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UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Instrumentation Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

From Co-coordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai, has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's), course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of Studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enable a much-required shift in focus from teacher-centric to learner-centric education. Since the workload estimated is based on the investment of time in learning, not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. **Choice Based Credit and Grading System** were implemented for First Year of Engineering (Undergraduate) from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year of Engineering (Undergraduate) in the academic year 2017-2018 and so on.

Dr. Suresh K. Ukarande
Coordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as a Chairman, Board of Studies in Instrumentation Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Instrumentation Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs and POs of undergraduate program in Instrumentation Engineering are listed below;

Program Educational Objectives (PEOs)

- *Graduates will have successful career in industry or pursue higher studies to meet future challenges of technological development.*
- *Graduates will develop analytical and logical skills that enable them to analyze and design Instrumentation and Control Systems.*
- *Graduates will achieve professional skills to expose themselves by giving an opportunity as an individual as well as team.*
- *Graduates will undertake research activities in emerging multidisciplinary fields.*

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
SE Instrumentation Engineering
University of Mumbai
(With Effect from 2017-18)

Scheme for Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC401	Applied Mathematics – IV	4	-	1	4	-	1	5
ISC402	Transducers –II	4	-	-	4	-	-	4
ISC403	Feedback Control system	4	-	-	4	-	-	4
ISC404	Analytical Instrumentation	3	-	-	3	-	-	3
ISC405	Signal Conditioning Circuit Design	4	-	-	4	-	-	4
ISL401	Application Software Practice	-	4#	-	-	2	-	2
ISL402	Transducer-II Lab Practice	-	2	-	-	1	-	1
ISL403	Feedback Control systems Lab Practice	-	2	-	-	1	-	1
ISL404	Analytical Instrumentation Lab Practice	-	2	-	-	1	-	1
ISL405	Signal Conditioning Circuit Design Lab Practice	-	2	-	-	1	-	1
Total		**19**	**12**	**01**	**19**	**06**	**01**	**26**

Out of four hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Examination Scheme for Semester IV

Course Code	Course Name	Examination Scheme					Total Marks
		Theory		Term Work	Oral	Pract./ Oral	
		End sem Exam (ESE)	Internal Assessment (IA)				
		Max Marks	Max Marks	Max Marks	Max Marks	Max Marks	
ISC401	Applied Mathematics – IV	80	20	25	-	-	125
ISC402	Transducers –II	80	20	-	-	-	100
ISC403	Feedback Control System	80	20	-	-	-	100
ISC404	Analytical Instrumentation	80	20	-	-	-	100
ISC405	Signal Conditioning Circuit Design	80	20	-	-	-	100
ISL401	Application Software Practice	-	-	50	-	25	75
ISL402	Transducer-II Lab Practice	-	-	25	-	25	50
ISL403	Feedback Control Systems Lab Practice	-	-	25	25	-	50
ISL404	Analytical Instrumentation Lab Practice	-	-	25	25		50
ISL405	Signal Conditioning Circuit Design Lab Practice	-	-	25	-	25	50
Total		**400**	**100**	**175**	**50**	**75**	**800**

Note: As per above Examination Scheme, the Minimum marks are as follows –

Max. Marks	Min. marks
80	32
50	20
25	10
20	8

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
ISC401	**Applied Mathematics - IV**	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
		04	--	01	04	--	01	05

Subject Code	**Subject Name**	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Test 1	Test 2	Avg.	End Sem Exam				
ISC401	**Applied Mathematics - IV**	20	20	20	80	25	--	--	125

Subject Code	**Subject Name**	**credits**
ISC401	**Applied Mathematics - IV**	**5**
Course Objectives	1. To develop analytical insight of the student to prepare them for graduate's studies in Instrumentation Engineering 2. To enhance their ability to solve and analyse engineering problem. 3. To provide students with a strong mathematical foundation to acquire the professional competence knowledge and skills.	
Course Outcomes	The students will be able to: 1. Check the given set of vectors is the vector space. 2. Find eigenvalues and eigenvectors of matrix and can diagonalize the matrix. 3. Find the probability distribution, expectation, variance and moments for the given data. 4. Use binomial distribution and Poisson distribution and normal distribution for the data for required probability. 5. Apply Cauchy's integral formula and theorem and residue theorem to solve the integral problem. 6. Find the correlation coefficients and rank correlation coefficients and lines regression between the two data.	

Details of syllabus:

Pre-requisites:

Basics of Complex numbers, Analytic Function, Matrices, Symmetric, Orthogonal and Unitary matrices, Rank, Normal form, Solution of system of linear equations, L. I. & L. D. vectors, Basics of Probability.

Module	Contents	Hrs.	CO mapping
1	**Linear Algebra: Vector Spaces** Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space. Vector spaces over real field, properties of vector spaces over real field, subspaces. The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	06	**CO1**
2	**Linear Algebra: Vector Matrix Theory** Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors Cayley-Hamilton theorem, examples based on verification of Cayley- Hamilton theorem. Similarity of matrices, Diagonalisation of matrices. Functions of square matrix, derogatory and non-derogatory matrices.	10	**CO2**
3	**Random Variables** Discrete & continuous random variables, expectation, Variance, Probability mass function and Density Function, Probability distribution for random variables Moments, Moment Generating Function. Functions of one random variable and their distribution and density functions	10	**CO3**
4	**Probability distribution** Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	6	**CO4**
5	**Complex integration** Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula. Taylor's and Laurent's Series Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem. Applications of Residue theorem to evaluate real Integrals of different types.	12	**CO5**
6	**Correlation & Regression** Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. Lines of Regression.	4	**CO6**

Text Books:

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.

Reference Books:

1. A Text Book of Applied Mathematics Vol. II by P. N. Wartilar & J. N. Wartikar, Pune,

Vidyarthi Griha Prakashan., Pune.

2. Advanced Engineering Mathematics by C. Ray Wylie & Louis Barrett. TMH International Edition.
3. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
4. Theory and Problems of Statistics by Murry R. Spieget, Schaum's outline series-McGraw Hill Publication.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC402	Transducer - II	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC402	Transducer - II	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC402	Transducer II	4
Course Objectives	1. To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure and vacuum measurement, force, torque and power measurement 2. To study electro-chemical sensors and transducers used for density and viscosity measurement	
Course Outcomes	The course would enable the students to: **1.** Explain working principle of strain gauges. **2.** Explain working principle of pressure transducers **3.** Learn transducers for vacuum measurement. **4.** Identify types of flow and use different transducers for flow measurement. **5.** Explain the terminologies of electrochemical sensors and their applications in industry. **6.** Identify sensors for power, density, humidity, pH measurement.	

Details of Syllabus:

Prerequisite: Knowledge of basic measurement techniques

Module	Contents	Hrs.	CO mapping
1	**Strain Measurement** Introduction, types of strain gauge, gauge factor calculation, materials for strain gauge, resistance strain gauge bridges, temperature compensation and applications of strain gauges	04	**CO1**
2	**Pressure Measurement** Pressure scales, units and relations, classification **Primary pressure sensors** - elastic elements like bourdon tube, diaphragm, bellows, properties and selection of elastic materials, Calibration using dead weight tester. **Electrical/Secondary Pressure Transducers**: Capacitive, piezo-electric and its material, variable reluctance, LVDT, strain gauge. **High Pressure Measurement**: Bulk modulus cell, Bridgeman type, capsule. **Differential pressure measurement**: Force balance, motion balance, DP Cell, semiconductor strain gauges.	12	**CO2**

	Pressure measurement using manometer: U-tube types, well type, inclined type, micro manometer		
3	**Vacuum Measurement** Units and relations, McLeod gauge, Pirani gauge, thermocouple gauge, hot and cold cathode ionization gauge, Knudsen gauge	04	**CO3**
4	**Flow Measurement** **Introduction to fluid flow**: properties of fluid, types of fluid, dimensionless numbers, types of fluid flow, continuity equation, Bernoulli's equation, hydrostatic law, Pascal's law, flow through pipes – major and minor losses, flow measurement through open channel-weirs and notches. Materials used for flow sensors, performance of materials, corrosion resistors, erosion, effect of vapour pressure **Head Type**: orifice, venturi, nozzle, pitot tube, annubar, characteristics of head type flow meters. **Variable Area Type**: Rotameter **Velocity and Inertia based flowmeters**: Turbine, electromagnetic, ultrasonic, positive displacement, anemometers, mass flow meters, solid flow measurements	16	**CO4**
5	**Electro-chemical Sensors** Terminology, equations, units. pH measurement-electrodes, measuring circuits, maintenance, temperature compensation, calibration. Conductivity measurement-probes and measuring circuits	04	**CO5**
6	**Miscellaneous Measurement** Force Measurement: strain gauge, LVDT, piezoelectric. Torque: Torsion bar, strain gauge. Power: Dynamometer, instantaneous power measurement, alternator power measurement. Density Measurement – Displacement and float type densitometers Hydrometers, Radiation and Ultrasonic densitometers Viscosity Measurement – Capillary tube viscometer, Efflux type viscometer, Variable area viscometer Introduction to Advances in sensors technology: Smart sensors, MEMS, Nano sensors, Semiconductor sensors, Optical fiber sensors.	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Nakra B.C., Chaudhary K.K., Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
2. Sawhney A.K., Electrical and Electronic Measurement and Instrumentation, Dhanpatrai And Co.
3. Rangan, Mani, Sarma, "Instrumentation Systems and Devices", 2nd ed., Tata Mc Graw Hill.

Reference Books:

1. Doeblin E.D., "Measurement system", Tata Mc Graw Hill., 4th ed, 2003
2. Liptak B.G., "Instrument engineer's handbook – Process measurement and analysis".
3. Douglas M. Considine, "Process Instruments and controls", Handbook, Mc Graw Hill.
4. Curtis Johnson, "Process Control Instrumentation Technology", 8th ed, 2005
5. Andrew Williams, "Applied Instrumentation in process industry", Vol-I, Gulf publishing company.
6. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi publications.
7. David W. Spitzer, "Industrial Flow Measurement", ISA Publication.
8. Sawhney A.K., "Mechanical Measurement", Dhanpatrai And Co.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC403	**Feedback Control System**	4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC403	**Feedback Control System**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC403	**Feedback Control System**	4
Course Objectives	1. The students should be able to learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective. 2. The students should learn how to represent system by transfer function and block diagram reduction method and Mason's gain formula. 3. The students should able to learn time response analysis and demonstrate their knowledge to frequency response. 4. Students can be able to learn stability analysis of system using Root locus, bode plot, polar plot, and Nyquist plot.	
Course Outcomes	Students will be able to - 1. Identify open and closed loop control system 2. Formulate mathematical model for physical systems. 3. Simplify representation of complex systems using reduction techniques. 4. Use standard test signals to identify performance characteristics of first and second-order systems. 5. Apply root locus technique for stability analysis. 6. Analyze performance characteristics of system using Frequency response methods.	

Details of Syllabus:

Prerequisite: Knowledge of Laplace and Inverse Laplace Transform.

Module	Contents	Hrs	CO mapping
1	**Introduction** Definition of control system and related terms, open loop and closed loop system, examples. Development of automatic control systems, classification of control system, examples	4	**CO1**
2	**Mathematical Models of Physical Systems** Definition of physical systems, principle of superposition and homogeneity, linear/non-linear, time variant/time invariant systems. Types of dynamic model, linear elements of electrical and mechanical systems, differential equations of physical systems-mechanical systems, electrical systems – RLC series, parallel circuits, Analogous systems.	8	**CO2**

3	**Transfer Function and Feedback Characteristics** Definition of transfer function, sinusoidal transfer function, transfer functions of physical systems, block diagram algebra, reduction rules, signal flow graphs-definition, construction, properties, and Mason's gain formula, sensitivity of closed loop and open loop systems, effect of feedback, effect of disturbances signals, regenerative feedback with examples	10	**CO3**
4	**Time Response Analysis** Standard test signals, pulse and impulse function, step function, ramp function, parabolic function, sinusoidal function, dynamic response, time response of first order system, time response of second order system, specifications, steady –state error, system types and error constants, design specifications of second order system-desired closed loop pole location and the dominant closed loop pole concept. Time response analysis of electrical RLC circuits – first and second order differential equations, steady-state, and transient response by using Laplace transform.	10	**CO4**
5	**Stability Analysis and Root Locus Method** Concept of stability, definitions, bounded input-bounded output stability, relative stability, necessary and sufficient conditions for stability, Routh's stability criterion, relative stability analysis, root locus technique, applications, concept, construction of root loci, root loci of different systems, electrical RLC circuits, etc.	08	**CO5**
6	**Frequency Response and Stability Analysis** Correlation between time and frequency response, polar plots, Bode plots, Nyquist stability criterion, frequency response specifications, stability analysis using-bode plots, polar plots, definition and significance of gain margin and phase margin, sensitivity analysis in frequency domain, Frequency response and analysis of electrical RLC circuits.	08	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1) Question paper will comprise of 6 questions, each carrying 20 Marks.
2) Total 4 questions need to be solved.
3) Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4) Remaining questions will be mixed in nature.
5) In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books.

1. Nagrath I. G., Gopal M., *Control System Engineering*, New Age International (P) Ltd. Publishers, 2000
2. Kuo Benjamin C., "Automatic Control Systems",6th Edition, Prentice Hall of India, New Delhi, 1993.

Reference Books

1. Gopal M. "Control Systems Principles and Design", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998.
2. Nise Norman S., "Control Systems Engineering", 3rd.Edition, John Wiley and Sons, Inc.-2000.
3. Lewis Paul H., Chang Yang, "Basic Control Systems Engineering", Prentice HallInternational, Inc. 1997.
4. Raymond T. Stefani, Bahram Shahian, late Clement J. Savant and, late Gene H. Hostetter, "Design of Feedback Control Systems", 4th Edition., Oxford, University Press, New Delhi, 2001.
5. Dhanesh N. Manik,"Control System", Cengage Learning India, 1stEdition, 2012.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	**Total**
ISC404	**Analytical Instrumentation**	3	-	-	3	-	-	**3**

Subject Code	Subject Name	Examination Scheme							
		Theory				Term Work	Pract. and Oral	Oral	**Total**
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISC404	**Analytical Instrumentation**	20	20	20	80	-	-	-	**100**

Subject Code	**Subject Name**	**Credits**
ISC404	**Analytical Instrumentation**	**3**
Course Objectives	1. Introduce the basic concept of qualitative and quantitative analysis of a given sample. 2.Study various spectroscopic techniques and its instrumentation. 3.Study the concept of separation science and its applications. 4.Study the concept of radiochemical analysis along with industrial analyzers.	
Course Outcomes	The students will be able to: **1)** Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis. **2)** Discuss the terms, principle, instrumentation, operation and applications of Molecular spectroscopic techniques. **3)** Differentiate between principle, instrumentation and operation of Atomic absorption and emission Spectroscopy. **4)** Explain the various Separation techniques and its instrumentation. **5)** Describe the principle and working of various Radiation detectors. **6)** Discuss the principle and working of various Gas analyzers.	

Details of Syllabus:

Prerequisite: Knowledge of sensors and analog electronic circuits.

Module	**Contents**	**Hrs**	**CO Mapping**

1	**Introduction:** Introduction to analytical Instrumentation. Compare classical analytical techniques with instrumental techniques. **Fundamentals of Spectroscopy:** Nature of Electromagnetic Radiation, Electromagnetic spectrum, Beer Lambert's Law statement and derivation. Deviations from Beer's law. Numerical on EMR and laws of photometry. Interaction of radiation with matter. Instrumentation of spectroscopic analytical system – Radiation sources, Wavelength selectors, Detectors, signal processors and readout modules.	06	CO1
2	**Molecular Spectroscopy:** Molecular Energy levels, correlation of energy levels with transitions. **Electronic transitions and Vibrational transitions** – Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications. Basic principle of Fluorescence, Phosphorescence and Raman Spectroscopy, components and instrumentation of Fluorimeters, Phosphorimeters and Raman spectrometers. **Nuclear/Rotational transitions** – Nuclear Magnetic Resonance (NMR) spectroscopy, basic principle and numerical problems based on NMR principle, instrumentation and constructional details of NMR Spectrometer. Electron Spin Resonance (ESR) Spectroscopy – Basic principle and construction of ESR spectrometer.	10	CO2
3	**Atomic Spectroscopy:** Atomic Energy levels, Atomic absorption spectrometers- components, working and absorption spectra. Atomic Emission spectrometers – components, working and emission spectra, comparison between AAS and AES.	03	CO3
4	**Separation Science:** **Chromatography:** Fundamentals of chromatographic Separations, Classification, Gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram. HPLC – Its principle and instrumentation. **Mass Spectrometers:** Basic principle, components and types of mass spectrometers, sample handling techniques for liquids and solids, resolution and numerical problems based on resolution. Interfacing Gas Chromatography and Mass spectrometry (GCMS).	09	CO4
5	**Radio Chemical Instrumentation:** Basics of Radioactivity, properties of radiations (α, β, γ). Half-life period and numerical problems based on half-life period. Radiation detectors – Ionization chamber, Proportional counter, Geiger Muller counter, Scintillation detector, Semiconductor detectors, Pulse height analyzers.	05	CO5

6	**Industrial Gas Analyzers:** Oxygen, Carbon dioxide(CO2), Carbon monoxide(CO) and NO_2 analyzers, Gas density analyzer.	03	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions will be of 4 to 5 marks.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Willard, Merritt, Dean, Settle, *Instrumental Methods of Analysis*, CBS Publishers & Distributors, New Delhi, 7th Edition.
2. Khandpur R. S., *Handbook of Analytical Instruments*, Tata McGraw–Hill Publications, 3rd Edition.

Reference Books:

1. Skoog, Holler, Niemen, *Thomson Principles of Instrumental Analysis*, Books-Cole Publications, 5th Edition.
2. Ewing Galen W., *Instrumental Methods of Chemical Analysis*, McGraw-Hill Book Company, 5th Edition.
3. Braun Robert D., *Introduction to Instrumental Analysis*, McGraw-Hill Book Company.
4. Sherman R.E., *Analytical Instrumentation*, ISA Publication.
5. B.R.Bairi, Balvindersingh, N.C.Rathod, P.V.Narurkar *Handbook nuclear medical Instruments,* McGraw-Hill Book Company.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISC405	**Signal Conditioning Circuit Design**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		4	-	-	4	-	-	4

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC405	**Signal Conditioning Circuit Design**	20	20	20	80	-	-	-	100

Subject Code	**Subject Name**	**Credits**
ISC405	**Signal Conditioning Circuit Design**	4
Course objectives	1. To give the knowledge about the various components analog signal conditioning. 2. To impart knowledge of design considerations of analog signal conditioning of components. 3. To give the students knowledge about various components digital signal conditioning. 4. To make the students capable to apply knowledge to design various transducer signal conditioning circuits 5. To give the students knowledge about the adjustable power supply design	
Course Outcomes	The students will be able to: 1. Explain principle of analog signal conditioning circuits 2. Design analog signal conditioners 3. Design digital signal conditioners 4. Apply knowledge of signal conditioning circuits to design temperature and pressure transducers signal conditioning 5. Apply knowledge of signal conditioning circuits to design optical and miscellaneous transducers signal conditioning 6. Apply knowledge to design different power supplies.	

Details of Syllabus:

Prerequisite: Knowledge of various sensors and basic electronics.

Module	**Contents**	**Hrs**	**CO mapping**
1	**Principles of Analog Signal Conditioning:** Standard analog signals, Signal Level and bias changes, Linearization, signal conversion, filtering and impedance matching, concept of loading. Passive circuits – Divider Circuits, Bridge circuits (Current, Voltage, Balanced and Unbalanced), RC filters	06	**CO1**
2	**Analog signal conditioners and their design** Practical applications of Op amp based circuits with design:	12	**CO2**

	Differentiators, Integrator, Instrumentation amplifier using 3 op amps Half wave, full wave milivolt rectification, absolute value circuit, Log and antilog amplifier with temperature compensation, active filters, threshold detector, zero crossing detector, window detector, Phase locked loops (PLL), Voltage to Current converter and Current to Voltage Converter, 555 Timer: modes of operation with applications. Guidelines for analog signal conditioning design and design based problems		
3	**Components of Digital Signal Conditioning**: Block diagram of Digital signal conditioning, Characteristics of digital data: digitized value, sampled data system and linearization, sample and hold circuit, peak detector, ADC (Successive Approximation, Flash, Ramp, dual slope) and DAC (R/2R, Weighted resistors) their types and specifications, V to F and F to V converters.	10	**CO3**
4	**Thermal and Pressure Transducers Signal Conditioning Design**: Thermal sensor signal conditioning, design considerations and application for RTD, Thermistor, thermocouple and solid state temperature sensor. Pressure Transducer signal conditioning Design: design considerations and applications for various pressure sensors.	8	**CO4**
5	**Optical and Other Transducer Signal Conditioning Design**: Optical Sensor signal conditioning - photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications. Other sensor signal conditioning: Potentiometer, LVDT, strain gauges, piezoelectric and capacitive transducers	6	**CO5**
6	**Power Supply Design**: Power supply design using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and LM317. Switched Mode Power Supply (SMPS): Block diagram with advantages and disadvantages over conventional power supply.	6	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Ramakant Gayakwad " Op-amp and Linear Integrated Circuits" , PHI Pearson Education.
2. C. D. Johnson, "Process Control Instrumentation Technology (VIII Edition)"

Reference Books:

1. Roy Choudhary, "Linear Integrated Circuits", Wiley Eastern, 1991.
2. Coughlin & Driscoll, "Op-amp and Linear ICs" 6 th Edition, PHI 2002.
3. C. D. Johnson, "Microprocessor Based Process Control" , PHI
4. Sergio Franco, "Design with op-amp analog ICs" McGraw Hill, 1988.
5. Robert G. Seippel, "Transducer Interfacing – Signal Conditioning for Process Control", Prentice Hill.
6. D. E. Pippenger and E. J. Tobanen, "Linear and Interface Circuits Applications", McGraw Hill, 1988.
7. Burr-Brown, "General Catalog", Tucson, Ariz:Burr-Brown, 1979.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL401	**Application Software Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	4*	-	-	2	-	2

* Out of 4 hours 2 hours theory shall be taught to entire class followed by 2hours practical in batches

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL401	**Application Software Practice**	-	-	-	-	50	25	-	75

Subject Code	**Subject Name**	**Credits**
ISL401	**Application Software Practice**	**2**
Course objectives	To study graphical programming language for creating simulation and custom applications that interact with real-world data or signals in fields of science and engineering.	
Course Outcomes	Students will be able to 1. Design logical operations, using Graphical programming language 2. Develop customized virtual instruments and represent them in required format with user friendly graphical programming software for LOOPS like FOR LOOP, WHILE LOOP etc. 3. Discuss Global variable, sequence structure etc. 4. Explain Visa programming 5. Discuss concepts of hardware used 6. Use the data acquisition card or simulated software module and make user interface in the field of engineering.	

Details of Syllabus:

Prerequisite: Knowledge of Mathematics and conversion, LOOPs, switch CASE of any other software like C program, simple concept of proportional process.

Module	**Contents**	**Hrs**	**CO mapping**
1	Graphical Programming Software basics: Components of virtual instrument, creating virtual files and sub-files, data types, debugging techniques.	03	**CO1**
2	Structures- FOR, WHILE, Case structure, Timing, formula nodes and math script, loops- shift registers Auto-indexing concept, feedback nodes. Arrays and clusters, Strings, File I/O.	07	**CO2**
3	Sequence structure -Local and global variables, Express virtual files	02	**CO3**
4	VISA programming, Understanding simple concepts of control using PID block, Plotting data -- graphs and charts,	06	**CO4**

5	Introduction to terms: Measurement system, sampling, calibration, measurement hardware- configuration.	02	**CO5**
6	Data Acquisition cards, Graphical Programming Software modules and tool sets, general applications of Graphical Programming Software.	04	**CO6**

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	To develop a VI to calculate speed, convert degree celcius to Fahrenheit	**CO1**
2	To develop a Sub VI to Perform Half adder and implement Full ADDER using Sub-VI	**CO1**
3	To develop VI using FOR and WHILE loop to add 10 numbers, calculate Factorial of a given number	**CO2**
4	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.	**CO2**
5	To create VI student database using String control and Array and cluster functions.	**CO2**
6	To develop a VI for storing all the points of simulated signal using File I/Os	**CO1**
7	To create VI to simulate traffic light control, stirred tank heater etc. using Sequence structure	**CO3**
8	To create VI to simulate bottle filling plant using Sequence structure.	**CO3**
9	Build a VI to plot circle in XY graph, generate and plot random numbers on chart, different colors in an intensity graph etc with graph, chart properties and options.	**CO4**
10	Applications of Graphical Programming Software in digital electronics—binary to decimal conversion etc.	**CO1,CO2**
11	Applications of Graphical Programming Software in control — simulate first and second order system response, effect of damping factor etc.	**CO4**
12	Applications of Graphical Programming Software in process —tank level/temperature control, alarm annunciator, batch process control etc.	**CO5**
13	Measurement of AC/ DC voltage and current using DAQ cards.	**CO6**
14	Any one Mini project based on the above syllabus	**CO1 -CO6**

Note:

Any other experiments based on syllabus which will help students to understand topic/concept can also be included.
For this course use Graphical Programming Software like Lab View or Open Source Software

Term Work:
Term work shall consist of minimum 10 programs from the list of suggested programs and one Mini-project of your choice or from the list given above.

The distribution of marks for term work shall be as follows:

Laboratory work (Performing Experiments)	: 20 Marks
Laboratory work (programs/ journal)	: 10 Marks
Mini Project	: 15 Marks
Marks Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical /oral Examination:
Practical/Oral examination will be based on entire syllabus.

Reference Books:

1. Robert Bishop, "Learning with LabVIEW ^{TM} 7 express", Pearson Education, 2005.
2. Jovitha Jerome, "Virtual Instrumentation", PHI, 2010.
3. Gupta S, "Virtual Instrumentation Using LabVIEW", Tata McGraw Hill Publishing Company Limited.
4. LabVIEW users manual.
5. National instruments Product catalog.

Website: www.ni.com

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL402	**Transducer - II Lab Practice**	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL402	**Transducer - II Lab Practice**	-	-	-	-	25	25	-	50

Subject Code	**Subject Name**	**credits**
ISL402	**Transducer II Lab Practice**	**1**
Course Objectives	1. To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure. 2. To study electro-chemical sensors and transducers used for density and viscosity measurement 3. To experimentally verify the principle and characteristics of various transducers	
Course Outcomes	Students will be able to - 1. Explain working principle of transducers used for strain measurement. 2. Explain working principle of transducers used pressure measurement. 3. Identify constant head type flow sensors such as orifice, venturi, tube, nozzle and pitot tube and study the applications. 4. Identify variable area and electromagnetic flow meters 5. Demonstrate the performance characteristics of various electrochemical sensors 6. Use miscellaneous sensors for density and viscosity measurement.	

Syllabus same as that of subject ISC402 Transducers-II

List of Laboratory Experiments:

Sr. No.	**Detailed Contents**	**CO mapping**
1.	Strain gauge characteristics and weight measurement	**CO1**
2.	Study use of semiconductor strain gauges for pressure measurement	**CO2**
3.	Study measurement of pressure using bellows, diaphragm, bourdon tube, manometer.	**CO2**
4.	Test and calibration of pressure gauges using dead weight tester.	**CO2**
5.	Measurement of flow using orifice/venturi tube/nozzle/pitot tube.	**CO3**
6.	Measurement of flow using rotameter.	**CO4**

7.	Measurement of flow using electromagnetic flow meter.	**CO4**
8.	Study and characterization of pH meter.	**CO5**
9.	Study and characterization of conductivity meter.	**CO5**
10.	Measurement of Density	**CO6**
11.	Viscosity measurement	**CO6**

Any other experiments based on syllabus which will help students to understand topic/concept.

Term Work:

Term work shall consist of minimum eight experiments.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs/ journal) : 10
Marks Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical /oral Examination:
Practical/Oral examination will be based on entire syllabus.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL403	Feedback Control Systems Lab Practice	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test1	Test2	Avg.					
ISL403	Feedback Control Systems Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL403	Feedback Control Systems Lab Practice	1
Course objectives	1. The students should be able to examine steady-state and frequency response of the Type 0, 1, and 2 systems. 2. The students should be able to examine steady-state and frequency response of first and second order electrical systems. 3. The students should able to examine time response analysis of first and second order systems. 4. Students can be able to inspect stability analysis of system using Root locus, Bode plot, polar plot.	
Course Outcomes	Students will be able to - 1. Plot frequency response of first-order electrical system. 2. Plot time response of second-order electrical system and calculate the steady-state error. 3. Demonstrate their knowledge to obtain the transfer function and transient and steady-state response to test signals such as step, ramp, and parabolic. 4. Understand the effect of damping factor on system response. 5. Inspect the time response specifications of systems by using root-locus. 6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system	

Syllabus same as that of subject ISC403 Feedback Control systems

List of Laboratory Experiments:

Sr. No.	Detailed Contents	CO mapping
1	To plot the effect of time constant on first – order systems response.	CO1
2	To plot the frequency response of first-order system	CO1
3	To plot the time response of second – order systems.	CO2
4	To examine steady state errors for Type 0, 1, 2 systems	CO3
5	To study the block diagram reduction technique by using simulation software.	CO3
6	To interpret the effect of damping factor on the performance of second order system.	CO4

7	To inspect the relative stability of systems by Root-Locus using Simulation Software	**CO5**
8	To inspect the stability of systems by Bode plot using Simulation Software	**CO6**
9	To determine the frequency response specifications from Polar plot of system	**CO6**
10	To inspect the stability of systems by Nyquist plot using Simulation Software	**CO6**

Any other experiments based on syllabus which will help students to understand topic/concept.

Note: Sr. 1 to 4 experiments should be performed using practical kit /bread-board and Sr. 5 to 10 by using simulation software like MATH CAD/MATLAB/SCILAB/OCTAVE or equivalent.

Term Work:

Term work shall consist of Eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral Examination:

Oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	**Total**
ISL404	**Analytical Instrumentation Lab Practice**	-	2	-	-	1	-	**1**

Subject Code	Subject Name	Examination Scheme							
		Theory				Term Work	Pract. and Oral	Oral	**Total**
		Internal Assessment			End sem Exam				
		Test 1	Test 2	Avg					
ISL404	**Analytical Instrumentation Lab Practice**	-	-	-	-	25	-	25	**50**

Subject Code	**Subject Name**	**Credits**
ISL404	**Analytical Instrumentation Lab Practice**	**1**
Course Objectives	1. To make students perform experiments to understand concept and working of various Analytical Instruments. 2. To develop skills in analyzing the sample using various spectroscopic techniques.	
Course Outcomes	The students will be able to: 1) Illustrate the concept and working of various spectrometers using different samples. 2) Analyze the given sample in qualitative and quantitative manner, using spectral techniques. 3) Use specific techniques employed for monitoring different pollutants in air and water. 4) Demonstrate the working of various radiation detectors. 5) Experiment the working of instruments used for clinical analysis, and pharmaceutical laboratories. 6) Illustrate the concept of separation science.	

Syllabus: Same as that of Subject ISC404 Analytical Instrumentation.

List of Laboratory Experiments / Assignments:

Sr. No.	**Detailed Content**	**CO Mapping**
1.	To calculate the refractive index of a given sample using Refractometer.	CO1
2.	To examine the optical density of a given sample using Photoelectric Colorimeter.	CO2

3.	To identify the optical density of a given sample using Balance cell Colorimeter.	CO2
4.	To determine the absorbance and transmittances of a given sample using Single/double beam UV/VIS spectrometer.	CO2
5.	To examine the optical density of given electrophoresis strip using Densitometer.	CO1
6.	To identify the turbidity of given sample using Nephalo-turbidity meter.	CO3
7.	To determine the pH of a given solution using pH meter.	CO5
8.	To determine the conductivity of a given sample using conductivity meter.	CO5
9.	To determine the Na and K concentration in a given sample using Flame Photometer	CO1
10.	To examine the fluorescence phenomenon using Photo-fluorimeter.	CO1
11.	To demonstrate the radioactive radiations using Geiger Muller counter and Scintillation counter.	CO4
12.	To demonstrate the working of Gas chromatograph.	CO6

Any other experiment based on syllabus which will help students to understand topic/concept.

Note:

1. Minimum of eight experiments and two assignments can be performed during the semester for term work and oral examination.
2. Industry visit is advised to understand the concept of Analytical Instrumentation subject.

Practical/Oral Examination:
Oral examination will be based on entire syllabus.

Term work:
Term work shall consist of minimum 08 experiments from the above given list and 02 assignments on the entire syllabus.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Two Assignments and viva on practicals : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
ISL405	Signal Conditioning Circuit Design Lab Practice	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End semExam	Term work	Pract. and Oral	Oral	Total
		Test 1	Test2	Avg.					
ISL405	Signal Conditioning Circuit Design Lab Practice	-	-	-	-	25	25	-	50

Subject Code	Subject Name	credits
ISL405	Signal Conditioning Circuit Design Lab Practice	1
Course objectives	1. To give the knowledge about the various components analog signal conditioning. 2. To impart knowledge of design considerations of analog signal conditioning of components. 3. To give the students knowledge about various components digital signal conditioning. 4. To make the students capable to apply knowledge to design various transducer signal conditioning circuits 5. To give the students knowledge about the adjustable power supply design	
Course Outcomes	The students will be able to 1. Explain working principle of signal conditioning circuits 2. Discuss the design considerations of analog signal conditioners used in transducer signal conditioning. 3. Discuss the design considerations of various digital signal conditioners used in transducer signal conditioning. 4. Apply knowledge of signal conditioning circuits to design temperature and pressure transducers signal conditioning 5. Apply knowledge of signal conditioning circuits to design optical and miscellaneous transducers signal conditioning 6. Apply knowledge to design different power supply.	

Syllabus: same as that of subject ISC405 Signal Conditioning Circuit Design

List of Laboratory Experiments:

Sr. No.	Detailed Content	CO Mapping
1	Demonstrate non-inverting buffer amplifier circuit	CO1

2	Design and demonstrate general signal conditioning circuit to convert sensor output to 0-5 V	CO2
3	Design and demonstrate general signal conditioning circuit to convert sensor output to 4-20 mA	CO2
4	Design and demonstrate signal conditioning circuit for low level signals in micro-volts' region	CO2, CO4
5	Design and demonstrate absolute value circuit for an application	CO2
6	Design and demonstrate signal conditioning circuit for weight measuring system using strain gauge	CO5
7	Design and demonstrate signal conditioning circuit for capacitive transducer	CO5
8	Design and demonstrate second order LPF and HPF for any application	CO2
9	Design signal conditioning circuit for RTD	CO4, CO2
10	Design signal conditioning circuit for optical sensor.	CO2, CO5
11	Design and demonstrate digital to Analog converter circuit	CO3
12	Design and demonstrate I to V and V to I converter circuit	CO2
13	Design and implement Astable and Monostable Multivibrator using IC 555.	CO3
14	Design adjustable voltage regulators using IC723/ LM317	CO6

Any other experiments based on syllabus which will help students to understand topic/ concept.

Term Work:

Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.