MASTER OF TECHNOLOGY
IN
CONTROL AND INSTRUMENTATION
COMMON CURRICULUM & SYLLABUS

The proposed curriculum for all core Engineering CSE, IT, ECE, EE and C&I

1st Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	EAM-101	Advanced Engg. Math	3	1	0	4	4
2	CIM101	Compulsory	3	1	0	4	4
3	CIM102	Compulsory	4	0	0	4	4
4	CIM103	Elective I	4	0	0	4	4
5	CIM104	Elective II	4	0	0	4	4
		Total of Theory				20	20

Practical / Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	CIM191	Laboratory I	0	0	3	3	2
2	CIM192	Laboratory II	0	0	3	3	2
3	CIM193	Seminar I	0	0	3	3	2
		Total of Practical / Sessional				9	6
TOTAL OF SEMESTER:			18	02	09	29	26

2nd Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	CIM201	Compulsory	3	1	0	4	4
2	CIM202	Compulsory	4	0	0	4	4
3	CIM203	Compulsory	3	1	0	4	4
4	CIM204	Elective III	4	0	0	4	4
5	CIM205	Elective IV	4	0	0	4	4
		Total of Theory				20	20

Practical / Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	CIM291	Laboratory III	0	0	3	3	2
2	CIM291	Laboratory IV	0	0	3	3	2
3	CIM293	Seminar II	0	0	3	3	2
		Total of Practical / Sessional				9	6
TOTAL OF SEMESTER:			18	02	09	29	26

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3rd Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	EMM301	Topic In Management	4	0	0	4	4
2	CIM301	Elective V	4	0	0	4	4
		Total of Theory				8	8

Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	CIM391	Pre-submission Defense of Dissertation	0	0	0	0	4
2	CIM392	Dissertation (Part-I)	0	0	0	20	10
		Total of Sessional				20	14
TOTAL OF SEMESTER:						28	22

4th Sem

Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total	Credits
1	CIM491	Dissertation (Completion)	0	0	0	24	14
2	CIM492	Post-submission Defense of Dissertation	0	0	0	0	8
	CIM493	Comprehensive Viva-Voce	0	0	0	0	4
						24	26
TOTAL OF SEMESTER:						24	26

Total Credits: 26 + 30 + 22 + 22 = 100

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FIRST SEMESTER:

A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	EMM101	Advanced Engineering Mathematics	1	100
2	CIM101	Control Systems - I	1	100
3	CIM102	Electrical Sensors and Transducers	1	100
4	CIM103	Elective I (Any one) a)Virtual Instrumentation and Human Machine Interface b)Soft Computing Techniques	1	100
5	CIM104	Elective II (Any one) a)Modeling and Simulation of Dynamic Systems b)Industrial Automation and Control	1	100
			TOTAL OF THEORY	500
B. PRACTICAL / SESSIONAL				
6	CIM191	Laboratory I - Control System Laboratory I	1	100
7	CIM192	Laboratory II - Instrumentation Laboratory I	1	100
8	CIM181	Seminar I	1	100
			TOTAL OF PRACTICAL / SESSIONAL	300
			TOTAL OF SEMESTER	800

SECOND SEMESTER:

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A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	CIM201	Control Systems - II	1	100
2	CIM202	Process Instrumentation and Control	1	100
3	CIM203	Digital Control Systems	1	100
4	CIM204	Elective III (Any one) a) Analytical Instrumentation b) Advanced Sensors and Materials c) Medical Instrumentation	1	100
5	CIM205	Elective IV (Any one) a) Introduction to Data Communication b) Experimental Methods and Analysis c) Remote Sensing and Control	1	100
			TOTAL OF THEORY	500
B. PRACTICAL / SESSIONAL				
6	CIM291	Laboratory III - Control System Laboratory II	1	100
7	CIM292	Laboratory IV - Instrumentation Laboratory II	1	100
8	CIM281	Seminar II	1	100
			TOTAL OF PRACTICAL / SESSIONAL	300
			TOTAL OF SEMESTER	800

THIRD SEMESTER:

A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	EMAN301	Introduction to Management	1	100
2	CIM301	Elective V (Any one) a) Robotics b) Opto-electronics based Instrumentation c) Ultrasonic Instrumentation	1	100
			TOTAL OF THEORY	200

B. SESSIONAL				
3	CIM382	Pre-submission Defense of Dissertation	1	100
4	CIM381	Dissertation (part I)	1	100
			TOTAL OF SESSIONAL	200
			TOTAL OF SEMESTER	400

FOURTH SEMESTER:

SESSIONAL				
1	CIM482	Post submission defense of dissertation	1	100
2	CIM481	Dissertation (Completion)	1	300
3	CIM483	Comprehensive Viva-Voce	1	100
			TOTAL OF SESSIONAL	500
			TOTAL OF SEMESTER	500

Advanced Engineering Mathematics

EAM-101
Contact: 3L+1T
Credit: 4

Complex Variables:
Review of complex variables, Conformal mapping & transformations, Function of complex variables, Pole and singularity, Integration with respect to complex argument, Residues and basic theorems on residues.

Numerical Analysis:
Introduction, Interpolation formulae, Difference equation, Roots of equations,
Solution of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE,
Introduction to stability, Matrix eigen value and eigen vector problems.

Optimization Technique:
Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

Linear Algebra:
Vector space, Linear dependence of vectors, basis, linear transformations, inner product space, rank and inverse of a matrix, solution of algebraic equations, consistency conditions, Eigen values and eigen vectors, Hermitian and Skew Hermitian matrices.

Books:
1. John B. Conway, Functions of one complex variable, Springer International.
2. James Ward Brown & Ruel V. Churchill, Complex variable and application., Mc Graw Hill International edition .
3. John H. Mathews, Numerical Methods for Mathematics , science and Engineering, PHI
4. D.C. Sanyal and K. Das, A text Book of Numeriacl analysis, U.N. Dhar & Sons Pvt. Ltd.
5. S.S.Rao,, Optimisation theory and application, Wiely Eastern limited
   Hoffman & Kunze. R, Linear Algebra, PHI

Control System – I

CIM101
Contact: 3L+1T
Credit: 4

Modelling and Analysis of LTI Systems:
Modelling of physical Systems. Hydraulic and pneumatic actuators. Inverted pendulum system. Linearisation, linearising continuous time non-liear models.
Time domain solution. Error constants. Effects of adding poles and zeros to transfer function. Design specifications and performance indices. Motion control systems, gear drives and sensors. Servo system with velocity feedback. Transportation lags. Approximation of time-delay functions. Sensitivity of control systems to parameter variations. Effects of disturbance signals. Disturbance rejection.

Analysis in state-space:

A perspective on state-space design. State variables. State models for physical systems. SISO and MIMO systems. Solution of state equations. Transfer function. Eigenvalues and eigenvectors. Jacobian linearization technique. State transformations and diagonalisation. Transformation to phase-variable canonical form. Controllability and observability. Duality property. Stability.

Introduction to Discrete-time Systems:
Basic elements of discrete-time control system. Z-transform and properties. Inverse Z-transform. Difference equation and its solution by Z-transform method. Z-transfer function. State diagram of digital systems. Time delay. Direct, cascade and parallel decomposition of Z-transfer functions.

Feedback control design:
Continuous control design. Proportional, derivative and integral control action. PID controller tuning rules. Ziegler-Nichols method. Two degree of freedom control systems.
Compensator design using Bode diagram in frequency response approach. Lag, Lead, Lag-lead compensator.
Control law design for full state feedback by pole placement. Full order observer system. Observer based state feedback. Separation principal.

Reference Books:

1. Ogata, K – Modern Control Engineering, PHI Learning
2. Kuo, B.C. – Automation Control Systems, Prentice Hall
3. Roy Choudhury, D – Modern Control Engineering, Prentice Hall
4. Nagrath, J. J. Gopal, M – Control System Engineering, New Age Pub.
5. Schulz, D.G. and Melsa, . L. – State Functions and Linear Control Systems, McGraw-Hill.

Electrical Sensors and Transducers

CIM102
Contact: 4L
Credit: 4
Introduction:
Differences between devices used for measurement of various parameters – sensors, transducers, probes, etc. Principle of physical and chemical transduction, sensor classification – thin / thick film, active / passive, electrical / mechanical / optical, etc.
Static and dynamic performance characteristics of analogue and digital transducers. Specifications. Determination of sensor characteristics, characterization and calibration.

Electrical Transducers:
Principles, design considerations for better performance characteristics, output circuits and interfacing techniques, and applications of following transducers.
(a) Variable resistance type – Potentiometers, strain gauges, RTD, thermistors, hotwire anemometers. (b) Variable inductance type – self and mutual inductance, pulse transducer. (c) Variable capacitance transducers. (d) Special Transducers: Semiconductor temperature sensors, thermo-electric sensors, piezoelectric sensors, magnetostrictive sensors, polymer like polypyrrole, smart sensors. (e) Electromechanical Transducers: Electrodynamic, eddy current, force balance transducers. Basics of MEMs devices.

Power System Transducers:

Analogue and digital transducers for measurement of voltage, current, power factor, frequency, power – active and reactive. RTU for tariff calculation.

Analogue Signal Conditioning techniques:
Bridge amplifier, carrier amplifiers, charge amplifiers and impedance converters, modulation – demodulation, dynamic compensation, linearization, multiplexing and demultiplexing.

Digital Interfacing techniques:
Digital Interfacing techniques. Interfaces, processors, code converters, linearizers.

Signal Transmission:
Transmitters, V-I, I-V and V-f converters. Single transmission .Cable transmission of analog and digital signal, fibre optic signal transmission, radio, telemetry, pneumatic transmission.

Signal Display / Recording systems:
Signal Display/Recording systems. Graphic display systems, storage oscilloscope, recorders-ink, thermal, UV, Data loggers.

Reference Books

1. Doeblin, E.O. – Measurement Systems: Application and Design, Mc Graw Hill International.
2. Patranabis, D – Sensors and Transducers, Wheeler Pub., New Delhi.
3. Murthy, D.V.S., Transducers and Instrumentation, PHI, New Delhi.
4. Swobada, G. – Telecontrol: Methods and Applications of Telemetry and Remote Control. Van Nostrand.
5. Newbert, H. K. – Instrument Transducers, Oxford University Press.

Virtual Instrumentation and Human Machine Interface

CIM 103 (a)
Contact: 4L
Credit: 4

Virtual Instrumentation:
Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

VI programming techniques:
VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Data acquisition basics:
Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

Interfacing:

VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Toolsets:
VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

Reference Books:

1. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
2. Lisa K. Wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

WEB RESOURCES
www.ni.com
www.ltrpub.com

Soft Computing Techniques

CIM 103 (b)
Contact: 4L
Credit: 4
Module 1
Introduction to Soft Computing, components of soft computing, traditional computing and drawbacks, advantages of soft computing techniques.

Module 2
Introduction to fuzzy logic: definition, general idea and importance in practical life. Fuzzy set theory: concept of fuzzy set, membership functions, comparison of fuzzy set and classical set. Operations on fuzzy sets, properties of standard operations, T norm and S norm, Extension principle and application. Height of fuzzy set, core of fuzzy set, support of fuzzy set, normal fuzzy set, normalization of fuzzy set, level set, α cut and strong α cut of fuzzy set, concentration and dilation of fuzzy sets, fuzzy singleton, crossover points.
Fuzzy relation: fundamentals of fuzzy relations, operations on fuzzy relations, composition of fuzzy relations, fuzzy reasoning, fuzzy relation inferences, compositional rule of inference, fuzzification. Fuzzy methods in control theory: Introduction to fuzzy logic controller, types of fuzzy logic controllers, basic structure of fuzzy knowledge based controllers, defuzzification methods, applications of fuzzy logic control.

Module 3
Introduction to artificial neural networks, artificial neuron model, types of activation functions. Learning in neural networks, feed forward and feedback neural networks, backpropagation training algorithm, Hopfield network, Boltzman machine. Self organizing map, learning vector quantization algorithm.

Module 4
Basic concept of genetic algorithm, comparison of GA and traditional techniques, objective function and fitness function, crossover, mutation, GA search, applications of GA.

Reference Book:

1. Klir, G.J. & Yuan,B.- Fuzzy sets and Fuzzy logic, theory and applications, Prentice Hall of India Private Limited.
2. M. Ganesh – Introduction to fuzzy sets and fuzzy logic, PHI.
3. N. P. Padhy – Artificial intelligence and intelligent systems, Oxford
4. Timothy J. Ross – Fuzzy logic with engineering applications, Wiley.
5. Nie and Linkens,- Fuzzy Neural Control-Principles, Algorithms and Application, PHI
6. J.S.R. Jang, C.T. Sun, E. Mizutani – Neuro-fuzzy and soft computing, PHI.
7. Kosco, B.-Neural Networks and Fuzzy System.PH
8. Haykin- Neural Network; A Comprehensive Foundation, PHI
9. Rajasekaran and Pai – Neural Networks , Fuzzy Logic and Genetic algorithms: Synthesis and Application, PHI.
10. Goldberg- Genetic Algorithms, Pearson.

Modeling and Simulation of Dynamic Systems

CIM 104 (a)
Contact: 4L
Credit: 4

Module 1:
Introduction, State space representation of systems of different kind. Simulation of the state model. Describing equations and different kinds of models. Eigen values and vectors, Similarity X'formation, invariants. Stability, controllability, observability, Leverrier's algorithm. Linearization of nonlinear systems

Module 2:
Theorem on feedback control, pole placement controller. Full order and reduced order observer design. Theory of industrial regulation, feed forward control. Application – motor speed control with disturbance rejection.

Module 3:
Heat flow in one dimension, finite element method. Modeling and simulation through bond graphs. Qualitative reasoning: M & S with Incomplete Knowledge.

Module 4:
Sensor modeling: Lumped parameter and distributed parameter models, Thick and thin film models. Numerical modeling techniques, model equations, application of Finite Element method.

Different effects on modeling – temperature, radiation, mechanical, chemical, magnetic, electrical (e.g. capacitive, resistive, piezo-resistive, frequency, etc.).

Examples of modeling: micro-modeling of photodiodes, magnetic, capacitive, mechanical sensors.

Reference Books:

1. D M Wiberg State Space and Linear Systems Schaum's Outline Series McGraw Hill 1971
2. W B J Zimmerman Process Modeling and Simulation with Finite Element Methods Univ. Of Sheffield UK 2004
3. Amalendu Mukherjee and Ranjit Karmakar Modeling and Simulation of Engineering Systems through Bond Graphs Narosa New Delhi 1999
4. Benjamin Kuiper Qualitative reasoning: Modeling and Simulation with Incomplete Knowledge MIT Press Cambridge Mass 1994
5. Thomas Kailath Linear Systems **Prentice Hall 1980**

6. Robert D. Strum and Donald E. Kirk Contemporary Linear Systems Using Matlab **Thomson Learning**1999
7. M Gopal Modern Control System Theory Wiley Eastern 1984
8. M Gopal Digital Control Engineering Wiley Eastern 1988
9. K Ogata Modern Control Engineering 4th edition Prentice Hall 2002
10. B C Kuo Automatic Control Systems 7th Edition Prentice Hall 1995
11. Patranabis, D.- Sensors and Transducers. 2nd edition, PHI, New Delhi,
12. Ghosh, M. K. Et al (ed) – Trends in.....
13. Learning MATLAB and Simulink Mathworks
14. Grandke, T. And Ko, W.H.(ed) – Sensors: Fundamentals and General Aspects. Vol I of Sensors: A Comprehensive Survey. VCH, Germany, 1989

Industrial Automation and Control

CIM 104 (b)
Contact: 4L
Credit: 4

Overview: Structure & components Industrial Automation systems. Architectural levels of Industrial controls.

Actuators & sensors: Servomotors, Stepper motors, Process I/O systems. Local & remote I/O systems.

Controllers: Different types of controllers, Single loop and Multiloop controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct Digital Controllers, Software implementation of Multiloop Controllers. Distributed Control Systems.

Sequence Control: Programmable Logic Controllers, Relay Ladder Logic, Programming.

Supervisory Controllers: Functionally of Supervisory Control Level, Process Optimization, Recipe Management Material. Tracking. Man-machine interfaces.

Process Operation Management Systems: Overview of process operation management systems, order, inventory management, process scheduling, quality management.

Industrial Communication Systems: Characteristic features of industrial networks. Low level networks and their features, Field bus architecture. Performance aspects of Industrial Automation Systems.

Reference Books:

1. Webb J.W-Programmable controllers: Principle and Applications, PHI New Delhi
2. Parr A –Programmable Controllers :An Engineers' Guide, Newnes, Butterworth-HeinnemanLtd-1993.
3. Liptak B.G (ED)-Process Control H andbook,vol-2 Chilton book Co.
4. Noltinc – Handbook for Instrumentation Engineers.
5. Bollinger J.G and Duffie N.A-Computer control of machines and processes, Reading M A, Addison-Wesley, 1988.

Control Systems – II

CIM 201
Contact: 3l+1T
Credit: 4

Non linear system:

Classification and types of non-linearity. Phenomena peculiar to non-linear systems. Methods of analysis. Linearization based on Taylor's series expansion. Jacobian Linearization.

Phase trajectory and its construction. Phase-plane analysis of linear and non-linear sustems. Existence of limit cycles. Describing function of typical non-linearities. Stability analysis by DF method. Introduction to DIDF. Popov's circle criterion. Stability analysis by Lyapunov's indirect and direct methods, Lypunov's theorem.

Introduction to Chaotic System.

Optimal Control:

Linear optimal control with quadratic performance index , Selection of performance measure. State and output regulators. Optimal state regulator problem with matrix Ricati equation .

Stochastic process haracterization . Stochastic optimal linear estimation & control . Response of linear continuous time system to white noise and optimal state estimator.

Robust Control:

Parametric uncertainty and Kharitnov's method for stability test. Stability function, complementary sensitivity function and return difference. Effect of high frequency plant uncertainty. Stability robustness. Structured and unstructured uncertainty. Additive and multiplicative perturbation models. Small gain Theorem. Stability robustness measures in frequency domain. Robust performance, tracking problems and disturbance rejection control. Integral control. Internal model principle of robust tracking. The error-space approach. Performance robustness and H∞ norm. Principal Gains and H∞ norm.

Reference Books:

1. Stepheni, Shahian, Savant, Hostetler – Design of feedback control systems, Oxford University Press.
2. Franklin. F., Powell, J .D. , Emami –Naeini,A –Feedback Control of Dynamic Systems, Addison-Weslay Publication.
3. Vidyasagar- Nonlinear system analysis, Prentice-Hall.
4. Gibson, J.E.- Non linear system , Mc. Grawhill.
5. Gopal. M, Modern Control System Theory, New Age International.
6. Gopal. M, Digital Control and State Variable Methods, TMH.
7. Zak.H.S , Systems and Control, Oxford University Press.
8. Peter Dorato,- Robust Control.

1. Morari and Zafirious, - Robust Process Control,

Process Instrumentation and Control

CIM 202
Contact: 4L
Credit: 4

Process characteristics:
Various process schemes / unit operations – Batch and Continuous processes – differences and characteristics. Description and characteristics like large time constants, time lag, etc. Of a few processes, such as, heat exchangers, furnaces, boilers and condensers, distillation columns, absorbers, reactors. Mineral processing industries – pH and blending processes

Measurement of process parameters:
Radio isotope and ultrasonic methods of instrumentation and its applications in process industries.
Measurement and transmission of process parameters like flow, pressure, level and temperature – invasive and non invasive techniques
Imaging technique of measurement

Process control methods and control action generation:
Different Control techniques and interaction of process parameters – On-off control, Feed forward, Cascade, Ratio, Override controls, Multivariable control, Optimal control, Adaptive control.
Three term controller as the basic controller. Means of generation of control actions using electronic and pneumatic components.
Digital P-I-D controller – scheme and simulation.

Controller tuning:
Tuning of controllers – Zeigler Nichols, Cohen Coon and other methods.

Final Control elements:
Control valves, valve positioners, torque motors, step motors.

Computer control of processes:
Supervisory control, direct digital control (DDC), distributed computer control.

Reference Books:
1. Harriot, Process Control. TMH, New Delhi
2. Patranabis, D. Principles of Process Control. TMH. New Delhi
3. Coughnower and Koppel Process System Analysis and Control. Mc Graw Hill.
4. Smith, L. Digital Computer Process Control. Intext Education Publishers, 1972
5. Franklin Digital Control of Dynamic Systems. 3rd Edition. Pearson, 2003.
6. Johnson, C. Process Control Instrumentation Technology. PHI, New Delhi.

Digital Control Systems

CIM 203
Contact: 3L+1T
Credit: 4

Z-domain Analysis of Discrete-time system:

Structure of computer control system. Digital signals and coding. Data conversion and Quantization. Sampling and Data hold operation. Zero Order Hold (ZOH) and First Order Hold(FOH). Sampling Theorem. Folding and aliasing. Pulse transfer function. Pulse transfer function of ZOH. Z-transfer function of open `loop and closed loop system. Block diagram and signal flow graph. State diagram of discrete data system with ZOH.

Transient and steady state response of discrete time systems. Steady state accuracy and error constants. Dead beat systems. Stability analysis. Mapping between s and z plane. Characteristic equation. Bilinear Transformation and Routh-Hurwitz Criterion, Jury's test. Effect of sampling rate on stability. Frequency response of discrete time systems. Discrete Nyquist stability criterion, Sensitivity analysis. Disturbance rejection.

State-space Analysis of Discrete- time systems.

State-space representation. Similarity transformations. Transformation to phase variable canonical form. Solution of discrete time state equation. State transition matrix`(STM). Computation of STM by z-transformation method. Diagonalization. Discretisation of continuous time state- space equation. Eigenvalues, eigenvector. Controllability and Observability. Integral control by state augmentation.

Digital Controller design:

Cascade compensation in frequency domain. Commonly used performance indices. Controller design in W-plane for desired steady-state accuracy and phase margin using Bode diagram.
Digital PID controller. Integration and differentiation filters. PI,PD, PID controller design in W-plane using Bode plot for realizing specified phase margin.
Pole Assignment Design based on full state feedback. Hardware implementation for the design.
Design of discrete time system with dead beat response.

Reference Book:

1. Gopal,`M – Digital Control Engineering ,New Age International .
2. Kuo, B . C – Digital Control System , Oxford University Press .
3. Ogata , K . – Descrete Time Control System , Prentice- Hall
4. Phillips , C.L , Nagle , H.T – Digital Control System Analysis & Design Prentice- Hall
5. Franklin .G. E . Powell J .D , Workman , M – Digital Control of Dynamic Systems, Addison-Weslay.
6. Nagrath, I.J . Gopal ,M – Control System Engineering , New Age International Publishers

Analytical Instrumentation

CIM 204 (a)
Contact: 4L
Credit: 4

Introduction:

Difference between analytical and other instruments. Online instrumentation and laboratory methods. Sampling techniques for liquids and gases for analysis.

Gas analysis:
Gas chromatography.
Thermal conductivity method, Heat of reaction method, Estimation of oxygen, Hydrogen, Methane, Carbon Dioxide, Carbon Monoxide, etc. In binary or complex gas mixtures. Zirconia – probe oxygen analyzers, paramagnetic oxygen meters. Electrochemical reaction method.

Humidity and moisture measurement techniques.
Techniques of density measurements: Solids, Liquids and gases.

Chemical composition analysis: Measurement of viscosity and consistency. Turbidity. pH and redox potential measurement, Electrical conductivity.

Spectrochemical analysis:
Mass spectroscopy, Emission spectroscopy, Absorption spectroscopy. Dispersive and non dispersive techniques.
X-ray spectroscopy. Atomic spectroscopy.

Reference Books:

1. Patranabis D- Principles of Industrial Instrumentation. 2nd edition. TMH, New Delhi, 1996.
2. Liptak B G (Ed) – Instrument Engineers Handbook, Volume I and II and supplement I and II, Chilton book co., Philadelphia, 1972.
3. Jones E B- Instrument technology, Volume II, Analysis instruments, Butterworth Scientific Publication , London.
4. O'Higgins P J - basic Instrumentation in industrial measurements, McGraw Hill Book co, NY 1966.
5. Skoog, D. A. And West, D. M.- Principles of Instrumental Analysis. Savuders College Publishing, Philadelphia
6. Ewing, G. W. – Instrumental Methods of Chemical Analysis, 5th edition, Mc Graw Hill, NY 1985.

Advanced Sensors and Materials

CIM 204 (b)
Contact: 4L
Credit: 4

Introduction:
Factors responsible for development of new sensors. Sensor design and packaging- partitioning, layout, technology constraints, scaling, compatibility study. Sensor characterization.

Thin and thick film sensors and the materials. Thin film deposition techniques, Langmuir- Blodgett technique of ultra-thin film deposition. Thick film devices and their development. Examples.

Microsensors and Microsystems. IC technology and micromachining, MEMS (Micro-Electro-Mechanical Systems), bulk and surface micromachining methods, silicon as a micromachining material, silicon microsensors thermal, pressure, accelerometer, flow, etc. Micro sensor array devices. Performance and calibration of microsensors.

Ceramics and oxides as sensor materials – Zirconia, Alumina, semiconductors, oxides of Tin and Zinc, Piezoelectric, pyroelectric, ferro electric materials.

Special sensors – Chemical, Biological , Olfactory or gas sensors, Smart sensors Use of Hall elements, Polymers, Organic materials, Nano materials for sensing.

Reference Books.

1. Patranabis, D. Sensors and Transducers. 2nd edition, PHI, New Delhi, 2003.
2. Ghosh, M. K, Sen, S and Mukhopadhyay, S. (ed) – Measurement and Instrumentation: Trends and Applications. Ane Books, New Delhi, 2008.
3. Triethy, H. L. Transducers in Electronic and Mechanical Design. Mercel Dekker, 1986.
4. Bhargava, - Engineering Materials: Polymers, Ceramics and Composites. PHI, 2003.
5. Gardner, J. W. Microsensors: Principles and Applications. John Wiley & Sons, 1994.
6. Edmonds, T.E (ed) – Chemical Sensors. Blackie, London, 1988.

Medical Instrumentation

CIM 204 (c)
Contact: 4L
Credit: 4

Introduction:
Physiology of cardiac, nervous, muscular and respiratory systems. Features of medical instrumentation and their problems.

Transducers and Electrodes:
Different types of transducers and their selection for biomedical applications. Electrode theory. Different types of electrodes, their selection criteria.

Cardiovascular measurement:
The heart and other cardio vascular systems. Measurement of blood pressure, blood flow, cardiac output and cardiac rate, Electrocardiography, Phono-cardiography, Ballistocardiography, Plethysmography, Magnet-cardigraphy, Cardiac pace-maker, Computer applications.

Measurement of electrical activities in muscles and brain:
Electromyography, Electroencephalograph and their interpretation. Respiratory system measurement: Respiratory mechanism, Measurement of gas volume , flow rate carbon dioxide & oxygen concentration in inhaled air, Respiratory controller. Instrumentation for clinical laboratory: Measurement of pH value of blood. ESR Measurement, Haemoglobin Measurement , oxygen & carbon dioxide concentration in blood, GSR Measurement, Polarographic Measurement, computer application.

Medical Imaging:
Ultra sound Imaging, Radiography, MRI, Electrical tomography & applications.

Biotelemetry:
Transmission and reception aspects of biological signals via long distances.

Patient care monitoring. Equipment standards and patient safety.

Reference Books:

1. Carr, - Introduction to Biomedical Equipment Technology. 4th edition, Pearson, 2003
2. Cromwell, L. Biomedical Instrumentation and Measurements. 2nd edition, Pearson, 2003.
3. Webster, J.S. Medical Instrumentation- Application and Design
4. Khandpur, R.S. Handbook of Biomedical Instrumentation, TMH, New Delhi, 1991.

Introduction to Data Communication

CIM 205 (a)
Contact: 4L
Credit: 4

Modulation techniques, Different kinds of AM and FM. AM and FM modulators and demodulators. Sensitivity for wire and wireless transmission. Power line carrier communication. Sampling theorem, Nyquist frequency, sampling techniques and signal reconstruction. Pulse code modulation, PAM, PWM, PPM signals.Pulse code modulation. Coding formats. Digital data communication techniques. Multiplexing, FDM and TDM systems, their relative merits, ASK, FSK,PSK and higher order modulation, techniques. Local area and public data Networks.

Data transfer techniques- asynchronous and synchronous. Serial and parallel interface
Standards. Communication media and adapters. Modems and their interfacing. IRIG and CCITT standards. Fiber optic and satellite communication. Remote control, Mechanical, electrical and electronic methods, special considerations. Typical telemetry and telecontrol schemes related to industry and space application.

Ref.Book:

1.Carlson B.A- Communication Systems- An Introduction to signals and Noise in Electrical Communiction, McGraw Hill International Students' Edition, 1986.

2 Schwartz M- Information transmission, modulation and noise, McGraw Hill, 1970.
3.Tanenbaum A,- Telecommunication Network, Pearson.
4.Proakis,J.G- Digital Communication , Mc. Grawhill
5.Miller,- Data Network Communication, Vikas.

Experimental Methods and Analysis

CIM 205 (b)
Contact: 4L
Credit: 4

Errors:

Concept of errors of measurement, Sources and Classification of errors, Systemic errors.

Random errors: Statistical analysis of errors, Normalized histograms, Probability distribution functions; Gaussian error curves, Chi-squared statistical test, Regression analysis of data, Best fit curve and estimation of model; Combination of errors, Variance of sum of two sets.
Errors of computed results – examples from engineering measurements, Special functional forms;

Methods of measurements:
Classification and examples; Instrument scales and reading errors; Importance of measurement method and environment on magnitude and nature of errors.

Methods of minimization and elimination of errors due to noise in measured data:
Measurement configuration, Input-output configuration, filtering, averaging and correlation techniques; Errors in digital instruments.

Reference Books

2. Holman, J. P. Experimental Methods for Engineers. Mc Graw Hill International Student Edition, 1966.
3. Cook, N. H. And Robinowicz, E. Physical Measurements and Analysis, Addison Wesley, 1965.
4. Schenk - Engineering Experimentation, McGraw Hill.

Remote Sensing and Control

CIM 205 (c)
Contact: 4L
Credit: 4

Electromagnetic radiation:
Classification and nature, spectral, spatial and temporal characteristics of objects.

Atmospheric interaction sensors:
Photographic, thermal, multi-spectral, passive microwave and active microwave sensors.

Ground data acquisition:
Photo-interpretation, image processing techniques, remote sensing applications.

Techniques of remote control:
Remote control in industry including oil pipelines, rocket motion and satellite movements.

Reference Books

1. Gupta - Remote Sensing Ecology, 2nd edition, Springer, 2005
2. Jensen - Remote Sensing of the Environment, Pearson, 2003
3. Barett, E.C. and Curtis, L.F. Introduction To Environmental Remote Sensing, 3/e, Chapman Hall, New York 1992.

5. Lo, C.P. Applied Remote Sensing, Wiley, New York 1986.

Introduction to Management

EMM-301
Contact: 4L
Credit: 4
To be Prepare by centrally

Robotics

CIM 302 (a)
Contact: 4L
Credit: 4

Basic concepts: Definition and origin of robotics – different types of robots – various generations of robots – degrees of freedom – Asimov's laws of robotics – Dynamic stabilization of robots.
Power sources and sensors: Hydraulic, pneumatic and electric drives – Determination of HP of motor and gearing ratio – variable speed arrangements – path determination – machine vision – ranging – laser-acoustic – magnetic – fibre optic and tactile sensors.
Manipulators, Actuators and Grippers: Construction of manipulators – manipulator dynamic and force control – electronic and pneumatic manipulator control circuits – and effectors – various types of grippers – design considerations.

Ref. Book:

1. Mair, G.M. –Industrial Robotics, Prentice Hall, NY, 1988.
2. Khafter, R.D., Chimelewski, T.A. and Negin, M. – Robot Engineering – An Integrated Approach, PHI, New Delhi, 1994.
3. Braddley, M. et. Al. (Eds) – Robot Motion: Planning and Control, MIT Press, Cambridge, Mass, 1982.
4. Lee, C.S.G. – Robot Arm Kinematics, Dynamics and Control, Computer, IEEE, Vol. 15, No. 12.
5. Paul, R.P. – Robot Manipulators: Mathematics, Programming and Control, MIT Press, Cambridge, Mass, 1981.
6. Mittal and Nagrath,- Robotics and Control, Tata Mc. Graw Hill,.
7. Sponge, M., and Vidyasagar M- Robot Dynamics and Control, John Wiley New York 1989.
8. Craig J.J.- Introduction to Robotics; Mechanisms and Control, 2/e, Addison Wesley, Reading, Mass 1989.

Optoelectronic based Instrumentation

CIM 302 (b)
Contact: 4L
Credit: 4

Introduction- Generation and propagation of light, Particle and Wave nature of light.
Optical phenomena: Reflection, refraction, absorption, dispersion, diffusion, scattering, diffraction – Fresnel effect, coherence, monochromacity, divergence, polarization, birefringence, Pockel effect, Kerr effect.

Optical sources: LED, Lasers – theory, types and characteristics

Optical detectors:
PIN, APD, Photomultiplier tubes (PMT), CCD – principle and characteristics.

Optical Waveguides: Optical fibres – principle, types, fabrication, characteristics.

Optical components: Beam splitters, couplers, connectors, reflectors, collimators (lens), gratings, beam expanders, filters, polarizers, opto-isolators, modulators, Kerr cells, Pockel cells.

Optical signal processing: Intensity, phase and holographic image. Interferometers – principle, types, readout devices, applications. Elimination of optical noise – optical Wheatstone Bridge, ratiometric measurement.

Optical sensing and instrumentation: Laser based instrumentation – distance measurement, Laser-Doppler velocimeter.
Optical 3 D imaging (Holography)- principle, readout devices, applications.
Optical 2 D imaging – technique, signal processing.
Optical fibre based sensors: techniques of signal modulation, read out devices, applications.
Optical data transmission using optical fibres. Introduction to Integrated Optics.

Reference Books:

1. Ghatak, A. Optics. TMH Publication, New Delhi, 1994
2. Hawkes, J. and Latimer, I. Lasers – Theory and Practice. Prentice Hall, London
3. Verdyen, J.T. Laser Electronics. PHI. New Delhi, 1993.
4. Senior, J.M. Fiber Communications – Principles and Practice. PHI, New Delhi, 1996
5. Culshaw, B. and dakins, J. (Ed) – Optical Fiber Sensors – Principles and Applications. Vol I & II. Artech House, London, 1989

Ultrasonic Instrumentation

CIM 302 (c)
Contact: 4L
Credit: 4

Introduction. Ultrasonic waves – Generation – Magnetostrictive and Piezoelectric effects. Propagation of various waves. Characterization of ultrasonic transmission – reflection and transmission coefficients, intensity and attenuation, medium parameters. Power level.

Search unit: Types, construction and characteristics

Ultrasonic test methods: Pulse echo, transit time, resonance, direct contact and immersion type.

Ultrasonic applications in instrumentation:
Vibration and sound pick ups. Flaw detection. Measurement of thickness, depth, flow, level, etc.
Applications in Medical diagnosis and therapy.
Applications in Marine systems – sonar imaging.

Acoustic Holography – principle and applications.
Variables affecting ultrasonic testing in various applications.

Reference Books:

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