AC 11/09/2012
Item No. 4.4

UNIVERSITY OF MUMBAI

Syllabus

for

Programme: M.E.

Course: Instrumentation

(as per credit based semester and grading system with effect from the academic year 2012–2013)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
IS101	Applied Linear Algebra	04	--	--	04	--	--	04
IS102	Advanced sensors and signal processing systems	04	--	--	04	--	--	04
IS103	System Modeling and simulation	04	--	--	04	--	--	04
ISE101x	Elective I	04	--	--	04	--	--	04
ISE102x	Elective II	04	--	--	04	--	--	04
ISL101	Lab Practice-I	--	02	--	--	01	--	01
ISL102	Lab Practice-II	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
IS101	Applied Linear algebra	20	20	20	80	03	--	--	100
IS102	Advanced sensors and signal processing systems	20	20	20	80	03	--	--	100

IS103	System Modeling and simulation	20	20	20	80	03	--	--	100
ISE101X	Elective I	20	20	20	80	03	--	--	100
ISE102X	Elective II	20	20	20	80	03	--	--	100
ISL101	Lab Practice-I	--	--	--	--	--	25	25	50
ISL102	Lab Practice-II	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	50	**50**	**600**

Semester II

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
IS201	Modern Control System	04	--	--	04	--	--	04
IS202	Advanced process Instrumentation and control	04	--	--	04	--	--	04
IS203	Introduction to Non-linear control theory	04	--	--	04	--	--	04
ISE203X	Elective III	04	--	--	04	--	--	04
ISE204X	Elective IV	04	--	--	04	--	--	04
ISL201	Lab Practice-III	--	02	--	--	01	--	01
ISL202	Lab Practice-IV	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory					**Term Work**	**Pract. /oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test1	**Test 2**	**Avg.**					

IS201	Modern Control System	20	20	20	80	03	--	--	100
IS202	Advanced process Instrumentation and control	20	20	20	80	03	--	--	100
IS203	Introduction to Non-linear control system	20	20	20	80	03	--	--	100
ISE203X	Elective III	20	20	20	80	03	--	--	100
ISE204X	Elective IV	20	20	20	80	03	--	--	100
ISL201	Lab Practice-III	--	--	--	--	--	25	25	50
ISL202	Lab Practice-IV	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	--	**50**	**50**	**600**

Semester III

Subject Code	**Subject Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ISS301	Seminar	--	06	--	--	03	--	03
ISD301	Dissertation I	--	24	--	--	12	--	12
Total		--	30	--	--	15	--	15

Subject Code	**Subject Name**	**Examination Scheme**						
		Theory				**Term Work**	**Pract. / Oral**	**Total**
		Internal Assessment			**End Sem. Exam.**			
		Test1	**Test 2**	**Avg.**				
ISS301	Seminar	--	--	--	--	50	50	100
ISD301	Dissertation I	--	--	--	--	100	--	100
Total		--	--	--	--	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISD401	Dissertation II	--	30	--	--	15	--	15
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
ISD401	Dissertation II	--	--	--	--	100	100	200
Total		--	--	--	--	**100**	**100**	**200**

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher
- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Subject Code	Elective I	Subject Code	Elective II
ISE1011	Bio- instrumentation and imaging	ISE1021	Instrumentation for non-conventional energy sources
ISE1012	Advanced analytical instrumentation	ISE1022	Advanced micro/nano systems
ISE1013	Automotive Instrumentation	ISE1023	Advanced Electronic Circuits For Instrumentation And Control Applications
ISE1014	Robotics	ISE1024	Process Identification

Subject Code	Elective III	Subject Code	Elective IV
ISE2031	Advanced digital signal processing	ISE2041	Advanced embedded system for Instrumentation
ISE2032	Advanced Nuclear Instrumentation	ISE2042	Adaptive Control System
ISE2033	Reliability Engineering	ISE2043	Fuzzy Logic, Neural network and control
ISE2034	Fiber Optics and laser Instrumentation	ISE2044	Intelligent And Autonomous Control

Subject Code	Subject Name	Credits
IS101	**Applied Linear Algebra**	**04**

Module	Detailed content	Hours
1	**Euclidean Vector Spaces :**Euclidean n-Space, Linear Transformation from R^n to R^m , Properties of Linear Transformations from Rn to Rm, Linear Transformations and Polynomials	10
2	**General Vector Spaces :** Real Vector Spaces, Subspaces, Linear Independence, Basis and Dimension, Row Space, Column Space & Nullspace, Rank and Nullity.	10
3	**Inner Product Spaces :**Inner Products, Angle and Orthogonality in Inner Product Spaces, Orthonormal Bases; Gram-Schmidt Prodcess; Q R-Decomposition, Best Approximation; Least Squares, Change of Basis, Orthogonal Matrices.	10
4	**Eigenvalues, Eigenvectors :**Eigenvalues and Eigenvectors, Diagonalization, Orthogonal Diagonalization	10
5	**Linear Transformation :**General Linear Transformation, Kernel and Range, Inverse Linear Transformations, Matrices of General Linear Transformations, Similarity, Isomorphism	08

REFERENCES:

1. Anthanasios Papoulis, " Probability, Random Variables & Stochastic Processes ", 3rd Edn., McGraw Hill, Inc, 1995.
2. Gantmacher, Feliks R. " the theory of Matrices Vol. I and II ", Chelsia Publishing Co., 1959
3. Gantmacher F.R., " Applications of Theory of Matrices ".
4. Hoffman K. & R. Kunze, " Linear Algebra ", 2nd Edn., Printice Hall, 1971.
5. Howard Anton, " Elementary Linear Algebra " – Wiley Student Edn., 2011.

Subject Code	Subject Name	Credits
IS102	**Advanced Sensor And Signal Processing Systems**	**04**

Module	Detailed content	Hours
1	**Classification of instruments transducers:**Input and output characteristics of various transducers, variable resistance transducer and its equivalent circuit, potentiometers, their construction and performance, variable inductance and variable capacitance transducers, their construction and performance, Piezoelectric transducer.	10
2	**Design techniques for sensor signal conditioning:** Sensor and signal conditioning for strain, force, pressure, flow and temperature measurement, Bridge configurations, Amplifying and linearising bridge outputs, Driving bridge circuits. Ratiometric techniques.	10
3	**High impedance sensors:** Photodiodes and high impedance charge output sensors, Signal conditioning of high impedance sensors	06
4	**Positioning, motion and temperature sensors :**LVDT, Hall effect magnetic sensors, optical encoders Accelerometer, RTDs, thermistors, thermocouples, semiconductors temperature sensors and their signal conditioning	08
5	**Micro-sensors and smart sensors:** Construction , characteristics, and applications.	06
6	**Hardware design techniques :** Grounding in mixed signal systems, Power supply noise reduction and filtering, Shielding and isolation technique, Over-voltage and Electrostatic discharge (ESD) protection techniques.	08

REFERNCES:

1) H.K.P Neubert “Instrument Transducers Oxford Herman University Press Eighth Impression 2008.

2) Ramon Pallas-Arenyand Johan G. Webster “Sensor And Signal Conditioning” John Wiley, New York 1991.

3) Dan Sheingold-Editior “Transducer Interfacing Handbook”, Analog Devices Inc 1980

4) “High Speed Design Technique” Analog Device Inc 1996

5) Jacoba Fraden “Handbook Of Modern Sensors “2nd Edition ,Springer-Verlag.New York 1996

6) Jerald G.Graeme “Photodiode Amplifiers And Op-Amp Solution”, Mc Graw Hill 1995

7) Harry L. Trietly , “Transducers In Mechanical And Electronic Design”, Marcel Dekker Inc 1986

8) Dan Shiengold , “Non Linear Circuits Handbook”, Analog Device Inc

9) Walt Kester-Editior, “System Application Guide”, Analog Devices Inc 1993

10) IMEGA, “Temperature Measurement Handbook”, Omega Instruments Inc

11) Henry Ott, “Noise Reduction Technique In Electronic Systems”, N.Y.John Wiley And Sons 1988

12) Ralph Morrison,”Grounding And Shielding Technique”, Fourth Edition,John Wiley,1998

Subject Code	Subject Name	Credits
IS103	**System Modeling and Simulation**	**04**

Module	Detailed content	Hours
1	Introduction – System modeling, Concept of a Model and Model building, Model classification, Identification, Simulation softwares. Continuous Time and Discrete Time Systems – Continuous-Time Linear systems, simple electrical circuits, Laplace transform, transfer functions, state-space model.	08
2	Discrete time systems, Z-transform, a-b tracking system, Feedback system, stability,controllability and observability. Nonlinear System Analysis and Modeling – Mathematical models for nonlinear systems, phase trajectory and local linearization, system stability, controllability and observalibility, Inputoutput mapping and system invertibility, Linearization and linearizability, nonlinear system modeling and simulation.	14
3	Computer Simulation – Numeric integration, state space simulation techniques, simulation of discrete-time systems, digital simulation languages. Robotic Systems and Automation – Modeling of robot, control of robots, modeling of mobile robots and control, applications	14

4	Design and analysis of Simulation Experiments – Design of simulation Experiments, analysis of simulation experiments, variance reduction techniques.	06
5	Digital Control systems – Basic Digital Control system, design approaches, implementation.	06

REFERENCES:

1. Naim A Kheir, System Modeling and Computer Simulation, Marcel Dekker Inc, 1996
2. Modeling & Simulation Using Metlab-Dr.Sailendra Jain(Wiley)
3. Louis Birta, Gilbert Arbez, Modeling and Simulation, Springer
4. Donald Boyo, System Analysis and Modeling, Academic Press, 2001.
5. System Modeling and Simulation –Frank L.Severance(Wiley)
6. I. Mitrani, Simulation Techniques for Discrete Event Systems, Cambridge
7. Theory of Modeling and Simulation, 2nd Edition, Zeigler & Kim & Praehofer, 2000, Academic Press, Elsevier

Subject Code	Subject Name	Credits
ISE1011	**Bio-Instrumentation and Imaging**	**04**

Module	Detailed content	Hours
1	**Transducers and Instrumentation for Bio-potential recording:** Sensors , Bio-potential Amplifiers (Chopper amplifier, Isolation amplifiers, Advanced Inst. Amplifiers), Multichannel Data acquisition system, Signal conditioning circuit design for ECG, EEG, and EMG etc., Noise and Interference, Grounding techniques, Optimization of Performance characteristics.	12
2	**Cardiac and Neuro-assist devices:** Cardiac Pacemaker, types, constructional details and design, Defibrillator and design, Stimulation electronics - Nerve and Muscle stimulators, Patient monitoring system	12
3	**Implantable electronic devices and recent advancements:** Wireless power and data transmission, receiver and transmitter specifications, Telemedicine, Implants – cochlear and retinal, Brain stimulators.	12
4	**Medical Imaging Systems** X-ray and CAT - tube design, image intensifier design, methods of image reconstruction , 3-D imaging. MRI - Pulse sequencing and MR image acquisition and reconstruction techniques Nuclear and Functional imaging - Radiation detectors, scanners, Gamma camera, PET, SPECT, fMRI Medical image processing - image reconstruction techniques like sampling, compression, segmentation and restoration .	12

REFERENCES

1. Rangan C.S., Sarma G.R., and Mani V.S.V., “Instrumentation devices and system”, Tata Mc Graw Hill Publishing Company limited, New Delhi, 1983.

2. John G.Webster, “Medical Instrumentation, Application and Design”, Third Edition, John Wiley and sons,1999.

3. Jacob Kline., “Handbook of Bio Medical Engineering”, Academic press Inc., Sandiego, 1988.

4. J.B.Gupta, “A course in electronic and electrical measurement and instrumentation”, S.K.Kataria & Sons, 1999.

5. D.N.Chesney and M.O.Chesney, “ Radio graphic imaging”, CBS Publications, New Delhi, 1987.

6. Peggy, W., Roger D.Ferimarch, “MRI for Technologists”, Mc Graw Hill, New York, 1995.

7. Steve Webb, “The Physics of Medical Imaging”, Taylor & Francis, New York.1988.

8. Larry L. Hench and Julian R.Jones, “Biomaterials, Artificial organs and Tissue Engineering”, 2005.

9. Norris, A.C. “ Essentials of Telemedicine and Telecare”. Wiley (ISBN 0-471-53151-0), 2002.

10. Wootton R. Craig, J., Patterson, V. (Eds.), “ Introduction to Telemedicine”. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006.

Subject Code	Subject Name	Credits
ISE1012	**Advanced Analytical Instrumentation**	**04**

Module	Detailed content	Hours
1	**Spectrophotometric /Gas Analysers** IR/NIR/UV/VIS Analysers – Cells, Detectors, Signal Processing, Calibration, Minimization of Interference and Comparative Analysis of Analysers & Gaseous Components Detected Hydrocarbon Analysers - Flame Ionisation Detectors, Principle of Operation Oxygen and NO/NO2 Analysers - Signal Processing, Calibration, Minimization of Interference, Applications Sampling Systems – Desirable Features, Filters, Flow and Pressure regulators, Coolers, Condensers, Vacuum Pumps, Blowback Cleaning System, Exhaust Practices.	08
2	**Electrochemical/Liquid Analyzers** pH Analyzers – Measurement and Compensation, Pre-amplifiers, Transmitters, Measurement cells. Conductivity Analyzer – Cells and Cell Constant, Effect of temperature on measurement calibration, acid and alkali titration measurement.	08

	Redox Analyzer - Principle of operation, components of analyzers and applications. Trace Oxygen and Residual Chlorine Analyzer - Principle of operation, components of analyzers and applications.	
3	**Compositional Process Analyser** Gas and Liquid Chromatography – columns, gas and liquid detectors, data processing, process chromatograph, calibration and application. Mass Spectrometry – Components, different types, sampling systems, calibration and applications.	08
4	**Biomedical Spectroscopy** Types of Biomolecules, different spectroscopic analysis techniques, principle of operation, components, data processing and applications, Blood gas analysers	06
5	**Environmental Analysers** Waste Water Environmental Analysis, analyser's principle of operations & components, calibration and applications.	04
6	**Nuclear Magnetic Resonance Spectroscopy** Principle of operation, components, sensitivity enhancement techniques and different types of NMR Spectrometers with applications.	06
7	**Radiochemical Instruments and Nuclear Pulse Spectroscopy** Radiation detectors – principle of operation, constructional details, calibration and applications Nuclear Spectroscopy – Instrumentation techniques, signal processing and electronics of nuclear spectroscopy, Pulse height analyser and various nuclear detectors.	08

REFERENCES

1. B. G. Liptak, "Instrument Engineers' Handbook: Process Measurement and Analysis", Butterworth Hieneman, Boston, 1995.
2. D.M. Considine, "Process Instruments and Control Handbook", 4th edition, McGraw Hill New York, 1993.
3. K. J. Clevett, "Process Analyzer Technology", John Wiley & Sons, 1986, New York.

4. Gas Analysis – Book 14 Fisher Rosemount Educational Services.
5. G. K. Macmillan, "pH Measurement and Control", ISA 1994.
6. pH and Conductivity – Book 13 Fisher Rosemount Educational Services.
7. R.E. Sherman, "Analytical Instrumentation", TWI Press, Indiana, 1996.
8. Meyers, "Encyclopedia of Analytical Chemistry".
9. Instruction Manuals at http:// www.frco.com/proanalytic/library/publicmanuals.html.

Subject Code	Subject Name	Credits
ISE1013	**Automotive Instrumentation**	**04**

Module	Detailed content	Hours
1	Thermodynamic engine cycles, ideal combustion engines, comparison of different engine concepts, potential of different fuels and propulsion systems.	08
2	Basic engine operation, fuel control, ignition control, lambda control, idle-speed control, knock control, combustion torque estimation.	10
3	Basic driveline equations, modeling of neutral gear, State-space formulation, Driveline speed control, Driveline control for gear shifting.	08
4	Vehicle modeling, wheel model, tyre characteristics, complete vehicle model, validation of the model, velocity estimation.	12
5	Vehicle control system, Antilock Braking Systems (ABS), control cycles of ABS, road model, PID driver model, hybrid driver model, model of human information acquisition, complete driver model	10

REFERENCES

1.T.Kailath, "Linear Systems", Prentice Hall Inc., New Jersey, 1996

2. J.M.Maciejowski, "Multivariable Feedback Design", Addison Wesley, Singapore, 1989

3. J.L.Meriam and L.G.Kraige, "Engineering Mechanics, Dynamics", John Wiley and sons, 5^{th} Edition, New York, 2002.

4. U.Kiencke, and L. Nielson, "*Automotive Control Systems*", Springer Verlag Berlin, 2000

Subject Code	Subject Name	Credits
ISE1014	**Robotics**	**04**

Module	Detailed content	Hours
1	**Robot Organization** Coordinate transformation, kinematics and inverse kinematics, Trajectory planning and remote manipulation.	08
2	**Robot Hardware** Robot sensors, Proximity sensors, Range sensors, Visual sensors, Auditory sensors, Robot manipulators, Manipulator dynamics, Manipulator control, Wrists, End efforts, Robot grippers.	12
3	**Robot and Artificial Intelligence** Principles of AI, Basics of learning, Planning movement, Basics of knowledge representations, Robot programming languages.	12
4	**Robot Vision Systems** Principles of edge detection, Determining optical flow and shape, Image segmentation, Pattern recognition, Model directed scene analysis.	08
5	**Robot Control and Application** Robot control using voice and infrared. Overview of robot applications. Prosthetic devices. Robots in material handling, processing assembly and storage.	08

REFERENCES

1. Koren, “Robotics for Engineers”, McGraw Hill International Company, Tokyo, 1995.
2. Vokopravotic, “Introduction to Robotics”, Springer, 1988.
3. Rathmill. K., “Robot Technology and Application”, Springer, 1985.
4. Charniak and McDarmott, “Introducation to Artificial Intelligence”, McGraw Hill, 1986.
5. K. S. Fu, R. C. Gonzally, C.S. G. Lee, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Company, 1997.
6. Barru Leatham, Jones, “Elements of Industrial Robotics”, Pittmann Publishing, 1987.
7. Mikell P. Groover, Mitchell Weiss, Roger. N. Nagel, Nicholas G. Odrey, “Industrial Robotic Technology Programming and Applications”, McGraw Hill Book Company, 1986.

Subject Code	Subject Name	Credits
ISE1021	**Instrumentation for non-conventional energy sources**	**04**

Module	Detailed content	Hours
1	**Energy resources and their utilization:** Indian and global energy sources, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Introduction to various sources of energy, Solar thermal, Photovoltaic, wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation.	02
2	**Solar photovoltaic system:** Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system and its instrumentation, Standards of solar photovoltaic system, Applications of PV system, PV hybrid system.	06
3	**Biogas:** Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Producer gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas process instrumentation and applications, Biomass conversion techniques, Biomass gasification, Energy recovery from urban waste, Power generation from liquid waste, Biomass cogeneration, Energy plantation.	08
4	**Wind energy:** Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Recent development.	06
5	**Nuclear Power:** Design and instrumentation for nuclear reactors-pressurised water, boiling power, gas cooled, fusion and heavy water reactors.	06

6	**Tidal power:** Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy, Limitations of tidal energy conversion systems.	04
7	**Hydrogen Energy:** Properties of hydrogen in respect of it's use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel, Development of hydrogen cartridge.	06
8	**Geothermal energy:** Structure of earth's interior, geothermal sites, earthquakes & volcanoes, Geothermal resources, Principal of working, Types of geothermal station with schematic representation, Problems associated with geothermal conversion.	04
9	**Ocean energy:** Principle of ocean thermal energy conversion, Wave energy conversion machines, Power plants based on ocean energy, Problems associated with ocean thermal energy conversion systems, Thermoelectric OTEC, Developments of OTEC.	04
10	**Energy storage:** Compressed air energy, flywheel energy, electrochemical energy, magnetic energy, thermal, chemical and hydrogen energy.	02

REFERENCE:

1) Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata McGraw Hill.

2) Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.

3) Rai G.D, "Non-Conventional energy Sources", Khanna Publishers.

4) Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd.

Subject Code	Subject Name	Credits
ISE1022	**Advanced Micro/Nano Systems**	**04**

Module	Detailed content	Hours
1	**Introduction** Introduction to nanotechnology and Nanomaterials, How It All Began: Synthesis of carbon buckyballs, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones .	04
2	**Quantum Mechanics :**Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli Exclusion Principle, Schrödinger's equation, Properties of the wave function, Application: quantum well, wire, dot, quantum cryptography Solid State Physics and Nanodevices-Structure and bonding, Application: carbon nanotube, Electronic band structure Electron statistics, Application: Optical transitions in solids, Semiconductor quantum dots, photonic crystals.	12
3	**Nanomaterials - Fabrication , MEMS and NEMS nanotubes synthesis** Bottom-up vs. top-down approach, Epitaxial growth ,Self-assembly, Modeling and Applications Production Techniques of Nanotubes Carbon arc bulk synthesis in presence and absence of catalysts High-purity material (Bucky paper) production using Pulsed Laser Vaporization (PLV) of pure and doped graphite High-pressure CO conversion (HIPCO) nanotube synthesis based on Boudoir reaction Chemical Vapor Deposition (CVD) .	06
4	**Nanomaterials** Characterization and commercial processes of synthesis of nonmaterial, Nanoclay, Nanoinroganic materials, Nanocarbontubes CNT, Applications of nanomaterials in water treatment, polymers, catalysis etc Structural, XRD, TEM, SEM, STM, AFM .	06
6	**MEMS :** Introduction to Microelectromechanical Systems (MEMS), Microsensors and Microactuators, Micromachining, System modeling and Simulation, different types of MEMS sensors and actuators.	08

7	**Micro Electromechanical Systems:** MEMS: Micro-transducers Analysis, Design and Fabrication, Microprocessor-Based Controllers and Microelectronics**,** Micro-switches, Micro-actuators for Electromechanical systems.	06

REFERENCES

1. K. Eric Drexler, "Nanosystems: Molecular Machinery, Manufacturing, and Computation", 1992 .

2. Mark Ratner & Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", November 2002 Read reviews.

3. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill, New Delhi, 2007.

4. K. K. Appukuttan, "Introduction to Mechatronics", Oxford Higher Education, 2003.

5. Nitaigour Premchand Mahalik, "Machatronics", Tata McGraw-Hill, 2003

Subject Code	Subject Name	Credits
ISE1023	**Advanced Electronic Circuits For Instrumentation and Control Applications**	**04**

Module	Detailed content	Hours
1	**Design of linear integrated circuit and their applications** Linear and log amplifiers, peak detect and milli volt rectifier circuits, analog switches and multiplexers, current and voltages references and their stability	08
2	**Instrumentation and special operational amplifiers** Advanced instrumentation amplifier and various designs to improve dynamic range and reduce power dissipation .High speed OP-amps CMOS OP-amps Micro power amplifiers low noise and chopper stabilized OP-amps	12
3	**Non linear integrated circuits** Comparators, voltage to frequency and frequency to voltage converters switched capacitor circuits filters. Power management in electronic circuits.	08

4	**Converters** D.C to D.C converters. Mixed signal processing. High speed and high resolution DACs and A/D converters. Various techniques of A/D conversion. flash ,successive approximation, multi slope ADC. Delta sigma ADC.	10
5	**Noise reduction techniques** Design of mixed signal processing circuits, grounding and isolation techniques R.F shielding.	10

REFERNCES:

1. E.Allen Douglas R.Holberg, “CMOS Analog Circuit Design”, Philip Oxford , University Press 2004

2. Kevin M.Daugherty, “Analog To Digital Converter”, Tata McGraw Hill Inc 1995

3.Manual: High Speed Design Technique- Analog Devices Inc 1996

4.Dan Shiengold, “Non Linear Integrated Circuits Hand Book”, Analog Devices.

5. Ralph Morrison,”Grounding And Shielding Technique”, Fourth Edition,John Wiley,1998

Subject Code	Subject Name	Credits
ISE1024	**Process Identification**	**04**

Module	Detailed content	Hours
1	**Introduction :** Introduction to process identification, dynamic systems, ARX model and linear least square, system identification procedures, Impulse response, frequency domain expression, signal spectra, multivariable systems.	06
2	**Models of Linear time invariant systems :**Linear models and sets of linear models, family of transfer function models, state space models, distributed parameter models, model sets, model structure and identifiably, identification of some model structures.	06
3	**Non-parametric methods of identification :**Time domain and frequency domain methods of system identification: Time response analysis and correlation analysis, frequency response analysis, Fourier analysis and spectral analysis, estimating the disturbance spectrum.	06
4	**General Parameter Estimation Techniques :**Fitting Models to Data; Model Quality; Measures of Model Fit; Model Structure Selection; Algorithmic Aspects	06
5	**Linear Black-Box S;ystems :**Linear System Descriptions in General; Linear, Ready-Made Models.	06
6.	**Special Estimation Techniques for Linear Black-Box Models :** Transient and Frequency Analysis; Estimating Impulse Responses by Correlation Analysis; Estimating the Frequency Response by Spectral Analysis; Subspace Estimation Techniqus for State-Space Models	06
7.	**Physically Parameterized Models** : Nonlinear Black-Box Models, Nonlinear Black-Box Structures, Non-linear Mappings, Possibilities;; Estimating Nonlinear Black-Box Models.	06
	User's Issues : Experiment Design; Model Validation and Model Selection, Software for System Identification; The Practical Side of	

8	System Identification.	06

REFERENCES:

1. Lennart Ljung: " System Identification - Theory for the User, 2nd , PTR Prentice Hall, Upper Saddle River, N.J., 1999.
2. T. Soderstrom, P. Stoica - " System Identification, Prentice Hall International, Hemel Hempstead, UK, 1989.
3. Yucai Zhu, " Multivariable System Identification for Process Control, Elsevier, 2001.
4. P.Van Overschee and B. De Moor, " Subspace Identification for Linear Sytems: Theory, Implementation, Applications. Kluwear Academic Publishers, Boston, 1996.
5. B.A. Ogunnaike and W.H. Ray, " Process Dynamics, Modeling & Control ", Oxford University Press, New York, 1994.
6. William S. Leave - " The control handbook ", - IEEE Press, 1996.

Subject Code	Subject Name	Credits
ISL101	**Lab Practice-I**	**01**

Expt.	Title
1	Linearizing circuit for "single element" varying bridge .
2	Kelvin sensing system to drive remote bridges.
3	Photovoltaic and photoconductive modes and their working.
4	Charge sensitive amplifier for capacitive sensors.
5	Piezoelectric transducer signal amplifier.
6	Active low pass, band pass and high pass filters for transducer signal processing.
7	Use of high resolution ADC for transducer signal processing.
8	Microcontroller based calibration system.

- Perform any six experiments from above list and two experiments from electives

Subject Code	Subject Name	Credits
ISL102	**Lab Practice - II**	**01**

Expt	Title
1	Experiments in MATLAB/Scilab For Computation of Eigen values, Eigen vectors, different types of norms etc.
2	QR Decomposition
3	LQ Decomposition
4	Gram Schmidt Orthogonalisation
5	Controller design using MRAC
6	Controller design using Lyapunov design
7	Controller design using variable structure scheme

- Perform any six experiments from above list and two experiments from electives

Subject Code	Subject Name	Credits
IS201	**Modern Control System**	**04**

Module	Detailed content	Hours
1	State Space Representation, Solution of State Equation, State Transition Matrix, Canonical Forms - Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form.	08
2	Controllability and Observability, Canonical Realizations, Duality, Decomposition of Uncontrollable and Unobservable realizations,Popov test. Effect of state feedback on controllability and observability, Design of State Feedback Control through Pole placement. Full order observer and reduced order observer.	10
3	Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.	10
4	Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.	08
5	Calculus of Variations: problems of Lagrange,. Mayer and Bolza. Euler-Language equation and transversality conditions, Lagrange multipliers. Pontryagin's maximum principle; theory; application to minimum time, energy and control effort problems, and terminal control problem.	12

REFERENCES

1. "Modern Control System Theory " by M. Gopal, New Age International Publishers, 2nd edition, 1996
2. D.E.Kirk, "Optimal Control Theory", Prentice-Hall. 1970.
3. M. Vidyasagar, "Nonlinear Systems Analysis". 2nd Edition.Prentice Hall, 1993.
4. "Modern Control Engineering ", by K. Ogata, Prentice Hall of India, 3rd edition, 1998
5. "Control Systems Engineering", by I.J. Nagarath and M.Gopal, New Age International (P)
6. "Digital Control and State Variable Methods " by M. Gopal, Tata McGraw-Hill Companies, 1997.
7. "Systems and Control" by Stainslaw H. Zak , Oxford Press, 2003.

Subject Code	Subject Name	Credits
IS202	**Advanced Process Instrumentation and Control**	**04**

Module	Detailed content	Hours
1	**Optimization control of process equipments** Heat exchanger, boilers, fired heaters, distillation column and pumps. Energy efficient device-adjustable speed drives and its advantages.	08
2	**Multivariable control** Effects of interaction, performance analysis, constraint control for SISO, MISO, Signal selector, Relative gain analysis, steady state decoupling, dynamic decoupling, Dead time compensation-Smith prediction, IMC, Dahlin algorithm.	08
3	**Automation** Process and factory automation, PLC, DCS and SCADA-architecture, programming, selection and sizing, installation and troubleshooting.	12
4	**Communication protocols** Open and proprietary protocol-advantages and disadvantages, wireless HART, Fieldbus-functions, hardware selection, Segment design and checking for safe and hazardous area, advantages and disadvantages, installation, documentation and economics	10
5	**Advanced intrinsic safety** Entity concept, FISCO, High power trunk, Dynamic arc recognition and termination technology with advantages and disadvantages.	05
6	**Safety Instrumented System** Components, technologies, SIL calculation methods, SIL-calculation of PFD, RRF etc. Phases of SIS overall implementation and reliability.	05

REFERENCES

1. Myke King, “Process control-A practical approach”, John Wiley, !st edition,2011.
2. Bela G Liptak, “ Instrument Enginner’s Handbook-Process software and digital networks”, CRC press, ISA,3rd edition,2002.

3. Bela G Liptak, “Optimisation of Unit operaion”, ISA.
4. Bela G Liptak, “ Instrument Enginner’s Handbook-Process Control”, Chilton Book Company, 3rd edition.
5. Gary Dunning, “Introduction to Programmable Logic controller”, Thomas Learning, edition, 2001.
6. Thomas Hughes, “Programmable Logic Controller”, ISA Publication.
7. Stuart A. Boyer, “SCADA supervisory control and data acquisition”, ISA Publication.
8. George Stephanopoulos, “Chemical process control”, PHI-1999
9. Paul Gruhn, Harry L cheddie, “ Safety Instrumented System: Design, Analysis and justification”, ISA, 2nd edition, 2006.
10. Ian Verhappen, Augsto Periria, “Foundation fieldbus”, ISA,2006

Subject Code	Subject Name	Credits
IS203	**Introduction to nonlinear control theory**	**04**

Module	Detailed content	Hours
1	**Linear versus nonlinear systems:** Nonlinear phenomena, multiple equilibria, limit cycles, complex dynamics, manifolds as state space, linearization methods for nonlinear systems, some classical examples.	08
2	**Planar dynamical systems:** Phase plane techniques, limit cycles, Poincare-Bendixson theorem, multiple equilibria, index theory, bifurcations (fold, pitch, fork, Hopf, saddle connection).	06
3	**Mathematical preliminaries :** Ordinary differential equations, control systems, solutions of initial value problems, existence and uniqueness of solutions, continuous	10

	dependence on initial conditions and parameters, differential equations with discontinuities, (time-dependent) vector fields, flows, introduction to differential topology.	
4	**Lyapunov stability:** Definitions of stability, basic stability theorems, converse Lyapunov theorems, LaSalle Invariance Principle, exponential stability theorem, linear systems, feedback stabilization.	08
5	**Feedback linearization:** SISO systems, input-output linearization, full state linearization, zero dynamics, applications to inversion, tracking and stabilization, MIMO systems, linearization by state feedback, full state linearization, dynamic extension, sliding mode, robust linearization.	08
6	**Input-output stability :** Definitions of input-output stability, small gain theorems, passivity, passivity theorems, describing functions, harmonic balance, connections with state space stability**.**	04
7	**Non-Linear Design Tools :** Sliding Mode Control ; Lyapunov Redesign ; Backstepping ; Passivity-Based Control; High-Gain Observers	04

REFERENCES

1) H.K. Khalil. " Nonlinear Systems " Prentice Hall,Englewood Cliffs, NJ, third edition, 2002.
2) S.S. Sastry - " Nonlinear Systems " : Analysis, Stability and Control. Interdisciplinary Applied Mathematics. Springer Verlag, New York, 1999.
3) H. Nijmeijer and A.J. van der Schaft. Nonlinear Dynamical Control Systems. Springer Verlag, New York, 1990.
4) A. Isidori. Nonlinear Control Systems. Springer Verlag, New York, 3 edition, 1995.
5) E.D. Sontag, Mathematical Control Theory : Deterministic Finite Dimensional Systems, volume 6 of TAM. Springer Verlag, New york, 2 edition, 1998.

Subject Code	Subject Name	Credits
ISE2031	**Advanced digital signal processing**	**04**

Module	Detailed content	Hours
1	**Signals and Systems** Introduction, Continuous time and discrete time signals, Transformations of independent variable, Exponential and Sinusoidal Signals, Unit impulse and unit step functions, basic properties. LTI Systems: Introduction, Convolution sum, Convolution integral, Properties of LTI systems.	04
2	**Multirate Signal Processing & Filter Banks** Introduction, Decimation, Interpolation, Fractional rate conversion, Multistage Filter implementation. Interpolated FIR filter (IFIR), IFIR technique for decimation filter and interpolation filter, analysis and Synthesis banks. Poly phase structures – Polyphase structure for decimation and interpolation filters.	10
3	**Applications of Multirate Signal Processing:** Filter banks, digital audio, analog voice privacy system, transmultiplexers, Multirate adaptive filters, Sub band coding – spectral analysis, amplitude and phase analysis, simple and M channel QMF.	10
4	**Adaptive Filtering** Principles of adaptive filtering, LMS and RMS algorithms. Applications in noise and echo cancellation.	08
5	**Homographic Signal Processing** Homograph systems for convolution, properties of complex spectrum, application of homographic deconvolution.	06
6	**Time Frequency Analysis** Need for time frequency analysis. Time frequency distributions, short time Fourier transform Wigner distribution. Introduction to wavelet transformation, wavelets and wavelet expansion systems, discrete wavelet transform, multiresolution formulation of wavelet systems, Haar Wavelet and other wavelet representations, scaling function, wavelet functions, Parseval's theorem,	10

REFERENCE:

1. P.P. Vaidhyanathan, “Multirate systems and filter banks”, Prentice Hall, 1993.

2. Emmanuel Ifeachor and Barrie Jervis, “Digital Signal Processing: A Practical Approach”, (2nd Edition), Prentice Hall, 2004.

3. J.G Proakis and D.G Manolakis ,” Digital Signal Processing: Principles, Algorithms and Applications”, PHI, 2004.

4. A.V. Oppehein and R.W. Schafer, “Discrete time signal processing”, PHI, 1992

5. Haykins,” Adaptive Filter Theory”, Prentice Hall, 1986

6. Leon Cohen, “Time Frequency analysis”, Prentice Hall, 1995

7.Orfanidis Sophocles J, “Optimum Signal Processing”, McGraw Hill, 1988

Subject Code	Subject Name	Credits
ISE2032	**Advanced Nuclear Instrumentation**	**04**

Module	Detailed content	Hours
1	**Nuclear instrumentation for research** Radiation detectors for high resolution nuclear pulse spectroscopy, HPGE, Ge(Li), Si(Li) detectors, high resolution Multi Channel Analyzers, Nuclear ADCs, Wilkinson, Gatti’s sliding scale technique, various modes of Multi Channel Analyzer, portable spectroscopy systems and their design. Timing spectroscopy, TDCs, TACs, spectrum stabilization.	16
2	**Instrumentation for reactors** Log and linear amplifiers, in core and out of core instrumentation, Neutron detector , BF3 detector, Fission counters, nuclear instrumentation for pressurized water reactors, boiling water reactors, self powered detectors , fast Neutron detection and spectroscopy.	08
3	**Detection of very low radio-activity** Liquid scintillation counting systems, noise reduction by coincidence detection.	04

4	**Instrumentation for accelerators** Various types of accelerators, detectors and electronics used.	04
5	**Nuclear medical instrumentation** Functional imaging, design and construction of imaging systems gamma camera, PET SPET. Calibrations and testing of various nuclear instruments and systems.	12
6	**Instrumentation for astrophysics experiments** Detection of cosmic events, detector arrays and trigger systems	04

REFERENCE:

1. G.F.Knoll ,"Radiation detection and measurement", John Wiely and Sons, 4th edition, 2010
2. P.W. Nicolson, " Nuclear electronics", John Wiely,1998.
3. Gerald. J.Hine, James A Sorenson, "Instrumentation in nuclear Medicine", Vol II, Academic press,1974
4. Ramesh Chandra, "Nuclear Medicine Physics", Williams and Wilkins,1998.
5. Irving Kaplan "Nuclear Physics.", Narosa Publishing House.1992

Subject Code	Subject Name	Credits
ISE2033	**Reliability Engineering**	**04**

Module	Detailed content	Hours
1	**Basic concepts of Reliability** Reliability and quality, maintainability and availability, reliability mathematics, reliability-analysis, designing for higher reliability, redundancy techniques, equipment hierarchy.	06
2	**Component reliability and hazard models** Component reliability from test data, Hazard models: Time-dependant – constant hazard, linear hazard, non-linear hazard, and stress dependant hazard models.	08
3	**System reliability models** Systems with components in series and parallel, k-out-of-m systems, non-series parallel systems, systems with mixed mode failures, fault tree technique.	08
4	**Redundancy techniques in system design** Component versus unit redundancy, weakest link technique, mixed redundancy, standby redundancy, redundancy optimization, double failures and redundancy.	08
5	**Maintainability and availability concepts** Maintainability and availability functions, frequency of failures, k-out-of-m systems, preventive maintenance.	06
6	**m-order systems with nonidentical units** non-maintained systems- logic-diagram approach, Event realization approach, maintained systems and trichotomous systems.	08
7	**Hierarchical systems** Conditional probability approach, system cost, economics of reliability engineering.	04

REFERENCE:

1.E Balguruswamy ,"Reliability Engineering ", McGraw Hill,10th edition,2010

2. R.Billintan & R.N. Allan,"Reliability Evaluation of Engineering and Systems", Plenum Press.

3.K.C. Kapoor & L.R. Lamberson,"Reliability in Engineering and Design", John Wiely and Sons.

4. S.K. Sinha & B.K. Kale,"Life Testing and Reliability Estimation", Wiely Eastern Ltd.

5. M.L. Shooman, "Probabilistic Reliability, an Engineering Approach", McGraw Hill.

6. G.H.Sandler, "System Reliability Engineering", Prentice Hall.

Subject Code	Subject Name	Credits
ISE2034	**Fiber Optics And Laser Instrumentation**	**04**

Module	Detailed content	Hours
1	**Optical Fibers And Their Properties** Principles of light propagation through a fiber, Different types of fibers and their properties, Fiber materials and their characteristics- Transmission characteristics of fibers, absorption losses, scattering losses, Dispersion, Measurement on optical fibers, Optical sources, Optical detectors.	06
2	**Fiber Optic Sensors In Measurement** Fiber optic instrumentation system, Fiber optic sensors Different types of modulators, Applications in instrumentation- Interferometric method of measurement of length, Measurement of pressure, temperature, current, voltage, liquid level and strain.	10
3	**Fundamentals Of Laser Instruments** Fundamental characteristics of laser, three level and four level lasers, properties of lasers, laser modes- resonator configuration, Q switching and mode locking, cavity dumping, types of Laser, gas laser, solid laser, liquid laser, semi conductor laser.	12
4	**Lasers In Measurements And Testing** Laser for measurement of distance, length, velocity, acceleration, current, voltage, and atmospheric effect , Laser application in Spatial Frequency Filtering ,Holography -Basic principle; methods; Holographic interferometry and applications; Holography, for non-destructive testing-	12

	Holographic components.	
5	**Lasers in Industry** Applications in Material processing, Laser Welding, Hole drilling, Laser Cutting, Laser Tracking, Medical applications of lasers; laser and tissue interaction,Laser instruments for surgery.	08

REFERENCES

1 I. John and Harry, “Industrial lasers and their applications”, McGraw Hill,

2 John F Ready, “Industrial applications of lasers” Academic press, 1978.

3 John Crisp, “Introduction to Fibre Optics”, an imprint of Elsevier Science, 1996.

4 Jasprit Singh, “Semi conductor Optoelectronics”, McGraw Hill, 1995.

5. Jeff Hecht, “Understanding Fiber Optics”, 5th edition, Prentice Hall publishers

6 A. Selvarajan, S.Kar and T.Srinivas , “Optical Fiber Communication Principles and Systems”, TMH

Subject Code	Subject Name	Credits
ISE2041	**Advanced Embedded System for Instrumentation**	**04**

Module	Detailed content	Hours
1	**Introduction to embedded systems** Definition and Classification, Overview of Processors and hardware units in an embedded system –Software embedded into the system, Any 8 bit Architecture design and Overview Design Tools.	08
2	**Interfacing devices** Device I/O Types and Examples, Timer and Counting Devices, Analog interfacing considerations.	12
3	**Embedded communication protocols** Embedded Networking: Introduction – Serial / Parallel Communication Serial communication protocols – RS232 standard RS485 Synchronous Serial Protocols Serial Peripheral Interface (SPI) Inter Integrated Circuits (I2C)	14

	USB protocol, CANbus protocol, Zigbee Wireless protocol, Design Example MODBUS on RS485 network.	
4	**Real time operating systems** Study of Micro C/OS-II /FreeRTOS / Vx Works or Any other popular RTOS , Definitions of process, tasks and threads ISRs and tasks by their Process Management Interrupt Routines Handling in RTOS RTOS Task scheduling models Handling of task scheduling and latency and deadlines as performance metrics Inter process communication and synchronisation I/o driver development.	14

REFERENCES

1. David E. Simon, "An Embedded Software Primer", Pearson Education, 2001.
2. Tammy Noergaard, "Embedded System Architecture, A Comprehensive Guide for Engineers and Programmers", Elsevier, 2006.
3. Raj Kamal, " Embedded Systems – Architecture, Programming and Design", Tata McGraw Hill, 2006.
4. Frank Vahid and Tony Gwargie, "Embedded System Design", Elsevier, Second Edition, 2004.
5. Ralf Niemann, "Hardware/Software Co-Design for Data Flow Dominated Embedded System", Kluwer Academic Pub, 1998.
6. Jorgen Staunstrup, Wayne Wolf, "Hardware/Software Co-Design: Principles and Practice", Kluwer Academic Pub, 1997.
7. Giovanni De Micheli, Rolf Ernst Morgon, "Reading in Hardware/Software Co-Design", Kaufmann Publishers, 2001.

Subject Code	Subject Name	Credits
ISE2042	**Adaptive control theory**	**04**

Module	Detailed content	Hours
1	**Introduction :** Adaptive control-definitions-essential aspects-classification; Different approaches to Adaptive Contol; Feedforward Adaptive Controllers; Feedback Adaptive Controllers	04
2	**Adaptive Control Based on Discrete-Time Process Identification :** Online Identification of Dynamic Processes and Stochastic Signals ; Process and Signal Models; Nonparametric Identification Methods; Parametric Identification Methods; Recursive Parameter Estimation Methods; Parameter Estimation of Time-varying Processes; Online Identification in Closed Loop; Determination of Model Order and Deadtime; Comparison of Different Parameter Estimation Methods.	10
3	**Controller Design :** The General Linear Controller; The PID Controller; The Cancellation Controller; The Deadbeat Controller; The Predictor Controller; The Minimum Variance Controller; The Generalized Predictive Controller; The State Controller and Observer; Suitable Control Algorithms for Adaptive Control.	10
4	**Parameter Adaptive Control :** Basic Approaches of Parameter Adaptive Control; Suitable Combinations of Parameter Estimators and Controllers; Stochastic Parameter Adaptive Controllers; Deterministic Parameter Adaptive Controllers; Comparison of some Parameter Adaptive Controllers; Parameter Adaptive Feedforward Control.	14
5	**Adaptive Control Based on the Model Reference Technique :** Model Reference Control with Local Parameter Optimization (Gradient Methods) ; Continuous-time MRAS; Examples with a Simulated Process	10

REFERENCES:

1) K.J. Astrom & Bjorn Wittenmark - " Adaptive Control " - Peerson Education, 2003
2) V.V. Chalam - "Adaptive Control Systems - Techniques & Applications " - - Marcel Dekker Inc.
3) Miskhin and Braun - " Adaptive Control Systems " - MC Graw Hills.

4) R. Isermann, K.H. , K.H. Lachmann, D. Matko - " Adaptive Control Systems " – PHI 1992.

Subject Code	Subject Name	Credits
ISE2043	**Fuzzy Logic, Neural Networks & Control**	**04**

Module	Detailed content	Hours
1	**Introduction to Neural Networks :** Artificial NeuralNetworks: Basic propertiesof Neurons; Neuron Models; Feedforward networks - Perceptrons; Widrow-Hoff LMS algorithm; Multiplayer networks - Exact and approximate representation; Back propagation algorithm; variants of Back propogation; Unsupervised and Reinforcement learning; Symmetric Hopfield networks and Associative memory; Competitive learning and self organizing networks, Hybrid Learning; Computational complexity of ANNs.	10
2	**Neural Networks Based Control :** ANN based control: Introduction: Representation and identification; modeling the plant, control structures - supervised control, Model reference control, Internal model control, Predictive control : Examples - Inferential estimation of viscosity an chemical process; Auto - turning feedback control; industrial distillation tower.	08
3	**Introduction to Fuzzy Logic :** Fuzzy Controllers: Preliminaries - Fuzzy sets and Basic notions - Fuzzy relation calculations - Fuzzy members - Indices of Fuzziness - comparison of Fuzzy quantities - Methods of determination of membership functions.	08
4	**Fuzzy Logic Based Control:** Fuzzy Controllers: Preliminaries - Fuzzy sets in commercial products - basic construction of fuzzy controller - Analysis of static properties of fuzzy controller - Analysis of dynamic properties of fuzzy controller - simulation studies - case studies - fuzzy control for smart cars.	12

5	**Neuro - Fuzzy and Fuzzy :** Neural Controllers: Neuro - fuzzy systems; A unified approximate reasoning approach - Construction of role bases by self learning : System structure and learning algorithm - A hybrid neural network based Fuzzy controller with self learning teacher. Fuzzified CMAC and RBF network based self-learning controllers.	10

REFERENCES:

1. Bose & Liang, " Artificial Neural Networks ", Tata Mcgraw Hill, 1996
2. Kosco B, " Neural Networks and Fuzzy Systems : A Dynamic Approach to Machine Intelligence,
   Prentice Hall of India, New Delhi, 1992.
3. Klir G.J. and Folger T.A., Fuzzy sets, " Uncertainty and Information " , Prentice Hall of India,
   New Delhi, 1994.
4. Simon Haykin - " Neural Networks ", ISA, Research Triangle Park, 1995

Subject Code	Subject Name	Credits
ISE2044	**Intelligent And Autonomous Control**	**04**

Module	Detailed content	Hours
1	**Introduction to intelligent control systems with high degree of autonomy:**Functional architecture, management, coordination and execution levels.	08
2	**Reference model architecture for intelligent systems design:** Evolution of RCS (real time control) RCS-3 and RCS-4 and their architecture organization and timing in the RCS hierarchy, task decomposition behavior generation world modeling sensory processing and value judgment modules	08
3	**Model based architecture concepts for autonomous systems design and simulation:** Model based planning, operation and diagnosis Hierarchical development of intelligent units, task based model development.	04
4	**Modeling and design of distributed intelligence systems:** The intelligent node and its model, measure of performance.	08
5	**Expert control:** PLC and DDC adaptive controller, Expert system, knowledge structuring, single loop controllers	04
6	**Modeling and analysis of artificially intelligent (AI) planning systems:** Classification and functional operation of AI planning system,AI planning and control theory. AI feedback planning systems Planning application.	08
7	**Fuzzy and neutral control :** Architecture and fuzzy logic controller (FLC) neural networks for learning control, Hybrid neural and fuzzy controllers.	8

REFERENCES:

1) Panos J. Antsaklis And Kevin M.Passino Kulwer , “An introduction to intelligent and autonomous control”, Acadamic Publisher 1992.

2) Young-Zuilu, “Industrial intelligent control”, John Wiley and sons 1996.

3) Johan Brignell And Neil White, “Intelligent sensor systems”, IOP Publishing Ltd London 1996.

4) Robert J. Schalkoff , “Artifical Neural Networks”, Tata Mcgraw Hill 2011.

Subject Code	Subject Name	Credits
ISL201	**Lab Practice-III**	**01**

Expt	Title
	To develop a VI to---
1	Simulate alarm annunciator
2	Simulate Discrete controller
3	Simulate continuous controller
4	Simulate bottle filling system
5	Create patient/student/employee database and save it in file
6	Simulate temperature controller using fuzzy controller
7	Find convolution, auto-correlation and cross correlation
8	Calculate LMMSE
9	Simulate signal conditioning and processing circuits using Multisim.
10	Acquire data for monitoring and controlling purpose.

- Perform any Six experiments from above list and two from electives.

Subject Code	Subject Name	Credits
ISL202	**Lab Practice-IV**	**01**

Expt	Title
1	Simulation of batch reactor control using PLC with GUI
2	Simulation of boiler start-up process control using PLC with GUI
3	Simulation of paint manufacturing process using PLC with GUI
4	Simulation of furnace control using PLC with GUI
5	Simulation of Heat exchanger feedback control scheme using DCS
6	Simulation of cascade control scheme using DCS
7	Simulation of feedforward control scheme using DCS
8	Simulation of boiler level control using DCS

- Perform any Six experiments from above list and two from electives.

.Subject Code	Subject Name	Credits
ISS301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Electrical Engineering
- Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.
- Seminar assessment should be based on following points
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
ISD301/ ISD401	**Dissertation (I and II)**	**12/ 15**

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt the solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Program.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai.

Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)