifications, why use digital control system, Advantages, disadvantages, examples of discrete data and digital control systems.
Signal Processing in Digital Control: Sampling process, Frequency domain analysis, ideal samples, Shanon’s sampling theorem, generation and solution of process, linear difference equations, data reconstruction process, frequency domain characteristics.
Discrete System Modeling: Determination of the transform, mapping between s and z domains, transform of system equations, open loop Hybrid sampled Data Control Systems, open loop discrete Input Data Control System, closed loop sampled data control system, modified transform method, response between sampling instants, stability on the z-plane and Jury’s stability test, steady state error analysis for stable systems.
State Variable Analysis of Digital Control Systems: State descriptions of digital processors, conversion of state variable models to transfer functions, conversion of transfer functions to canonical state variable models, first comparison form, second companion form, Jordon Canonical form, state description of sampled continuous time plants, solution of state difference equations, closed form solution, state transition matrix, Cayley Hamilton Technique, concept of controllability and observability, loss of controllability and observability due to sampling.
Design of Digital Control: Digital PI, PD and PID Controller, Position and velocity forms, state regulator design, design of state observers, dead beat control by state feedback and dead beat

Recommended Books:

1. Kuo BC, “Digital Control Systems,” Oxford University Press
2. Ogata K, “Discrete Control Systems,” Prentice Hall

Reference Books:

3. Houpis CM, Lamount GB, “Digital Control Systems-Theory, Hardware, Software,” McGraw-Hill
4. Gopal M, “Digital Control and State Variables Methods,” Tata McGraw-Hill
5. Deshpande PB and Ash RH, “Computer Process Control,” ISA Publication
6. George VI and Kurian CP, “Digital Control Systems,” Cengage Learning India
7. Phillips CL and Troy NH, “Digital Control System – Analysis and Design,” Prentice-Hall

ICPE-364 **Renewable Energy Systems** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓				✓		✓
CO4	✓	✓		✓	✓			✓	✓	✓		✓

On successful completion of this course, the student will be able to:

1. Learn about availability and prospects of renewable energy sources
2. Understand the effect of electric energy generation on the environment
3. Understand the methods to harness solar, wind, biomass, hydro, geothermal, and ocean energy, and learning their applications in the society
4. Get familiar with the smart grid

Introduction: Energy Sources and their availability, renewable energy sources, Prospects of renewable energy sources, application of non-conventional and renewal energy sources, smart grid.

Environmental Aspects of Electric Energy Generation: Introduction Thermal pollution, Atmospheric pollution, Effects of Hydroelectric projects, Nuclear power generation and environment, Green House Gas Effects, Global Environmental awareness, Energy options for Indian Economy.

Solar Energy: Solar radiation estimation, Basic Principle of Solar Energy physical Principal of the conversion of solar radiation into heat, Collectors, Solar Energy storage system, solar thermal electric conversion, solar electric Power Plant & applications.

Wind Energy: Basic Principle of wind energy conversion, nature & Power of wind, site selection, wind energy conversion SYSTEM. Scheme for Electric Generation, Generator Control load control, Inter connected SYSTEM & applications.

Small Hydro Power: General description, classification of schemes, siting and economic considerations, system components: weir/intake channel, desilting tank, forbay, spillway, penstock, turbine, generator, governor, control.

Biomass Energy: Biomass conversion technologies bio mass generation, classification of Bio Gas Plants material used in Bio Gas Plants., Selection of site & applications.

Geothermal Energy: Sources of Geothermal energy Estimation of Geothermal Power, Geothermal Power Plants, Geothermal energy in India and Prospects.

Ocean Energy: Ocean thermal electric conversion, site selection, Power Plant, Prospects of ocean energy in India, tidal Power tidal Power Plant, Prospects in India.

MHD & Hydrogen Energy: Basic Principle MHD SYSTEM, advantages, Power OUTPUT of MHD Generation, future Prospects. Principle and classification of fuel cell energy, hydrogen as alternative fuel for Generation of Electrical Energy & applications.

Fuel Cell: Fuel Cell, Management of Fuel, Thermonic power generation, water Resource Electricity deviend scenario storage and handling, Introduction to smart grid

Recommended Books:

1. D.P Kothari, K.C. Singla, Rakesh Ranjan “Renewable Energy Sources and Emerging Technologies” PHI Publications.
2. G.D. Rai “NON-Conventional energy Sources” Khanna Publications.

Reference Books:

1. Jain &Bala Subramanyam “Power Plant Engineering”

ICPE-368 Autonomous Mobile Robot [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓					✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓				✓						
CO4	✓	✓		✓	✓				✓			✓

Course outcomes:

- To understand the basic knowledge of mobile robots
- To understand perception in case of robots
- To solve the problems of SLAM
- To understand mobile robot path planning

Introduction: Introduction to robots, various components of robot, applications of robots, classification of robots, mobile robot actuators, advantages and disadvantages of robots

Mobile robot fundamentals: Types of mobile robot locomotion in robots, legged mobile robots, wheeled mobile robots, mobile robot kinematics: kinematic models and constraints, mobile robot maneuverability, mobile robot work space, motion control.

Perception: mobile robot perception, sensors for mobile robots, representing uncertainty, feature extraction, Mobile robot mapping, sonar sensor model, laser sensor mapping, fundamentals of vision sensor

Mobile robot localization: Introduction, challenges of localization, noise aliasing, mobile robot navigation. Probabilistic map based localization.

Mobile robot planning and navigation: path planning, obstacle avoidance, navigation architecture.

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
   An C H, Atkeson C G & Hollerbach J M, "*Model based control of a Robot manipulator*", MIT Press, Mass., 1988

ICPE-351 Switchgear and Protection [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the different types of electrical faults
2. Understand various protection schemes
3. Understand the operation of various protection devices and their coordination
4. Understand different Indian electricity protection rules

Introduction: Principles and need for protective schemes – nature and cause of faults – types of fault – per unit representation - analysis of symmetrical fault – current limiting reactors. CTs and PTs and their applications in their protection schemes.
Protective Relays: Definition - Requirement of relays - Universal relay torque equation - Non directional and directional over current relays – Earth fault relays - Distance relays - Impedance, Mho and Reactance relays - Differential relays - Negative sequence relays - Pilot (Translay) relay – Power line carrier communication - Carrier and Microwave pilot relays – Under frequency relays - Introduction to static relays - Microprocessor and computer based protective relaying.
Apparatus and Line Protection: Alternator, transformer, Busbar and motor protection using relays – Feeder Protection – radial and ring main system. Microprocessor based protective schemes. **Circuit Breakers:** Functions of switchgear - Elementary principles of arc extinction - Arc control devices - Recovery voltage and restriking voltage - current chopping and capacitance current breaking - Bulk oil, low oil, air break, air blast, and sulphur hexafluoride and vacuum circuit breakers - HVDC breakers - Rating - Testing of circuit breakers. **Surge and Surge Protection:** Switching surges - Lightning phenomenon – Traveling waves on transmission lines - Over voltage due to lightning - Protections against lightning - Lightning arresters – Types - Lightning arrester selection - Surge absorbers.
Earthing and Insulation Co-Ordination: Solid, resistance and reactance Earthing - Arc suppression coil - Earthing transformers – Earth wires - Earthing of appliances- Insulation co-ordination: Definition - Determination of line insulation - Insulation levels of sub-station equipment - Co-ordination amongst items of substation equipment - Introduction to Indian Electricity rules.
Recommended Books:
1. Bhalja B, Maheshwari RP and Chothani NG, “Protection and Switchgear,” Oxford University Press
2. Wright A and Christopoulos C, “Electrical Power system protection,” Chapman & Hall

Reference Books:
3. Anderson, “Power System Protection,” Wiley India
4. Wadhwa CL, "Electrical Power Systems,” New Age International Publishers
5. Horowitz SH and Phadke AG, “Power System Relaying,” Wiley International
6. Paithankar YG, Bhide SR, “Fundamentals of Power System Protection,” Prentice Hall

ICPE-370 Power Plant Instrumentation [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

Course Outcome:
After completion of this course, the students would be able to:

1. Understand different types of power plants
2. Learn about the methods used for measurement of process variables related to power plant
3. Study the concept of burner management system
4. Understand the different configuration of turbine control system.

Syllabus:

Overview of Power Generation: Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation, thermal power plants, building blocks – details of boiler processes P&I diagram of boiler, cogeneration.
Measurements in Power Plants: Electrical measurements, current, voltage, power, frequency, power, factor etc., non electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector – smoke density measurement – dust monitor**.**
Analyzers in Power Plants: Flue gas oxygen analyzer, analysis of impurities in feed water and steam, dissolved oxygen analyzer, chromatography, pH meter, fuel analyzer, pollution monitoring instruments.
Control Loops in Boiler: Combustion control ,air/fuel ratio control, furnace draft control, drum level control, main stem and reheat steam temperature control, super-heater control, attemperator, de-aerator control – distributed control system in power plants, interlocks in boiler operation.
Turbine, Monitoring and Control: Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.
Recommended Books:
1. Dukelow SG, “The control of Boilers,” Instrument Society of America
2. Krishnaswamy KM, Bala P, Bala MP, “Power Plant Instrumentation,” Prentice Hall

Reference Books:
3. Elonka SM.and Kohal AL, “Standard Boiler Operations,” Tata McGraw-Hill
4. Lindsley D, “Power-Plant Control and Instrumentation,” IEE Press
5. Jervis M, “Power Station Instrumentation,” Butterworth-Heinemann

Seventh Semester

ICPC-401 PLC, DCS & SCADA [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓		✓	✓		
CO2	✓	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
CO4	✓				✓			✓	✓			

Course Outcome:
On successful completion of this course the student will be able to:

1. Learn hardware, architecture and software for PLC and SCADA
2. Learn PLC and SCADA programming for selected industrial processes
3. Study DCS architecture and industrial automation
4. Learn various industrial data communication protocols

Syllabus:

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: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions, PLC functions with BITS.

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

Bit Functions of PLC: Digital bit functions and applications; sequencer functions and applications.

Distributed Control System: Meaning and necessity of distributed control; hardware components of DCS; DCS software**.**

Introduction to SCADA: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked, SCADA Protocals- 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",

ICPC-403 Biomedical Instrumentation [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Know the human anatomy and physiological signal Measurements
2. Learn about the techniques used for measurement of Blood flow, blood pressure, respiration rate and body temperature
3. Analyze the recording of ECG, EEG, EMG and ERG signals
4. Understand the concept of assisting and therapeutic devices

Syllabus:

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).

ICPC-423 Biomedical Instrumentation Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Learn about the electrode placement for recording the bio-signals and their calibration
- Record EMG, EEG, ECG, Blood pressure, heart sounds, respiration rate and volumes
- Analysis and inference of above mentioned bio-signals

Syllabus:

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 values 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.

ICPC-421 PLC, DCS and SCADA Laboratory [0 0 2 1]

Course Outcome:
On successful completion of this course the student will be able to:

- Perform different control actions for process stations
- Perform various advance control strategy experiments on process stations

5. Perform PLC and SCADA programming using ladder logic and RS View for different process stations
6. Perform DCS programming for various industrial processes

Syllabus:

At least 8 experiments are to be performed out of the following list:

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.

The list of experiments given above is only suggestive. The Instructor may add new experiments as per the requirement of the course.

ICCI-400 Major Project-A [0 0 4 -]

Course Outcome:

After completion of this course, the students would be able to:

1. Identify projects relevant to Instrumentation and Control systems
2. Design, model, simulate and fabricate a prototype
3. Prepare the project report

The Project is aimed at training the students to analyze any problem in the field of Instrumentation and Control systems independently. The project may be analytical, computational and experimental or combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in 7th & 8th Semesters. All the students are required to implement a research paper already published. During the project period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

Detailed Course Content of Electives-4 & 5

ICPE-451 **Artificial Intelligence** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓				
CO4		✓				✓		✓	✓	✓		✓

On successful completion of this course, the student will be able to:

1. Learn the fundamentals of artificial intelligence followed by Fuzzy Rule Base
2. Learn fundamentals of neural networks and their applications
3. Learn about human language technologies
4. Understand Bayesian and Deep Learning for machine vision and signal processing; explore pattern recognition applications

Artificial intelligence fundamentals: Advanced search, Constraint satisfaction problems, Knowledge representation and reasoning, Non-standard logics, Uncertain and probabilistic reasoning (Bayesian networks, fuzzy sets), Foundations of semantic web: semantic networks and description logics., Rules systems: use and efficient implementation, Planning systems.

Machine learning
Computational learning tasks for predictions, learning as function approximation, generalization concept, Linear models and Nearest-Neighbors (learning algorithms and properties, regularization), Neural Networks (MLP and deep models, SOM), Probabilistic graphical models, Principles of learning processes: elements of statistical learning theory, model validation, Support Vector Machines and kernel-based models, Introduction to applications and advanced models.

Human language technologies: Formal and statistical approaches to NLP, Statistical methods: Language Model, Hidden Markov Model, Viterbi Algorithm, Generative vs Discriminative Models, Linguistic essentials (tokenization, morphology, PoS, collocations, etc.), Parsing (constituency and dependency parsing), Processing Pipelines, Lexical semantics: corpora, thesauri, gazetteers, Distributional Semantics: Word embeddings, Character embeddings, Deep Learning for natural language, Applications: Entity recognition, Entity linking, classification, summarization, Opinion mining, Sentiment Analysis, Question answering, Language inference, Dialogic interfaces, Statistical Machine Translation, NLP libraries: NLTK, Theano, Tensorflow.

Intelligent Systems for Pattern Recognition: Signal processing and time-series analysis, Image processing, filters and visual feature detectors, Bayesian learning and deep learning for machine vision and signal processing, Neural network models for pattern recognition on non-vectorial data (physiological data, sensor streams, etc), Kernel and adaptive methods for relational data, Pattern recognition applications: machine vision, bio-informatics, robotics, medical imaging, etc., ML and deep learning libraries overview: e.g. scikit-learn, Keras, Theano

References:

ICPE-453 **Physiological Control System** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓						✓		✓
CO2	✓	✓	✓			✓						
CO3	✓	✓			✓			✓			✓	
CO4	✓	✓		✓							✓	

Course Outcome: On successful completion of this course the student will be able to:

1. Use of principles of control theory and system analysis to better understand the processes involved in physiological regulation.
2. Understanding of physiological models on the basis of lumped parameter and distributed parameter.
3. Understanding of time domain and frequency domain analysis
4. Implementation of models on a simulation platform.

Syllabus:

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.

Recommended Books:

1. Khoo MCK, “Physiological Control Systems – Analysis, Simulation and Estimation,” Wiley-Blackwell

2. VanDeGraff KM and Rhees RW, “Schaum's Easy Outline of Human Anatomy and Physiology,” Tata McGraw-Hill

Reference Books:

3. Ogata K, “Modern Control Engineering,” Prentice Hall

4. Nagrath IJ and Gopal M, “Control Systems Engineering,” Anshan Publishers

5. Friendland B, “Advanced Control System Design,” Prentice Hall

ICPE-455 **Identification and Adaptive Control** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓					✓	✓
CO2	✓	✓		✓	✓	✓	✓		✓	✓		✓
CO3	✓	✓	✓	✓			✓	✓				✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand non parametric methods of system identification
2. Understand different types of parametric estimation methods
3. Know the design procedure of adaptive control schemes for linear and non-linear systems

Syllabus:

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 tunning control and self tracking control.

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

Recommended Books:

1. Karl J Astrom and Bjorn Wittenmark, “Adaptive Control” Pearson Education
2. Landan ID, “System Identification and Control Design,” Prentice Hall

Reference Books:

3. Chalam V V, “Adaptive Control Systems – Techniques and Applications,” Marcel Dekkar Inc.
4. Nagrath IJ and Gopal M, “Control System Engineering,” New Age International Pub
5. Goodwin GC and Sin KS, “Adaptive Filtering Prediction and Control,” Prentice Hall
6. Sanchez M, Juan M and Jose R, ”Adaptive Predictive Control for concept to Plant optimization” Prentice Hall

ICPE-457 Optimization Techniques [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓						✓
CO2	✓	✓		✓	✓	✓	✓		✓			✓
CO3	✓	✓	✓	✓			✓	✓				✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand different classes of optimization algorithms using appropriate optimization techniques
2. Understand procedure to select appropriate optimization algorithms for a given application
3. Gain knowledge about genetic Algorithms and its application in process control and instrumentation

Syllabus:

Introduction to optimization: functions of single variable, functions of several variables, formulation of optimization problems. Review of classical methods, linear programming, non- linear programming.

Constraint optimality: criteria, constrained optimization, constraint direct search method, linearization methods for constrained problems, transformation method. Nonlinear programming: problem formulation, Quadratic Approximation Methods for Constrained Problems Unconstrained minimization techniques.

Dynamic programming: sub-optimization, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem. Case studies

Stochastic Optimization Techniques: Introduction, types, Local Search, Population Based, Introduction to Genetic Algorithms, Motivation from Nature, Genetic Algorithms: Working Principle: Representation, Fitness Assignment, Reproduction, Crossover, Mutation, Constraint Handling, Real Parameter Genetic Algorithms, Combined Genetic Algorithm, Advanced Genetic Algorithms, Applications.

Ant Colony Optimization: Introduction, Ant System, Ant Colopny System, ANTS, Significant Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO): Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Applications.

Recommended Books:

1. Rao SS, “Optimization Techniques,” New Age International
2. Kothari DP and Dhillon JS, “Power System Optimization,” Tata McGraw-Hill

Reference Books:

3. Mohan C and Deep K, “Optimization Techniques,” New Age International
4. Onwubolu GC, Babu BV, “New Optimization Techniques in Engineering,” Springer-Verlag
5. Dorigo M, Stützle T, “Ant Colony Optimization,” MIT Press
6. Wiesi T, “Global Opimization Algorithms,” ebook http://www.it-weise.de/

ICPE-459 **Digital Image Processing** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓						✓
CO2	✓	✓		✓	✓	✓	✓		✓			✓
CO3	✓	✓	✓	✓			✓	✓				✓

Course Outcome:

After completion of this course, the students would be able to:

1. Understand the fundamentals of digital image
2. Learn imageenhancement to improve subjective perception
3. Understand image restoration techniques
4. Design algorithm for image segmentation

Syllabus:

Digital Image Fundamentals: Elements of a Digital Image Processing system - Structure of the Human eye - Image formation and contrast sensitivity - sampling and Quantization - Neighbours of a pixel - Distance measures.

Image Transform: Need of image transform – Fourier transform-properties-Walsh Transform- Hadamard Transform- Discrete Cosine Transform- KL transform- introduction to wavelet transform.

Image Enhancement: Spatial domain enhancement: gray level transformations - histogram processing-Enhancement using arithmetic / logic operations-smoothing spatial filters-sharpening spatial filters-combining spatial enhancement methods. Frequency domain enhancement: filtering in frequency domain- smoothing frequency domain filters-sharpening frequency domain filters- homomorphic filtering.

Image Restoration: A model of the degradation /restoration process- Noise models: properties of noise, probability density function, periodic noise, and estimation of noise parameters- Restoration by spatial filtering: mean filters, order statistics filters. Periodic noise reduction by frequency domain filtering: band reject, band pass, and notch filters-Inverse filtering - Wiener filtering- Geometric mean filter. **Image Compression:** Image compression models: source encoder and decoder- channel encoder and decoder-Elements of information theory: measuring information- information channel- fundamental coding theorems-using information theory- Error-free compression: variable length coding-LZW coding-bit-plane coding-loss less predictive coding- Lossy compression: lossy predictive coding- transform coding- wavelet coding-Image Standards: binary image compression standards- continuous tone still image compression standards.

Image Segmentation: Detection of discontinuities: point, line and edge detection-Edge linking and boundary detection Thresholding: global thresholding- optimal thresholding-local thresholding- thresholds based on several variables- Region based segmentation: basic formulation- region growing- region splitting and merging.

Recommended Books:

1. Gonzalez RC and Woods RE, "Digital Image Processing," Pearson Education
2. Pratt WK , "Digital Image Processing," Wiley India

Reference Books:

3. Bovik AC, "Handbook of Image and Video Processing," Academic Press
4. Jain AK, "Fundamentals of Digital Image Processing," Prentice Hall
5. Lim JS, "Two Dimensional Signal and Image Processing," Prentice Hall
6. Chanda B and Majumder Dutta D, "Digital Image Processing and Analysis," Prentice Hall

ICPE-461 Instrumentation System Design [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓				✓		✓
CO2	✓	✓		✓	✓	✓	✓		✓		✓	✓

Course Outcome:
After completion of this course, the students would be able to:

1. Understand the design concepts of Instrumentation and Control system
2. Design complete Instrumentation scheme including transducers, their signal conditioning and display system design

Syllabus:

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, LED Matrix, Bar Graph LED display, 7 segment LCDs, CRT Displays
Microprocessor based system design: Design considerations.
Some case studies in instrumentation

Recommended Books:

1. Norton HN, “Handbook of Transducers” Prentice Hall
2. Neubert HKP, “Instrument Transducers” Oxford University Press
3. Pallas-Areny R and Webster JG, “Sensors and Signal Conditioning,” Wiley India Pvt Ltd.

Reference Books:

4. Northrop RB, “Introduction to Instrumentation and Measurements,” CRC Press
5. Dally JW, Riley WF and McConnell KG, “Instrumentation for Engineering Measurements,” Wiley India
6. Sonde BS, “Introduction to System Design using Integrated Circuit,” New Age International,
7. Michael S, “Microprocessor Based Design,” Prentice Hall
8. Rangan CS, Sharma GR and Mani VSV, “Instrumentation Devices & Systems,” Tata McGraw-Hill

ICPE-463 Energy Audit and Management [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓				✓		
CO4	✓	✓		✓	✓			✓	✓			✓

On successful completion of this course, the student will be able to:

1. Understand the commercial and non-commercial energy scenario followed by basics forms of energy and their conversions
2. Learn types of energy-audit and then energy management approach
3. Understand the role of Energy Service Companies
4. Learn about energy monitoring and targeting, and importance of Energy Management Information Systems

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features.

Basics of Energy its various forms and conservation: Electricity basics – Direct Current and Alternative Currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature and pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer.

Evaluation of thermal performance: calculation of heat loss – heat gain, estimation of annual heating & cooling loads, factors that influence thermal performance, analysis of existing buildings setting up an energy management programme and use management – electricity saving techniques.

Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, 3.1 Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering

Financial Management: Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs)

Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS) Energy Efficiency.

Thermal Utilities and systems: Energy efficiency in thermal utilities like boilers, furnaces, pumps and fans , compressors, cogeneration (steam and gas turbines), heat exchangers ,lighting system, Motors belts and drives, refrigeration system.

Heat Recovery and Co-generation: Heat recovery from ventilation, air co-generation of heat and electricity, heat recovery and bottoming cycles.

Recommended Books:

1. W. F. Kenny, “Energy Conservation In Process Industry”.
2. AmlanChakrabarti, “Energy Engineering and Management”, Prentice hall
3. CB Smith, “Energy Management Principles” , Pergamon Press, New York
4. Hand outs New Delhi, Bureau of energy efficiency
5. W. C. Turner, “Energy Management Hand Book”.John Wiley and sons

ICPE-465 Industrial Safety [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	
CO2	✓	✓		✓	✓		✓	✓				
CO3	✓	✓	✓			✓				✓		
CO4	✓	✓		✓	✓			✓	✓			✓

On successful completion of this course, the student will be able to:

1. Learn fundamentals of industrial safety while emphasizing on regulations, laws, and agencies
2. Understand the hazards in chemical process industries and refineries
3. Learn about personal protective equipment
4. Learn to prepare for emergency conditions in industry

Introduction to Industrial Safety: Introduction, Environmental and Occupational Diseases, Repetitive Stress Injury, Regulations, Laws, and Agencies, Overview of Pollution Issues, Injury and Illness Statistics

Hazards in the Chemical Process Industries: Introduction, General Terminology, Polymer Production, Rubber Products, Manufacturing Industry, Sulfuric Acid Manufacturing, Phosphoric Acid Manufacturing, Insecticide Manufacture, Concepts of Industrial Hygiene, Sources of Information

Inhalation Hazards in Refineries: Introduction, Inhalation and Fire Hazards, Pressure Relieving Systems, Inhalation Hazards from Tanker Operations

Personal Protective Equipment: Introduction, Eye, Face and Head Protection, Foot and Hand Protection, chemical Protective Clothing, Levels of Protection, Working with Asbestos and Other Synthetic Mineral Fibers, Radiofrequency/Microwave Radiation, Web Sites for Additional Information

Safety and Emergency Preparedness: Introduction, Emergency Preparedness and Response, Accident Investigation Principles, Assessing Hazards on the Job, Assessing Confined Space Operations Using the Internet

Safety in the Laboratory: Introduction, Compressed and Liquefied Gases, Flammables and Combustibles, Corrosives, Ethers **and** Other Peroxide-Forming Chemicals, Oxidizers, Carcinogens

Recommended Book:

"Practical Guide to Industrial Safety: Methods for Process Safety Professionals", Nicholas P. Cheremisinoff,

ICPE-467 Machine Vision [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓			✓			✓	
CO2	✓	✓	✓	✓	✓				✓	✓		
CO3	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓	✓			✓

Course Outcome:
After completion of this course, the students would be able to:

1. Get acquainted with possibilities and limitations of application of image processing and computer vision
2. Understand knowledge about computer vision and their application in selected technical and industrial tasks
3. Get acquainted with solutions of projects in the industry, traffic, and state offices
4. Learn to participate on real solutions in teams

Syllabus:

Vision in Humans & Machines: Visual System Mechanics, Visual Perception, Color perception.
Image Processing: Image characterization, Sampling & quantization, Spatial Frequency processes, Neighborhood/ Point processes, Image Processing & Machine.
vision
Computer Graphics: Definitions, Graphic objects & procedures, Usefulness to machine vision.
Machine Vision: Goals, Finite Image spaces, Applications like; a) Identification & Sorting of fish
b) Object counting c) Vehicle License Plate Number sensing.
Objects & Regions: a) Thresholding: Optimum & Class variance b) Segmentation c) Mensuration
Recognition: Representation & Pattern/Feature Analysis
Image Sequences: Frame-to-Frame Analysis, Image Trackers & Data Management.
Vision Systems: Survey, Knowledge based vision: VISIONS, ACRONYM & SCERPO etc. Model based vision: VITREO & PARVO,
Design of a Real Time MV System
Recommended Books:
1. Sonka M, Hlavac V and Boyle R, "Image Processing, Analysis, and Machine Vision", Thomson Learning
2. Myler HR, "Fundamentals of Machine Vision", Prentice Hall

Reference Books:

3. Jain R, Kasturi E, and Schunck BG, “Machine Vision”, McGraw-Hill
4. Wandell BA, “Foundations of Vision”, Sinauer Associates Inc.
5. Schalkoff, Robert J, “Digital Image Processing and Computer Vision”, John Wiley & Sons.
6. Levine, Martin D, “Vision in Man and Machine”, McGraw-Hill.

Eight Semester

ICPC-402 Advanced Process Control [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓						✓
CO2	✓	✓		✓	✓	✓	✓		✓			✓
CO3	✓	✓	✓	✓			✓	✓				✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Learn various techniques used into process industries
2. Learn computer control systems (DCS/PLC) in process control
3. Learn multivariable control systems

Syllabus:

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, Furances 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).

ICPC-404 Virtual Instrumentation [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓				✓	✓		
CO3	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓		✓			✓
CO5	✓			✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Gain knowledge about basic concepts in Virtual Instrumentation, comparison with hardwired instruments, components of VI system, LabVIEW as VI software, structure of VI program and block diagram programming methodology
2. Gain knowledge on programming skills in LabVIEW, study and use of different functions to build virtual instruments
3. Gain knowledge on the concepts of data acquisition, interfacing signals to data acquisition card, methods to build data acquisition program
4. Gain knowledge of signal processing methods and functions for time and frequency domain analysis of signals
5. Develop virtual instrument for modelling, monitoring and control of real time processes in LabVIEW

Syllabus:

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 Jenningi R, "*Labview graphical programming* "3rd ed. MGH (2002).
5. James K "*PC interfacing and data acquisition* ", 2002.

ICPC-406 Industrial Automation and Robotics [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓			✓			✓			✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the modern concepts of industrial automation, automated flow lines and automated guided vehicle systems etc.
2. Understand the flexible manufacturing system and role of computer based industrial control
3. Understand the basic fundamentals of robotics, their kinematics, dynamics analysis and design of manipulators
4. Understand the characteristics and implementation of actuators and sensors for factory automation and robotics

Syllabus:

Industrial Automation: Introduction to automation in Production System, types of production system, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, Automated Flow Lines with Storage Buffers, Automation for Material Handling, Conveyor Systems, Automated Guided Vehicle Systems, Automated Storage/Retrieval Systems.

Factory Automation: Flexible Manufacturing Systems concept – Automatic feeding lines, ASRS, transfer lines, automatic inspection – Computer Integrated Manufacture – CNC, intelligent automation, Industrial networking, bus standards.

Computer Based Industrial Control: Introduction & Automatic Process Control, overview of SCADA System & RTU, PLC and its applications for automation.

Fundamentals of Robotics: Introduction, classification of Robots, History, Advantages and Disadvantages, components, degree of freedom, joints and coordinates, reference frames, workspace, languages and applications, Introduction to mobile robot mapping and path planning, introduction to SLAM.

Robot Kinematics and Dynamics: Introduction to Forward and inverse kinematics of robots, Denavit-Hertenberg representation of forward kinematics of robot, short overview, dynamic equations for multiple degree of freedom robots.

Actuators: Characteristics of actuating system, Comparison of actuating systems, Hydraulic devices, Pneumatic devices, Electric motors. Sensors: Sensor characteristics, Position sensors, Velocity sensors, Acceleration sensors, Force and pressure sensors, Torque sensors, micro switches, Light and IR sensors, Touch and tactile sensors, Proximity sensors, Range finder, Voice Recognition devices, Introduction to multi-sensor data fusion.

Books Recommended

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

ICPC- 426 Industrial Automation and Robotics Laboratory [0 0 2 1]

Course Outcome:
The experimental component of Laboratory exercise:

1. Measures the motion and positioning of the 3-DOF manipulator
2. Trajectory planning of mobile robot
3. Pan Tilt position and velocity control LRF (Laser Range Finder) mapping
4. Mapping by Vision sensor Kinematics of given manipulator

At least 8 experiments are to be performed out of the following list:

1. To study various components of 3-DOF cleaning manipulator
2. To study encoders as a velocity, acceleration and displacement measurement
3. To find out the direct kinematics of given manipulator
4. To study the hydraulic actuators
5. To study the pneumatic actuators
6. To study the sonar sensor for environment mapping

7. To study the acceleration sensor
8. To plan a trajectory for specific task of manipulator
9. To study the differential drive of mobile robot
10. To programme a mobile robot on collision avoidance path
11. Programme the manipulator single axis for specified motion
12. Programme the manipulator for multiple axis for different specified tasks
13. To control the system belt using PLC

ICCI-400 Major Project (Part-II) [0 0 4 4]

The Project is aimed at training the students to analyze any problem in the field of Instrumentation and Control systems independently. The project may be analytical, computational and experimental or combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in 7th & 8th Semesters. All the students are required to implement a research paper already published. During the project period, every student has to present the progress of their works before the duly constituted committee of internal teachers of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

ICCI-420 Industrial Lectures [- - - 1]

A minimum of 2-5 lectures of two hours duration by Industry/Academic/R&D experts will be arranged by the Department. The evaluation methodology will be based on objective type questioning at the end of each lecture.

Detailed Course Content of Electives-6

ICPE-452 Control System Design [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓			✓			✓			✓
CO5		✓	✓		✓		✓	✓		✓	✓	

Course Outcome:

After completion of this course, the students would be able to:

1. Analyze systems using transfer function and state space models
2. Design controllers and compensators using conventional techniques
3. Design using frequency response method
4. State space design
5. Perform process identification and PID tuning for the same

Syllabus:

Introduction: The feedback concept and modelling, Transfer Function and stability, concept of Block diagram representation and reduction, Signal Flow 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.

Recommended Books:

1. Stefani RT, Savant CJ, Shahian Balram and Hostetter G H, “Design of feedback controls systems,” Oxford University Press

2. Goodwin CG, Graebe SF and Salgado M E, “Control System Design,” Pearson Education

Reference Books:

3. Gopal M, “Control Systems: Principles and Design,” Tata McGraw-Hill

4. Chen CT, “Linear System Theory and Design,” Rinehart and Winston Press

5. Ogata K, “Discrete Time Control Systems,” Prentice Hall

6. Kuo BC, “Digital Control Systems,” Oxford University Press

ICPE-454 Brain Computer Interfacing [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓				

On successful completion of this course, the student will be able to:

1. Review various physiological signals
2. Learn Interfacing of various physiological signals with external world
3. Familiarize with associated research directions

An Introduction to Human Computer Interfacing: Introduction to Human-computer Interaction, The nature of human-computer interaction.

Methodology for Designing User-computer Interfaces:- conceptual, semantic, syntactic, and lexical levels of the design of an interactive system. Interaction Tasks, Techniques, and Devices: Design of novel interaction techniques, Modes of human-computer communication, Voice, Gesture and Eye movement. P300 based communication, Thought Translation device (TTD), Graz-HCI research, μ-rhythm synchronization and desynchronization.

BCI Techniques: General Signal processing and machine learning tool for HCI analysis, Spectral filtering, spatial filtering, PCA, ICA, AR modeling, CWT, DWT Classification Techniques: Bayesian Analysis, LDA (Linear Discriminant Analysis) SVM (Support Vector Machine) ANN (Artificial Neural Network)

User Interface Software: Languages and tools for specifying and interfaces, Dialogue independence, UIMS (user interface management system) approach .BCI2000: A general purpose software platform for HCI research.

Applications of HCI: HCI for Communication and motor control, combining HCI and Virtual reality: Scouting Virtual worlds.

Recommended Books:

1. Dornhege G, Millan JDR, Hinterberger T, Mcfarland DJ and Muller KR, “Toward Brain-Computer interfacing,” MIT Press
2. Rangayyan RM, “Biomedical Signal Analysis: a case study Approach,” Wiley India

Reference Books:

3. Tompkins WJ (Ed.), “Biomedical signal Processing,” Prentice Hall
4. Berger TW, Chapin JK et.al., “Brain-Computer Interfaces-An International Assessment of Research and Development trends,” Springer Science
5. Bronzino JD (Ed.), “The Biomedical Engineering Handbook,” CRC Press

ICPE-456 Soft Computing [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓	✓		✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓

Course Outcome:
After completion of this course, the students would be able to:

1. Understand the merits of soft computing techniques over the conventional computing techniques
2. Comprehend the basics of the soft computing tools like ANNs, SVMs, fuzzy logic and evolutionary computing and their usage in real world applications

Syllabus:
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, Controller, Classification of Control Systems, Neural Networks in direct and indirect control, Fuzzy Controller design.
Recommended Books:
1. Kosko B, "Neural Networks and Fuzzy Logic," Prentice Hall
2. Haykin S, "Neural Networks," Pearson Education

Reference Books:
3. Berkin RC and Trubatch SL, "Fuzzy System Design Principles," Prentice Hall
4. Yegnanarayana B, "Artificial Neural Networks," Prentice Hall
5. Anderson JA, "An Introduction to Neural Networks," Prentice Hall

ICPE-458 Advanced Sensors [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓	✓		✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓		✓	✓		✓	✓			✓	
CO4	✓		✓		✓	✓		✓	✓	✓	✓	

Course Outcome:

After completion of this course, the students would be able to:

1. Understand recent trends in sensor technology and its engineering applications
2. Gain knowledge on multi-sensor data fusion techniques for intelligent systems
3. Gain knowledge on different concepts of smart sensors and systems, and their design methods, fabrication techniques(IC, MEMS/NEMS), data processing and coding methods & functions
4. Understand the working and the use of smart chemical, robotics, fiber optics sensors in different application areas

Syllabus:

Introduction to Multi-sensor: Data fusion Techniques, Application of Data Fusion, Process models for Data Fusion, Limitation of Data Fusion system.

Smart Sensors: Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Nonlinearity, Approximation and regression, Noise and interference, response time, drift, cross-sensitivity, Information Coding/Processing, Data communication, standards for smart sensor interface, the Automation.

Recent trends in sensor technology: Introduction, film sensors, thick film sensors, Thin film sensors, semiconductor IC technology-standard methods.

MEMS/NANO: Micro electromechanical systems (MEMS), Micromachining, Biomedical Applications, Nano-sensors, Carbon Nanotubes.

Chemical Sensors: Introduction, semiconductor gas detectors, Ion Selective electrodes, Conductometric sensors, Mass sensors.

Robotics sensors: Introduction, characteristics, types of sensors, touch or tactile sensors, binary and analog sensors, proximity sensors, types of proximity sensors, contact and non-contact proximity sensors, robotic vision.

Fiber optic sensors: Fiber optic sensors for the measurement of temperature, Pressure, displacement, turbidity, pollution.

Biosensors: Enzyme sensors, Cell based biosensors using Microelectrodes, Biosensors in Food Analysis.

Recommended Books:

1. Pallas-Areny R and Webster JG, “Sensors and Signal Conditioning,” Wiley India
2. Gardener, “Micro sensors, MEMS and Smart Devices,” Wiley India

Reference Books:

3. Khazan AD, “Transducers and their Elements – Design and Applications,” Prentice Hall
4. Patranabis D, “Sensors and Transducers,” Prentice Hall
5. Middlehook S and Audet SA, “Silicon Sensors,” Academic Press
6. Dorf RC, “Sensors, Nanoscience, Biomedical engineering and instruments,” CRC Press
7. Zanger H and Zanger C, “Fiber optics Communication and other applications,” Macmillan publishing
8. Joshi RM, “Biosensors,” ISHA Books

ICPE-460 **Operation Research** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

Operations Research: Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.

Linear Programming Problem: Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Sensitivity Analysis, Primal and Dual Problems, Economic Interpretation.

Transportation and Assignment: Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling sales man Problem.

Queuing Theory:
Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:8/FCFA

Inventory Control: Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis.

Replacement theory: Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.

Game Theory:
Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods

Decision Theory:
Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.
Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

References:

1. Operations Research: An Introduction, Author : Hamdy Taha, Publisher : Pearson
2. Operations Research, Author : A M Natarajan, P Balasubramani, A Tamilarasi, Publisher : Pearson Education Inc
3. Operations Research, Author : P Mariappan, Publisher : Pearson

4. Operations Research, Author : H N wagner, Publisher : Prentice hall
5. Optimization in Operations Research, Author : Ronald Rardin, Publisher : Pearson Education Inc
6. Operations Research, Author : R. Paneerselvam, Publisher : Prentice Hall of India Pvt. Ltd., Quantitative Techniques in Management, Author : N D Vohra, Publisher : Tata McGraw-Hill

Open Electives

ICOE-371 **Computer Networks** **[3-0-0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3		✓				✓		✓	✓	✓		✓

On successful completion of this course, the student will be able to:

1. Get familiar with the basics of computer network and associated physical layer types followed by architecture and reference models
2. Understand Internetworking; network layer and routing
3. Learn about application layer protocols and security in computer networks

Introduction: Introduction to Computer Network and Physical Layer Types of Networks: Broadcast and Point-to-point- LAN-MAN-WAN- Wireless networks.

Architecture and Reference Models: Layered architecture- OSI reference model, TCP/IP reference model –Internet Protocol Stack – Network Entities in Layers- Connection oriented and Connection less services,

Internetworking: Principles of Internetworking, Connectionless Internetworking, the Internet Protocol, Routing Protocol, IPv6 (IPng)

Distributed Applications: Abstract Syntax Notation One (ASN.I), Electronic Mail-SMTP and MIME, Uniform Resource Locators (URL) and Universal Resource Identifiers (URI), Hypertext Transfer Protocol (HTTP)

Network Layer and Routing: Network Service model – Datagram and Virtual circuit service-Routing principles-Link state routing-distance vector routing-hierarchical routing-multicast routing-IGMP Internet Protocol (IP): IPv4 addressing-routing and forwarding datagram-datagram format-datagram fragmentation- ICMP- Network Address Translators (NATs)-IPv6 packet format-transition from IPv4 to IPv6-Mobile IP. Routing in the Internet: Intra Autonomous System Routing: RIP - Inter Autonomous System Routing: BGP.

Transport Layer: Transport Layer Services-Relationship between Transport Layer and Network Layer-Transport Layer in Internet-Multiplexing and De multiplexing.

Connectionless Transport: UDP-Segment structure-Checksum Connection Oriented Transport: TCP-TCP connection-TCP Segment Structure-Round trip Time estimation and

Application Layer and Network Security: Application Layer Protocols - WWW and HTTP-File transfer Protocol: FTP Commands and Replies – Domain Name System (DNS) - DHCP- SMTP- POP- IMAP - SNMP. Security in Computer Networks: Principles of Cryptography-Symmetric key-Public key-authentication protocols -Digital Signatures – Firewalls. Security in different Layers: Secure E-mail- SSL – IP security.

Text/References:

1. James F. Kurose and Keith W. Ross, "Computer Networking – A Top-Down Approach Featuring the Internet", 5/e Pearson Education, 2002.
2. Behrouz A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill, 3/e, 2006.
3. S. Keshav, "An Engineering Approach to Computer Networking", Pearson education, 2002.

ICOE-372 Elements of Control Engineering [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2	✓	✓	✓	✓		✓	✓		✓			
CO3	✓	✓				✓		✓	✓			

On successful completion of this course, the student will be able to:

1. Understand different types of control systems and their mathematical models
2. Learn time-domain and frequency domain analysis of control system
3. Learn state-space approach to model a control system

Introductory Concepts: Functional elements of an instrumentation system. Some examples of instrumentation system; Potentiometers, Synchros, Tachogenerators 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.

Recommended Books:

1. Ogata K, "Modern Control Engineering," Pearson Education
2. Nagrath IJ and Gopal M, "Control System Engineering," New Age International
Reference Books:
3. Dorf RC and Bishop RH, "Modern Control System," Pearson Education
4. Kuo BC, "Automatic Control System," John Wiley & Sons
5. DiStefano JJ, Stubberud AR and Williams IJ, "Schaum's Outline of Theory and Problems of Feedback and Control Systems," Tata McGraw-Hill

ICOE-373 Sensors and Transducers [3-0-0-3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	
CO2	✓	✓	✓	✓		✓	✓		✓			✓
CO3	✓	✓				✓		✓	✓			✓

On successful completion of this course, the student will be able to:

1. Learn the meaning of measurement systems followed by characteristics of measurement systems
2. Learn working principle and types of resistive, capacitive and inductive transducers and their applications
3. Understand working of active transducers and their applications

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.

Books Recommended:

6. Murty DVS, "Transducers & Instrumentation", Prentice Hall of India
7. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons
8. Kalsi HS, "Electronic Instrumentation," Tata McGraw Hill
9. Patranabis D, "Sensors and Transducers," Prentice Hall of India

ICOE-374 Electronics Instrumentation and Measurements [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓		✓	✓	

On successful completion of this course the student will be able to:

1. Understand working of general instrument system, types of error, calibration, etc.
2. Measurement of various electrical quantities and parameters
3. Understand the principle and working of magnetic instruments followed by Cathode Ray Oscilloscope

Syllabus:

Measurement Systems: Measurement system architecture, errors in measurements. Standard used in measurement: Electrical standards, time and frequency standards, physical standards.

AC/DC Bridge Measurements: Wheatstone bridge, Kelvin Bridge, Anderson Constant current loop; resistance ration bridge, Schering bridge, Parallel C bridge, De Sauty bridge, Wein bridge, Maxwell's bridge, hay bridge, Owen bridge, Anderson bridge, Heaviside Mutual inductance bridge. Measurement of high resistance including loss of charge method and Mega Ohm bridge method.

Basic Electrical Measurements: DC voltage/current measurements, Static electric field and potential of charged surfaces measurement, Electromechanical and analog electronic AC voltmeters, AC current measurements, Phase measurements, frequency and time measurements, Q-meter for capacitance and inductance measurements.

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.

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; Oscilloscope specifications and performance; special purpose oscilloscopes

Books Recommended:

1. Northrop RB., "Introduction to Instrumentation and Measurements," CRC Press
2. Bell DA, "Electronic Instrumentation and Measurements," Prentice Hall
3. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons
4. Carr JJ, "Elements of Electronic Instrumentation and Measurements," Pearson Education India

ICOE-375 Virtual Instrumentation [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓				✓	✓		
CO3	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓		✓		✓			✓
CO5	✓			✓	✓	✓	✓	✓	✓		✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Gain knowledge about basic concepts in Virtual Instrumentation, comparison with hardwired instruments, components of VI system, LabVIEW as VI software, structure of VI program and block diagram programming methodology
2. Gain knowledge on programming skills in LabVIEW, study and use of different functions to build virtual instruments
3. Gain knowledge on the concepts of data acquisition, interfacing signals to data acquisition card, methods to build data acquisition program
4. Develop virtual instrument for modelling, monitoring and control of real time processes in LabVIEW

Syllabus:

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.

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 Jenningi R, "*Labview graphical programming* "3rd ed. MGH (2002).

ICOE-376 Non-Conventional Energy Sources [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓		✓		

On successful completion of this course the student will be able to:

1. Learn to harness solar and wind energy and explore their applications
2. Understand energy conversion processes
3. Learn to harness energy from biomass

Introduction to Energy Sources: World energy futures, Conventional energy sources, Nonconventional 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 Fission 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, Bio-logical conversion of Solar energy.

Recommended Books:

1. Bansal NK, Kleemann M, Heliss M, "Renewable energy sources and conversion technology," Tata McGraw-Hill
2. Jain HC, "Non Conventional Source of Energy " , Advent Books Division Reference Books:
3. Bent S, "Renewable Energy," Academic Press
4. Boyle G, "Renewable Energy :Power for a Sustainable Future," Oxford University Press

ICOE Digital Signal Processing [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Classify the signals and systems and will be able to mathematically represent them
2. Carry out discrete time system analysis
3. Design digital filters and understand their applications

Introduction: Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

Discrete Time System Analysis: Z-transform and its properties, inverse Z-transforms; difference equation – Solution by Z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Fourier transform of discrete sequence – Discrete Fourier series.

Discrete Fourier Transform & Computation: DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure.

Design of Digital Filters: FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Pole-zero placement, Impulse-invariant, matched z-transform and bilinear transformation methods.

Digital Signal Processors: Introduction – Architecture – Features – Addressing Formats – Functional modes - Introduction to Commercial Processors.

Recommended Books:

1. Proakis JG and Manolakis DG, "Digital signal processing," Pearson Education India
2. Ifeacher EC and Jerris BW, "Digital signal processing - A practical approach," Pearson Education
3. Chen C-T, "Digital signal processing - Spectral computation and filter design," Oxford University Press
4. Ambardar A, "Digital signal processing - A modern introduction," Cengage Learning India

Lyons RG, "Understanding Digital Signal Processing," Pearson Education India

ICOE-471 Smart Materials and Structures [3-0-0-3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Get familiar with the smart materials such as piezoelectric polymers
2. Learn about high band width and low strain smart sensors and their utility in Structural Health Monitoring
3. Learn about smart composite beams and their finite element modeling

Introduction to Smart Materials, Principles of Piezoelectricty, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids

High-Band Width, Low Strain Smart Sensors: Piezeoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors

Smart Actuators Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control

Smart Composites Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams

References:
1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Gauenzi, P., Smart Structures, Wiley, 2009
3. Cady, W. G., Piezoelectricity, Dover Publication

ICOE-472 Intellectual Property Rights [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:
1. Get familiar with the intellectual property right in India
2. Understand the terminology--- Patents, Copyrights and Trademarks
3. Learn to protect industrial designs at national and international level

Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR in abroad, some important examples of IPR.

Patents: Introductions, Importance of patents, Indian patenting systems, International patenting system, Patent search, Drafting of a patent, Filing of a patent

Copyright: Introduction, Importance of copyright, Rights covered by copyright, National and international copyright system, Filing of copyright

Trademarks: Introduction, Rights of trademark, kind of signs that can be used as trademarks, types of trademark, Protection of trademark, case study of well known trademarks
Geographical Indications: Introduction, Importance of GI, Filing of GI, national and international system of GI, Case study of Indian GI,s

Industrial Designs: Introduction, Protection of Industrial design at National and International level, International agreements on IPR's: agreement between WIPO and

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

Recommended Books:

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
3. "Indian Patents Law – Legal & Business Implications," Macmillan India

ICOE-437 Industrial Automation and Robotics [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓			✓			✓			✓

Course Outcome:
On successful completion of this course the student will be able to:

5. Understand the modern concepts of industrial automation, automated flow lines and automated guided vehicle systems etc.
6. Understand the flexible manufacturing system and role of computer based industrial control
7. Understand the basic fundamentals of robotics, their kinematics, dynamics analysis and design of manipulators
8. Understand the characteristics and implementation of actuators and sensors for factory automation and robotics

Syllabus:

Industrial Automation: Introduction to automation in Production System, types of production system, Principles and Strategies of Automation, Basic Elements of an Automated System, Automated Flow Lines with Storage Buffers, Automation for Material Handling, Conveyor Systems, Automated Guided Vehicle Systems, Automated Storage/Retrieval Systems.

Factory Automation: Flexible Manufacturing Systems concept – Automatic feeding lines, ASRS, transfer lines, automatic inspection – Computer Integrated Manufacture – CNC, intelligent automation, Industrial networking

Computer Based Industrial Control: Introduction & Automatic Process Control, overview of SCADA System & RTU, PLC and its applications for automation.

Fundamentals of Robotics: Introduction, classification of Robots, History, Advantages and Disadvantages, components, degree of freedom, joints and coordinates, reference

frames, workspace, languages and applications, Introduction to mobile robot mapping and path planning, introduction to SLAM.

Actuators: Characteristics of actuating system, Comparison of actuating systems, Hydraulic devices, Pneumatic devices, Electric motors.

Robot Sensors: Sensor characteristics, Position sensors, Velocity sensors, Acceleration sensors, Force and pressure sensors, Torque sensors, micro switches, Light and IR sensors, Touch and tactile sensors, Proximity sensors, Range finder, Voice Recognition devices, Introduction to multi-sensor data fusion.

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

ICOE-474 Brain Computer Interfacing [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Understand human computer interaction and its nature
2. Learn methodology to design user-computer interface and various modes of communication
3. Understand signal processing and machine learning tool for HCI analysis

An Introduction to Human Computer Interfacing: Introduction to Human-computer Interaction, The nature of human-computer interaction.

Methodology for Designing User-computer Interfaces:- conceptual, semantic, syntactic, and lexical levels of the design of an interactive system. Interaction Tasks, Techniques, and Devices: Design of novel interaction techniques, Modes of human-computer communication, Voice, Gesture and Eye movement. P300 based communication, Thought Translation device (TTD), Graz-HCI research, μ-rhythm synchronization and desynchronization.

BCI Techniques: General Signal processing and machine learning tool for HCI analysis, Spectral filtering, spatial filtering, PCA, ICA, AR modeling, CWT, DWT Classification

Techniques: Bayesian Analysis, LDA (Linear Discriminant Analysis) SVM (Support Vector Machine) ANN (Artificial Neural Network)

Applications of HCI: HCI for Communication and motor control, combining HCI and Virtual reality: Scouting Virtual worlds.

Recommended Books:

1. Dornhege G, Millan JDR, Hinterberger T, Mcfarland DJ and Muller KR, "Toward Brain-Computer interfacing," MIT Press
2. Rangayyan RM, "Biomedical Signal Analysis: a case study Approach," Wiley India
3. Tompkins WJ (Ed.), "Biomedical signal Processing," Prentice Hall

ICOE-475 Biomedical Measurements [3-0-0-3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓			✓	✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Understand origin of Bio Potential and its propagation
2. Understand electrode configurations in case of biosignals such as ECG, EEG, etc. followed by Bio-Amplifiers
3. Learn to measure non-electrical parameters such as blood pressure, respiratory signals, etc. followed by bio-chemical measurement

Bio Potential Electrodes: Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode– skin interface, half cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.

Electrode Configurations: Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG, ERG and EOG – unipolar and bipolar mode.

Bio Amplifier: Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.

Measurement Of Non-Electrical Parameter: Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic,

mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.
Bio-Chemical Measurement: Biochemical sensors - pH, pO2 and pCo2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

Recommended books:
1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004
2.Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
3. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.

ICOE-476 Testing and calibration [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓	✓		
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:
1. Understand concept of metrology, accuracy, precision and calibration
2. Understand the concerns for better measurements
3. Learn to manage the metrology system

Introduction: Definition of metrology, Measurements in manufacturing, Measurement in the global marketplace, Importance of measurement, testing of instruments, study of various errors in instruments.

Development and Concerns of Metrology: Need for better measurements, Determine and describe the differences between resolution, accuracy, precision, calibration, Type A uncertainty and Type B uncertainty

Standards and Standardization: Working standards, check standards and international standards, Levels of standard accuracies, accuracy ratio between levels of calibration pyramid, Requirements of traceability, Metrology standardization documents
Managing the Metrology System: When a metrology system is needed, Components of a metrology system, Periodic calibration, determining period, fixed time intervals or other means, measurement assurance
Calibration of instruments: Pressure calibration, temperature calibration, light calibration, calibration Record keeping, documented procedures

Books:

1. Northrop RB., “Introduction to Instrumentation and Measurements,” CRC Press
2. Bell DA, “Electronic Instrumentation and Measurements,” Prentice Hall
3. Sawhney AK, “Electrical and Electronics Measurements and Instrumentation,” Dhanpat Rai and Sons
4. Carr JJ, “Elements of Electronic Instrumentation and Measurements,” Pearson Education India

ICOE-477 Optimization Techniques [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓	✓		
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Get familiar with linear and non-linear programming
2. Learn constrained optimization techniques; multi-objective and goal programming
3. Learn stochastic optimization techniques followed by Particle Swarm Optimization

Introduction to optimization: functions of single variable, functions of several variables, formulation of optimization problems. Review of classical methods, linear programming, non- linear programming.

Constraint optimality: criteria, constrained optimization, constraint direct search method, linearization methods for constrained problems, transformation method. Nonlinear programming: problem formulation, Quadratic Approximation Methods for Constrained Problems Unconstrained minimization techniques.

Dynamic programming: sub-optimization, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem. Case studies.

Stochastic Optimization Techniques: Introduction, types, Local Search, Population Based, Introduction to Genetic Algorithms, Motivation from Nature, Genetic Algorithms: Working Principle: Representation, Fitness Assignment, Reproduction, Crossover, Mutation, Constraint Handling, Real Parameter Genetic Algorithms, Combined Genetic Algorithm, Advanced Genetic Algorithms, Applications.

Ant Colony Optimization: Introduction, Ant System, Ant Colony System, ANTS, Significant Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO): Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Applications.

Recommended Books:

1. *Rao SS, "Optimization Techniques," New Age International*
2. *Kothari DP and Dhillon JS, "Power System Optimization," Tata McGraw-Hill*

Reference Books:

3. *Mohan C and Deep K, "Optimization Techniques," New Age International*
4. *Onwubolu GC, Babu BV, "New Optimization Techniques in Engineering," Springer-Verlag*
5. *Dorigo M, Stützle T, "Ant Colony Optimization," MIT Press*
6. *Wiesi T, "Global Opimization Algorithms," ebook http://www.it-weise.de/*

Course outcomes:

On successful completion of this course the student will be able to:

- Understand different classes of optimization algorithms using appropriate optimization techniques
- Understand procedure to select appropriate optimization algorithms for a given application
- Gain knowledge about genetic Algorithms and its application in process control and instrumentation

ICOE-481 Computer Control of Industrial Processes [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓	✓		
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Understand fundamentals of hierarchical control
2. Learn communication protocols in a process control industry
3. Understand P-I diagrams and then advanced process techniques such as adaptive control

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

Introduction to Computer Control systems in Process Control: Introduction, operator system communication, Recognition of process states, operator process interaction, operator role, Engineering work station. DCS Configuration, control console equipment, communication between components, local control units, DCS flow sheet symbols, DCS I/O hardware and set point stations, DCS software, Communications hierarchy, ISO reference model, Industrial communication systems, MAP/TOP protocol, types of bus:- Field Bus, Rack Bus, PROFIBUS, FIPBUS, Comparison of buses, HART protocol.

Advanced Process Control Techniques: Concept of multi-loop process controls, analysis and applications of cascade, ratio, Feed-forward, override, split-range, selective and Auctioneering Control, Dead time compensation, Adaptive control, inferential control, statistical control.

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.

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

Recommended Books:

1. *Liptak GB, "Instrument Engineers' Handbook, vol.2: Process Control and Optimization," CRC Press*
2. *Krishna K, "Computer Based Industrial Control," Prentice Hall*

Reference Books:

3. *Eckman DP, "Industrial Instrumentation," Wiley Eastern*
4. *Coughanowr DR, "Process System Analysis and Control," McGraw-Hill*
5. *Stephanopoulos G, "Chemical Process Control – An introduction to Theory & Practice," Prentice Hall*
6. *Johnson CD, "Process Control Instrumentation Technology," Prentice Hall*
7. *Singh SK, "Industrial Instrumentation and Control," Tata McGraw-Hill*

Course outcomes:

On successful completion of this course the student will be able to:
- Learn the industrial automation used in process industry
- Learn different advanced process control techniques
- Design instrumentation and control strategies for different industrial processes
- Learn different multivariable controllers and their implementation issues

ICOE- 482 **Machine Learning** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓						✓	✓
CO2		✓	✓	✓		✓	✓		✓			
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO4		✓				✓		✓	✓	✓		✓

INTRODUCTION: Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

LINEAR MODELS: Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

TREE AND PROBABILISTIC MODELS: Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS: Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

GRAPHICAL MODELS: Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

TEXT BOOKS:

1. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.

REFERENCES:

1. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012

2. Jason Bell, —Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
3. Ethem Alpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014

ICOE-483 Industrial Measurements [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Learn temperature, pressure, and flow measurement techniques employing various sensors and transducers
2. Learn to measure other physical variables such as mass, weight, level, etc.

Introduction: Review of functional block diagram of sensor based measurement system, generalized performance characteristics of sensor based instruments, definition, terminology and classification, review of displacement, velocity and acceleration measurement.

Temperature Measurement: Definitions and standards, primary and secondary fixed points calibration of thermometers, study of filled in system thermometer, bimetallic thermometers, electrical method of temperature measurement, resistance temperature detectors, thermocouple radiation pyrometry.

Pressure Measurement: Classification of pressure sensor, units of pressure, manometers, elastic type pressure gauges (bourdon tube, diaphragm, bellows), electrical transducers for pressure measurement (elastic elements with strain gauges, capacitive type pressure transducer), measurement of vacuum (McLeod gauge, thermal conductivity and lonization gauge), calibration of pressure gauges, dead weight tester.

Flow Measurement: Construction details and theory of head flow meters (Orifice plate, venturitube, pitot tube), Inferential flow meter – turbine flow meter, electromagnetic flow meter, hot wire anemometer, ultrasonic flow meter.

Other Variable measurements: Level measurement (float type level indication, differential pressure method, electrical type level gauges using resistive and capacitive probes and ultrasonic level sensor), mass, weight, force, torque and shaft power measurement.

Recommended Books:

1. Doebelin EO, “Measurement System: Application & Design,” Tata McGraw-Hill.
2. Rathakrishnan E, “Instrumentation, Measurements and Experiments in Fluids,” CRC Press

Reference Books:

3. Rangan CS, Sharma GR and Mani VSV, “Instrumentation devices & Systems,” Tata McGraw-Hill
4. Patranabis D, “Principles of Industrial Instrumentation,” Tata McGraw-Hill
5. Beckwith TG, Lienhard JH and Marangoni RD, “Mechanical Measurements,” Pearson Education
6. Nakra BC and Chaudary KK, “Instrumentation Measurement and Analysis,” Tata McGraw-Hill
7. Liptak BG, “Instrument Engineer’s Handbook, Vol. 1: Process Measurement and Analysis,” CRC Press

ICOE-484 Smart Sensors and Sensor Networking [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓	✓		
CO3	✓	✓	✓			✓		✓				✓

On successful completion of this course, the student will be able to:

1. Learn about architecture of smart sensors and smart sensor technologies along with relevant applications in measuring temperature, humidity, etc.
2. Understand sensor and actuator networking
3. Learn about various wireless network protocols followed by IEEE standard 1451

Review of Basic Concepts: Measurement system, transducers, sensors and actuators; signal conditioners; data communications and networking.

Basics of Smart Sensors: Definition and architecture of smart sensor; different levels of integration in small sensors, differences between smart, intelligent and network sensors; advantages of smart sensors ; smart actuators and transmitters.

Smart Sensor Technologies: IC Technologies: thick film, thin film and monolithic IC technologies; Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface micromachining, other micro-machining techniques.

Examples of Smart Sensors: Principles, characteristics and constructional details of typical smart sensors for temperature, humidity, pressure and vibrations.

Basics of Sensor and Actuator Networking: Field-level, controller-level and enterprise-level networks; Sensor and actuator network (SAN): Network topologies; seven-layer OSI model of communication system.

Wired Network Protocols: RS-422, RS-485, HART and Foundation Fieldbus protocols, comparison with Ethernet (IEEE – 802.3) protocol.

Wireless Network Protocols: Need and advantages of wireless sensor and actuator network(WSAN); Zigbee (IEEE – 802.15.4) protocol, Merits of Zigbee over WiFi (IEEE – 802.11) and Bluetooth for sensor and actuator networking.

IEEE Standard 1451: Introduction to IEEE Standard 1451: "Smart Transducer Interface for Sensors and Actuators"; highlights of parts 1451.1, 1451.2, 1451.3, 1451.4 and 1451.5 of the Standard.

Recommended Books:

1. Patranabis D, "Sensors and Transducers," Prentice Hall
2. Frank Randy, "Understanding Smart Sensors," Artech House

Reference Books:

3. Callaway EH, "Wireless Sensor Networks : Architecture and Protocols," CRC Press
4. Anand MMS, "Electronic Instruments and Instrumentation Techniques," Prentice Hall
5. William S, "Data and Computer Communications," Pearson Education
6. IEEE Standard 1451, "Smart Transducer Interface for Sensor and Actuators," IEEE Press

ICOE-485 Internet of Things System Design [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand the modern concepts of IoT
2. Understand the network and communication aspects; explore applications of IoT
3. Implement IoT in Python

Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, IoT & M2M Machine to Machine, Difference between IoT and M2M, Software define Network
Network & Communication aspects Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination
Challenges in IoT Design challenges, Development challenges, Security challenges, Other challenges
Domain specific applications of IoT Home automation, Industry applications, Surveillance applications, Other IoT applications

Developing IoTs Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python

Reference Books:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”

2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

Recommended Books:

There is no textbook for the course. The following material will be used for reference.

1. Internet of Things: A Hands-on Approach, By Arshdeep Bahga and Vijay Madisetti
2. Introduction to Embedded Systems: A Cyber-Physical Systems Approach, By Edward Ashford Lee and Sanjit Arunkumar Seshia
3. Introduction to Computation and Programming using Python, by John Guttag
4. Python documentation: https://www.python.org/doc/
5. Android developer: https://developer.android.com/training/index.html
6. Recent publications for case studies

ICOE-486 **Physiological Control System** **[3 0 0 3]**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓						✓		✓
CO2	✓	✓	✓			✓						
CO3	✓	✓			✓			✓			✓	
CO4	✓	✓		✓							✓	

Course Outcome: On successful completion of this course the student will be able to:

1. Use of principles of control theory and system analysis to better understand the processes involved in physiological regulation.
2. Understanding of physiological models on the basis of lumped parameter and distributed parameter.
3. Understanding of time domain and frequency domain analysis
4. Implementation of models on a simulation platform.

Syllabus:

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.
Recommended Books:
1. Khoo MCK, "Physiological Control Systems – Analysis, Simulation and Estimation," Wiley-Blackwell
2. VanDeGraff KM and Rhees RW, "Schaum's Easy Outline of Human Anatomy and Physiology," Tata McGraw-Hill

Reference Books:
3. Ogata K, "Modern Control Engineering," Prentice Hall
4. Nagrath IJ and Gopal M, "Control Systems Engineering," Anshan Publishers
5. Friendland B, "Advanced Control System Design," Prentice Hall

ICOE-487 Process Optimization [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓

Course Outcome:
On successful completion of this course, the student will be able to:
1. Understand modeling of second order electrical and mechanical systems followed by heat exchangers, dryers, etc.
2. Learn identification techniques of various processes
3. Learn optimization terminology such as convex functions followed by optimization of unconstrained functions

Modeling and Simulations Introduction: Types of models, modeling of process control systems in time domain and frequency domain, Fitting polynomials in the step test data. Lagrange Interpolation formula, Least square fitting, process models of some typical

systems in differential equations form, Gravity flow tank, Tanks in series, Tanks in parallel, dead time, first and second order models, higher order models, Modeling of first and second order electrical systems, mechanical systems, electromechanically systems and oscillatory systems.

Modeling of Mechanical, Chemical systems: Reaction dynamics, Modeling the chemical reactions, CSTR models, Plug flow reactor model, modeling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

Process Identification: Identification of physical processes, off-line and on-line identification, Step testing, pulse testing, sine wave testing, ATV identification method, prediction error methods, introduction to numerical algorithm for subspace state space identification, Least square method, Relationships among time, Laplace and frequency domain.

Analysis of multivariable systems. Open loop and close loop characteristics equations, multivariable Nyquist plot, Loci plot, Niederlinski index, Resiliency, Morari Resiliency Index (MRI), interaction relative gain array (Bristol array) inverse nyquist array , robust nests doylt stein criterion, skogestad and morari method .

Basic Concepts of Optimization: Continuity of functions, Convex and Concave functions, Convex Region, Extremum of the objective functions, quadratic approximation

Optimization of unconstrained functions. Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton, Quasi-newton and secant methods, region elimination method, polynomial approximation methods, Multidimensional problem, evaluation of unidimensional search methods, unconstrained multivariable Optimization, simplex method, direct methods, indirect methods, steepest descent method secant methods.

References:

1. W. L. Luyben, Process, Modeling, Simulation and Control for Chemical Engineersı by McGraw Hill, 1973
2. Thomas Edgar, David Himmelblau, Optimization of Chemical Processesı, Second edition, McGraw Hill, 2001.
3. W. F. Stoecker, Design of Thermal Systems International Education, McGraw hill 1989.
4. J. Malley, Practical Process Instrumentation and Control ı McGraw Hill.
5. Deo Narsingh ,System Simulation with digital Computer ı Prentice Hall India, New Delhi., Singiresu S.Rao, Engineering Optimization (Therory & Practice), third Edition,New Age International(p) Ltd,Publishers.

Minor Electives (MI)

ICMI-201 Electrical Measurements [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓				✓	✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓			✓		✓		✓	✓	

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand working of general electrical measuring system, types of error, calibration etc
2. Measurement of various electrical quantities and parameters
3. Understand the principle and working of various electrical instruments and devices

Syllabus:

Measurement Systems: Measurement system architecture, errors in measurements. Standard used in measurement: Electrical standards, time and frequency standards, physical standards.

AC/DC Bridge Measurements: Wheatstone bridge, Kelvin Bridge, Anderson Constant current loop; resistance ration bridge, Schering bridge, Parallel C bridge, De Sauty bridge, Wein bridge, Maxwell's bridge, hay bridge, Owen bridge, Anderson bridge, Heaviside Mutual inductance bridge

Basic Electrical Measurements: DC voltage/current measurements, Static electric field and potential of charged surfaces measurement, Electromechanical and analog electronic AC voltmeters, AC current measurements, frequency and time measurements.

Magnetic Measurement: Working principle and theory of Ballistic galvanometer, Measurement of flux density, determination of B-H curve, Hysteresis loop, 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 power factor, secondary burden and frequency. Steady-state performance of current transformers,
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

Books Recommended:

1. Northrop RB., "Introduction to Instrumentation and Measurements," CRC Press
2. Bell DA, "Electronic Instrumentation and Measurements," Prentice Hall
3. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons

4. Carr JJ, "Elements of Electronic Instrumentation and Measurements," Pearson Education India

ICMI-202 Transducers and Signal Conditioning [3 1 0 4]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓		✓	✓				✓		✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓		✓	✓				✓		✓	✓	✓

Course Outcome:
On successful completion of this course the student will be able to:

1. Understand study about the concepts of measurement, error and uncertainty, transducer classification, terminology, static and dynamic characteristics of transducers
2. Gain knowledge on working principle construction, operation, characteristics and features of different transducers
3. Understand the concepts of signal conversion and signal conditioning methods for different transducers
4. Understand the selection criteria of transducer for particular application and use the same for developing the applications

Syllabus:

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, Hall effect transducer, Photo-voltaic transducer.

Other Transducers: Optical transducers: photo-emissive, photo-conductive and Photo-voltaic cells, Digital Transducers: Optical encoder, Shaft encoder.

Signal Conditioning: Concept of signal conditioning, Application of Op-amp circuits used in instrumentation, Instrumentation amplifiers, grounding , and shielding.

Books Recommended:

1. Murty DVS, "Transducers & Instrumentation", Prentice Hall of India
2. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons
3. Kalsi HS, "Electronic Instrumentation," Tata McGraw Hill
4. Patranabis D, "Sensors and Transducers," Prentice Hall of India
5. Doebelin EO, "Measurement Systems: Application and Design," Tata McGraw Hill

ICMI-301 Microprocessors and Interfacing [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓			✓			✓		✓
CO2	✓	✓	✓		✓			✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Course Outcome:

On successful completion of this course the student will be able to:

1. Understand the architecture of 8-bit, 16-bit & Pentium microprocessors
2. Program the 8085 microprocessor & comprehend the basic concepts about the peripherals and interfacing devices
3. Develop microprocessor based systems for real time applications

Syllabus:

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

Introduction to Pentium Microprocessors: Introduction, Real mode and protected mode operation, Software model of the Pentium, Functional description, Pentium processor registers, Pentium data organization, Instruction types, Addressing modes, Interrupts**.**

Recommended Books:

1. Gaonkar RS, "Microprocessor architecture, programming and application with 8085," Penram International Publishing
2. Hall DV, "Microprocessors and interfacing," Tata McGraw-Hill

Reference Books:

3. Shen JP, "Modern processor design: Fundamentals of superscalar processors," Tata McGraw-Hill
4. Mathur AP, "Introduction to microprocessors," Tata McGraw-Hill
5. Ray AK and Bhurchandi KM, "Advanced microprocessor and peripherals: Architecture programming and interfacing," Tata McGraw-Hill

ICMI-303 Control System Engineering [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓	✓		✓	
CO2	✓	✓	✓	✓	✓		✓	✓	✓			
CO3	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓			✓	✓					✓
CO5	✓	✓		✓	✓	✓	✓	✓		✓		✓

Course Outcome:

On successful completion of this course the student will be able to:

6. Learn the representation of systems, their transfer function models
7. Find the time response of systems subjected to test inputs and the associated steady state/dynamic errors
8. Analyze the concept of stability in time domain and frequency domain
9. Learn basics of compensation
10. Use of various control components

Syllabus:

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 and 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, polar plot.

Text Books

1. Ogata K, “Modern Control Engineering,” Pearson Education
2. Nagrath IJ and Gopal M, “Control System Engineering,” New Age International

Reference Books

3. Kilian, “Modern Control Technology,” Cengage Learning
4. Dorf RC and Bishop RH, “Modern Control System,” Pearson Education
5. Kuo BC, “Automatic Control System,” Prentice Hall
6. DiStefano JJ, Stubberud AR and Williams IJ, “Schaum’s Outline of Theory and Problems of Feedback and Control Systems,” Tata McGraw-Hill

ICM-401 PLC, DCS & SCADA [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓		✓	✓		
CO2	✓	✓	✓	✓		✓	✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
CO4	✓				✓			✓	✓			

Course Outcome:
On successful completion of this course the student will be able to:

1. Learn hardware, architecture and software for PLC and SCADA
2. Learn PLC and SCADA programming for selected industrial processes
3. Study DCS architecture and industrial automation
4. Learn various industrial data communication protocols

Syllabus:

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: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions, PLC functions with BITS.

Bit Functions of PLC: Digital bit functions and applications; sequencer functions and applications.

Distributed Control System: Meaning and necessity of distributed control; hardware components of DCS; DCS software**.**

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

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

ICMI-402 Industrial Automation and Robotics [3 0 0 3]

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓			✓			✓		✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO4	✓	✓	✓			✓			✓			✓

Course Outcome:
On successful completion of this course the student will be able to:

4. Understand the modern concepts of industrial automation, automated flow lines and automated guided vehicle systems etc.
5. Understand the flexible manufacturing system and role of computer based industrial control
6. Understand the basic fundamentals of robotics, their kinematics, dynamics analysis and design of manipulators
7. Understand the characteristics and implementation of actuators and sensors for factory automation and robotics

Syllabus:

Industrial Automation: Introduction to automation in Production System, types of production system, Principles and Strategies of Automation, Basic Elements of an Automated System, Automated Flow Lines with Storage Buffers, Automation for Material Handling, Conveyor Systems, Automated Guided Vehicle Systems, Automated Storage/Retrieval Systems.

Factory Automation: Flexible Manufacturing Systems concept – Automatic feeding lines, ASRS, transfer lines, automatic inspection – Computer Integrated Manufacture – CNC, intelligent automation, Industrial networking, bus standards. overview of SCADA System & RTU, PLC and its applications for automation.

Fundamentals of Robotics: Introduction, classification of Robots, History, Advantages and Disadvantages, components, degree of freedom, joints and coordinates, reference frames, workspace, languages and applications, Introduction to mobile robot mapping and path planning, introduction to SLAM.

Actuators: Characteristics of actuating system, Comparison of actuating systems, Hydraulic devices, Pneumatic devices, Electric motors.

Sensors: Sensor characteristics, Position sensors, Velocity sensors, Acceleration sensors, Force and pressure sensors, Torque sensors, micro switches, Light and IR sensors, Touch and tactile sensors, Proximity sensors, Range finder, Introduction to multi-sensor data fusion.

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

END