Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC23/7/2020
Item No 4.143

UNIVERSITY OF MUMBAI

Syllabus for Approval

1	Title of the Course	S.Y of B.E in Instrumentation Engineering
2	Eligibility for Admission	**After Passing First Year, Engineering as per the Ordinance 0.6242**
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	**New** / Revised REV- 2019 'C' Scheme
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date:

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

AC- 23/7/2020

Item No. 143

UNIVERSITY OF MUMBAI

Bachelor of Engineering
In
Instrumentation Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC23/7/2020
Item No. 143

UNIVERSITY OF MUMBAI

Syllabus for Approval

1	Title of the Course	S.Y of B.E in Instrumentation Engineering
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ **REV- 2019 'C' Scheme**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date:

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

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 Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are 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. Choice based Credit and grading system enables 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 and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
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University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

PREAMBLE

Technical education in our country is progressing rapidly in manifolds. To maintain the quality of education a systematic approach is necessary, which can be obtained by building a strong technical base with the quality. Accreditation provides quality assurance in higher education and recognition to the institution or program, meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially the range of skills and knowledge that a student will have at the time of graduation from the program. Faculty of Science & Technology of the University of Mumbai has taken a lead in incorporating a philosophy of outcome-based education in the process of curriculum development. The earlier syllabus was more focused on providing information and knowledge across various domains, which led to loading of students heavily, in terms of direct contact hours.

I, as a Chairman, Board of Studies in Instrumentation Engineering of University of Mumbai, happy to state here that, the revised curriculum focused on not only providing knowledge content but also on skill-based activities like attitudes, self-learning, and project-based activities. More than 30 senior faculty members from the different affiliated institutes of University of Mumbai were actively participated in this process. They are either Heads of Departments or their senior representatives from the Department of Instrumentation Engineering. The salient features of revised syllabus of Instrumentation Engineering, REV 2019 'C' Scheme are:

1. The overall credits and approach of the curriculum proposed in the present revision are in line with AICTE model curriculum.
2. Course objectives and course outcomes are framed as per NBA guidelines (Bloom's Taxonomy) and are clearly defined for each course.
3. Detailed guidelines are presented to understand the depth and the approach to course to be taught, which will enhance learner's learning process.
4. The credit and grading system enables a learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching.
5. Minimizes the burden of contact hours, total credits of the entire program will be approximately 172. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skillsets.
6. It also focuses on continuous evaluation which will enhance the quality of education.
7. Credit assignment for courses is based on 15 weeks teaching-learning process, however, the content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond the syllabus, etc.
8. The revised curriculum emphasizes on skill-based laboratories and project-based learning by introducing mini projects in the second and third year of programs, which will facilitate self-learning of students.

Dr. Alice Cheeran - Chairperson (BoS in Instrumentation Engineering)
Dr. M. D. Patil - Member
Dr. M. J. Lengare - Member
Dr. Sharad P. Jadhav - Member
Dr. Dipak Gawali – Member

Program Structure for Second Year Instrumentation Engineering

(With Effect from 2020-2021)

Scheme for Semester- III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ISC302	Transducers-I	4		--	4		--	4
ISC303	Analog Electronics	3	--	--	3	--	--	3
ISC304	Digital Electronics	3	--	--	3	--	--	3
ISC305	Electrical Networks and Measurements	4	--	--	4	--	--	4
ISL301	Transducers-I - Lab	--	2	--	--	1	--	1
ISL302	Analog Electronics - Lab	--	2	--	--	1	--	1
ISL303	Digital Electronics - Lab	--	2	--	--	1	--	1
ISL304	Object Oriented Programming Lab	--	3#	--	--	1.5	--	1.5
ISM301	Mini Project – 1 A	--	3$	--	--	1.5	--	1.5
Total		**17**	**12**	**1**	**17**	**06**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR & OR	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg.					
ISC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ISC302	Transducers-I	20	20	20	80	3	--	--	100
ISC303	Analog Electronics	20	20	20	80	3	--	--	100
ISC304	Digital Electronics	20	20	20	80	3	--	--	100
ISC305	Electrical Networks and Measurements	20	20	20	80	3	--	--	100
ISL301	Transducers-I - Lab	--	--	--	--	--	25	25	50
ISL302	Analog Electronics - Lab	--	--	--	--	--	25	25	50
ISL303	Digital Electronics - Lab	--	--	--	--	--	25	25	50
ISL304	Object Oriented Programming Lab	--	--	--	--	--	25	25	50
ISM301	Mini Project – 1 A	--	--	--	--	--	25	25	50
	Total	**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

Out of 3 hours, 1 hours theory shall be taught to entire class and 2 hours practical in batches

Scheme for Semester -IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC401	Engineering Mathematics -IV	3	--	1	3	--	1	4
ISC402	Transducers-II	4	--	--	4	--	--	4
ISC403	Signal Conditioning and Circuit Design	3	--	--	3	--	--	3
ISC404	Feedback Control System	3	--	--	3	--	--	3
ISC405	Control System Components	4	--	--	4	--	--	4
ISL401	Process Control Components - Lab	--	2	--	--	1	--	1
ISL402	Signal Conditioning and Circuit Design - Lab	--	2	--	--	1	--	1
ISL403	Feedback Control System - Lab	--	2	--	--	1	--	1
ISL404	Virtual Instrumentation -Lab	--	3#	--	--	1.5	--	1.5
ISM401	Mini Project – 1 B	--	3$	--	--	1.5	--	1.5
Total		**17**	**12**	**1**	**17**	**6**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR & OR	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ISC401	Engineering Mathematics -IV	20	20	20	80	3	25	--	125
ISC402	Transducers-II	20	20	20	80	3	--	--	100
ISC403	Signal Conditioning and Circuit Design	20	20	20	80	3	--	--	100
ISC404	Feedback Control System	20	20	20	80	3	--	--	100
ISC405	Control System Components	20	20	20	80	3	--	--	100
ISL401	Process Control Components - Lab	--	--	--	--	--	25	25	50
ISL402	Signal Conditioning and Circuit Design - Lab	--	--	--	--	--	25	25	50
ISL403	Feedback Control System - Lab	--	--	--	--	--	25	25	50
ISL404	Virtual Instrumentation- Lab	--	--	--	--	--	25	25	50
ISM401	Mini Project – 1 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

out of 3 hours, 1 hours theory shall be taught to entire class and 2 hours practical in batches

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC301	Engineering Mathematics-III	3	--	1	3	--	1	4

Subject code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC301	Engineering Mathematics-III	20	20	20	80	25	-	-	125

Subject Code	Subject Name	Credits
ISC301	Engineering Mathematics-III	4
Course Objectives	**The course is aimed** 1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications. 2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills 3. To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane. 4. To understand the basics of Linear Algebra and its applications 5. To use concepts of vector calculus to analyze and model engineering problems.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Apply the concept of Laplace transform to solve the real integrals in engineering problems. 2. Apply the concept of inverse Laplace transform of various functions in engineering problems. 3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems. 4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables. 5. Illustrate the use of matrix algebra to solve the engineering problems. 6. Apply the concepts of vector calculus in real life problems.	

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	**CO-1** **7**
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	CO-2 6
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	CO-3 7
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z) Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	CO-4 7

05	**Module: Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	CO-5 6
06	**Module: Vector Differentiation and Integra**l 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	CO-6 6

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4 - 6 students should be assigned a self-learning topic. Students should prepare a presentation/ problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:-

1. Advanced engineering mathematics, H.K. Das, S. Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC302	Transducers-I	4	--	--	4	--	--	4

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC302	Transducers-I	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC302	Transducers-I	4
Course Objectives	**The course is aimed** 1. To introduce the students for the purpose of explaining the measurement systems, errors of measurement. 2. To understand the definition and classification of sensors and transducers based of their principle of operation and their applications in the various industries. 3. To familiarize the student with the identification, classification, construction, working principle and application of various transducers used for displacement, level, temperature, speed and vibration measurement.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Explain the measurement systems, sources errors of measurement. 2. List and compare various standards used for selection of transducers/sensors. 3. Describe the working principles of various displacement sensors and transducers. 4. Interpret and apply different temperature transducers/sensors for industrial applications. 5. Formulate and Design the solutions for given applications using appropriate level sensors and transducer. 6. Apply the techniques of speed and vibration measurement in different industries.	

Prerequisite: Units and standards of measurement, concept of transducers (resistive, piezoelectric, pressure, optical and pyro sensors, etc.), Knowledge of basic measurement.

Details of Syllabus:

Module	Contents	Hrs.	CO Mapping
1.	**Instrumentation System** Units and standards of measurement, Introduction, block diagram, functional elements of measurement system, static and dynamic characteristics of transducer, Measurement and calibration systems- Requirement. sources of errors and their statistical analysis, standards and calibration.	**04**	**CO1**
2.	**Sensor and Transducer:** Definition, working principle, classification (active, passive, primary, secondary, mechanical, electrical, analog, digital), selection criteria, transducer specifications, test condition and operating conditions.	**04**	**CO2**
3.	**Displacement transducers:** **Resistive type transducers:** potentiometer (linear and logarithmic), piezo-resistive effect. **Inductive type transducers:** LVDT, RVDT (transfer function, linearity, sensitivity, source, frequency dependence, phase null, and signal conditioning). **Capacitive type transducers:** Linear and rotary (with change in distance between plates, change in dielectric constant and change in overlapping area) **Digital transducer:** translational and rotary encoders (absolute position and incremental position encoders). **Proximity sensors:** inductive, capacitive, optical, ultrasonic, hall-effect and magnetic. **Pneumatic transducer:** flapper- nozzle transducer**.** Comparative study for Displacement Transducers with applications, and materials for capacitive, resistive, inductive and ultrasonic transducers**.**	**14**	**CO3**
4.	**Temperature transducers:** Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of mechanical temperature Sensors (thermometer, thermostat). **Resistance temperature detector (RTD):** Principle, types, Configurations, construction and working of RTD, Material for RTD, Signal Measurement techniques for RTD, Comparative Response curves for RTD, 2 wire, 3wire and 4 wire RTD Element, Lead wire Compensation in RTD, self-heating effect, Specifications, advantages, disadvantages and applications of RTD and sums. **Thermistors**: Principle, types (NTC and PTC), characteristics, Construction and working of Thermistor, Materials, specifications of Thermistor, applications and sums. **Thermocouples:** Principle, thermoelectric effect, See beck effect, Peltier effect, laws of thermocouple, types of thermocouple with Characteristic	**14**	**CO4**

	curve, thermocouple table, Sensitivity, constructional Features of Thermocouples., Thermo couple specifications, electrical noise and noise reduction techniques, cold junction Compensation method, thermopile, thermocouple emf measurement method, Thermo well Material of construction and its specifications and sums. **Pyrometers:** Principle, Construction and working of Radiation and optical pyrometers and its Applications. Comparative study for Temperature Transducers.		
5.	**Level Transducers:** working principle, types, materials, design criterion: float, displacers, bubbler, and DP- cell, ultrasonic, capacitive, microwave, radar, radioactive type, laser type transducers, level gages, resistance, thermal, TDR/ PDS type (Time domain reflectometry/ Phase difference sensors), solid level detectors, fiber optic level detectors, Level switches. Comparative study for Level Transducers.	**08**	**CO5**
6.	**Speed and Vibration Measurement:** stroboscopes, toothed rotor, eddy current, electromagnetic transducers (moving coil, moving magnet), AC and DC tachometers: Hall Effect proximity pickup, photoelectric, photo-reflective, pulse counting method. Seismic, LVDT, piezoelectric.	**08**	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be a 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. B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments - 632 page.
2. Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003) - 344 pages.
3. A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996 -
4. Rangan, Mani, Sharma.Instrumentation systems and Devices, 2nd Ed.,Tata McGraw Hill.
5. D.V.S. Murthi, “Instrumentation and Measurement Principles”, PHI, New Delhi, Second ed. 2003.

Reference Books:

1. Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2. Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003.
3. Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
4. Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
5. S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
6. B.E. Jones, Instrument Technology.
7. Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
8. Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC303	Analog Electronics	3	-	-	3	-	-	3

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.					
ISC303	Analog Electronics	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC303	Analog Electronics	3
Course Objectives	**The course is aimed** 1. To familiarize the student with basic electronic devices and circuits. 2. To analyze the DC biasing circuits, low and high frequency AC analysis of various electronic devices. 3. To introduce the students with basic construction and operation of differential and multistage amplifier. 4. To design different types voltage regulators and discuss the power amplifiers. 5. To employ various devices for industrial and consumer electronics.	
Course Outcomes	**On successful completion of course learner/student will be able to:** **1.** Demonstrate the application of diodes and formulate the DC analysis of BJT. **2.** Formulate and attribute BJT biasing techniques and its frequency response. **3.** Apply the basic construction and characteristics of FET to analyze the DC and AC circuits. **4.** Utilize the basic construction and characteristics of MOSFET to formulate the DC and AC circuits. **5.** Describe the Differential and multistage amplifier and its stages in detail. **6.** Discuss the power amplifiers and design power supply using different IC	

Pre-requisite: Introduction of PN junction

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1.	**Bipolar Junction Transistor:** Introduction to Diodes and its applications as Clipper and Clamper, Bipolar Junction Transistor, Device structure and physical operation, characteristics, the BJT as an amplifier and a switch, DC Analysis of BJT Circuits, Biasing BJT Amplifier Circuits, Stability Analysis.	**08**	**CO1**
2.	**BJT AC Analysis:** Amplification in AC domain, BJT transistor modelling, The r_e Transistor model, Hybrid equivalent model for CE configuration, Derivation of parameters trans-conductance, input resistances, voltage gain and current gain. Single stage BJT amplifiers CE configuration (with and without feedback), Small Signal equivalent circuit, frequency response of a CE amplifier, low frequency response, high frequency response.	**08**	**CO2**
3.	**Field effect Transistors:** Introduction to JFET, Types, Construction, Operation, Static Characteristics, Pinch off voltage, FET Volt-Ampere characteristics, FET Configurations (CS/CD/CG) and their Comparison. Biasing of FET. FET as an amplifier and its analysis (CS) and its frequency response.	**06**	**CO3**
4.	**MOS Field effect Transistors:** Introduction to MOSFET as basic element in VLSI, Device structure and physical operation, current – voltage characteristics, the MOSFET as an amplifier and a switch, DC Analysis of MOSFET Circuits, Biasing MOSFET Amplifier Circuits, frequency response of a CS amplifier, low frequency response.	**06**	**CO4**
5.	**Differential and Multistage Amplifiers:** Preview, the Differential Amplifier, Basic BJT Differential Pair (SIBO, SIUO, DIBO, DIUO), Capacitive coupled and Direct coupled multistage amplifier. Differential Amplifier with Active Load, Gain Stage and Simple Output Stage, Diff-Amp Frequency Response.	**04**	**CO5**
6.	**Power Amplifier:** Definition and amplifier types, Series fed class A amplifier, Transformer coupled class A amplifier, Class B amplifier operation and circuits, Amplifier distortion, Push Pull Amplifier, **Power supply design** using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and 317. Switched Mode Power Supply (SMPS) – Block diagram with advantages and disadvantages over conventional power supply.	**07**	**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. Robert L. Boylestad, Louis Nashelsky, *"Electronic Devices and Circuit Theory",* PHI publishers, 2004
2. Thomas L. Floyd," Electronic Devices", Pearson 2015.
3. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar , "*Microelectronic Circuits,: Theory and Applications",* OUP, 2013
4. D. A. Neamen, "Micro *Electronic Circuit Analysis and Design*", McGraw-Hill, New Delhi, 2010.

Reference Books:

1. J. Millman and C. C. Halkias*, "Integrated Electronics: Analog and Digital Circuits and Systems",* Tata McGraw-Hill Publishing Company, 1988.
2. D. A. Bell, "*Electronic Devices and Circuits*", OUP, India, 2010.
3. T. F. Boghart, J. S. Beasley and G. Rico, "*Electronic Devices and Circuits*", Pearson Education, 2004.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC304	Digital Electronics	3	-	-	3	-	-	3

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.					
ISC304	Digital Electronics	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC304	Digital Electronics	3
Course Objectives	**The course is aimed** 1. To provide an understanding of the principles of digital electronics and use of number systems. 2. To give knowledge about combinational circuits. 3. To describe working and design methods of sequential circuits. 4. To familiarize with the basics of asynchronous sequential circuits and design techniques. 5. To provide understanding of memory devices and state machines. 6. To make the students understand basic logic families and their applications.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Represent numerical values in various number systems and perform number conversions between different number systems. 2. Analyze and design, digital combinational circuits using logic gates with IEEE/ANSI standard symbols. 3. Formulate and design sequential logic circuits. 4. Formulate and design asynchronous sequential logic circuits. 5. Explain nomenclature and technology in memory devices. 6. Apply the concept of logic families and their application to design the digital system.	

Pre-requisite: Knowledge of number systems and Boolean logic.

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1.	**Binary number system:** Binary Arithmetic, Binary codes: Weighted, BCD, 8421, Gray code, Excess 3 code, ASCII, Error detecting code. **Reduction methods:** Boolean laws, De-Morgan's Theorem, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Karnaugh map Minimization, Don't care conditions.	**06**	**CO1**
2.	**Design of combinational logic circuits:** Adders, Subtractors, Code conversion, Parity checker, Magnitude comparators, BCD adder, Multiplexer, Demultiplexer, Encoder and Decoder. Implementation of combinational logic circuits using Multiplexer and Demultiplexer. Hazards in logic circuits and its elimination.	**10**	**CO2**
3.	**Sequential logic circuits :** Flip flops- SR, D and Master slave JK, T, Realization of one flip flop using other flip flops, Asynchronous & Synchronous counters, Modulo n counter, shift registers.	**06**	**CO3**
4.	**Asynchronous sequential circuits:** Circuit Design – primitive state / flow table, Minimization of primitive state table, state assignment, Excitation table, Excitation map, cycles.	**05**	**CO4**
5.	**Logic families:** Basics of digital integrated circuits, basic operational characteristics and parameters. TTL, Schottky clamped TTL, tri-state gate ECL, IIL, MOS devices CMOS comparison of logic families. PMOS, NMOS and E2 CMOS, BiCMOS**.**	**06**	**CO5**
6.	**Memory and programmable logic devices:** PROM / EPROM / EEPROM / EAPROM Programmable Logic Devices – Programmable Logic Array (PLA), Programmable Array Logic (PAL), Introduction to Complex Programmable Logic Device (CPLD), Field Programmable Gate Arrays (FPGA).	**06**	**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. M. Morris Mano, *"Digital Design",* Prentice Hall of India, 2003.
2. John .M Yarbrough, *"Digital Logic Applications and Design",* Thomson-Vikas publishing house, 2002.
3. Barry B. Brey, *"The Intel Microprocessors*", Pearson/Prentice Hall, 2006.
4. B. Ram, *"Fundamentals of Microprocessors and Microcontrollers",* Dhanpat Rai Publications, 2004.

References Books:

1. Charles H. Roth., *"Fundamentals of Logic Design",* Thomson Publication Company, 2003.
2. Donald P. Leach and Albert Paul Malvino*, "Digital Principles and Applications",* Tata McGraw Hill Publishing Company Limited, 2003.
3. R. P. Jain, *"Modern Digital Electronics",* Tata McGraw–Hill publishing company limited, 2003.
4. Thomas L. Floyd, *"Digital Fundamentals",* Pearson Education, 2003.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC305	Electrical Networks and Measurements	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.					
ISC305	Electrical Networks and Measurements	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC305	Electrical Networks and Measurements	4
Course Objectives	**The course is aimed** 1. To introduce the concept of circuit elements lumped circuits, circuit laws and reduction. 2. To introduce the concept of circuit elements and analyze DC and AC circuits using various theorems. 3. To analyze the transient response of series and parallel A.C. circuits. 4. To analyze two port model of circuit and evaluate its parameters. 5. To synthesize the circuits using different techniques. 6. To demonstrate basic analog and digital Instruments. 7. To identify the various techniques for measurement of R-L-C.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Analyze AC and DC circuits using different theorems. 2. Evaluate transient and steady-state the parameters of passive electrical networks. 3. Analyze network using poles and zeros and determine their parameters like Z, Y, and ABCD. 4. Synthesize the networks using canonical forms. 5. Demonstrate construction and working principle and applications of analog and digital instruments. 6. Formulate electrical bridges and evaluate electrical parameter like R, L, C.	

Prerequisite: Analysis of DC networks for independent sources, mesh, node analysis, network theorems, and fundamentals of RLC networks.

Detailed Syllabus

Module	Contents	Hrs.	CO mapping
1.	**Network Theorems** Analysis of networks with dependent sources: mesh analysis, nodal analysis, super mesh and super node concept, source transformation technique, superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem. Solution of networks with AC sources, Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention).	**12**	**CO1**
2.	**Transient Analysis** Initial Conditions in Elements, Solution of a First order and Second order differential equations, Transients in R-L, R-C and RLC Circuits.	**08**	**CO2**
3.	**Network Functions and Two-Port parameters** Network functions for one port and two port networks, driving point and transfer functions, ladder network, poles and zeros of network functions, time domain behaviour from pole-zero plot. Two-Port parameters, Open circuit, Short circuit, transmission and hybrid parameters, relationship between parameter sets, reciprocity and symmetry conditions, parallel connection of two port networks.	**08**	**CO3**
4.	**Fundamentals of Network Synthesis.** Causality and stability, Hurwitz polynomials, positive real functions, synthesis of one port networks with two kinds of elements. Properties and synthesis of L-C, R-C, R-L driving point impedances, synthesis of R-L-C function.	**10**	**CO4**
5.	**Analog & Digital Meters** D'Arsonaval galvanometers, PMMC and PMMI instruments. Shunts and multipliers, Construction and working principle of: ammeters, voltmeters, ohmmeters, power factor meter, energy meter, Q meters, Analog multimeters. Electronic Voltmeters, Digital Voltmeter and digital multimeter. CRO, Measurement of phase and frequency.	**07**	**CO5**
6.	**Measurement of R, L, C** Measurement of medium, low and high resistance, Megger AC bridges, measurement of self and mutual inductances (Maxwell and Hay Bridges). Measurement of capacitance (Schering Bridge). Derivations and numerical related to all bridges.	**07**	**CO6**

Internal Assessment Test:

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. Kuo Franklin F., *"Network analysis and synthesis",* Wiley International, 1962.
2. Van Valkenburg M.E., *"Network analysis",* Eastern Economy Edition, 1983.
3. A. K. Sawhney, Puneet Sawhney, *"A course in Electrical and Electronic Measurement and Instrumentation",* Dhanpat Rai and Co. Rai, 1996.

Reference Books:

1. Hayt William, Kemmerly Jr.Jack E., *"Engineering circuit Analysis",* Tata McGraw Hill, 2002.
2. Edminister Joseph A., Nahvi Mohmood, *"Electric Circuits",* Tata McGraw Hill, 1999.
3. Shyammohan Sudhakar, *"Circuits and Networks Analysis and Synthesis",* Tata McGraw Hill, 2000.
4. Ravish Singh, " Electrical Networks Analysis and Synthesis", Mc-Graw Hill

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL301	Transducers-I - Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL301	Transducers-I - Lab	--	--	--	--	25	25	-	50

Subject Code	Subject Name	Credits
ISL301	Transducers-I –Lab	1
Course Objectives	**The course is aimed** 1. To make students understand the Identification, construction, working principle of various transducers used for Displacement measurement, Temperature measurement, Level measurement and miscellaneous measurement. 2. To experimentally verify the principle and characteristics of various transducers.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Demonstrate various measurement techniques and measuring instruments. 2. Demonstrate Flapper Nozzle system. 3. Plot and validate the performance characteristics of displacement transducers 4. Validate the characteristics of various temperature transducers. 5. Describe the construction and operation of various level transducers. 6. Demonstrate the performance characteristics of miscellaneous	

Syllabus: Same as that of Subject ISC302 Transducers-I

List of Experiments:

Sr. No	Contents	CO Mapping
1.	Demonstrate the basic measurements techniques and Measuring Instruments.	CO1
2.	Plot response curve for Flapper Nozzle system and validate the results with stand values.	CO2
3.	Plot and validate the LVDT characteristics.	CO3

4.	Test and evaluate distance using ultrasound transducer.	CO3
5.	Measure and verify the given displacement using Potentiometer.	CO3
6.	Plot and validate the characteristics of RTD	CO4
7.	Draw and validate the characteristics of various Thermocouples.	CO4
8.	Draw and validate the characteristics of Thermistors.	CO4
9.	Test and compare temperature measurement with and without Thermo-well.	CO4
10.	Perform and validate Liquid Level Measurement using DP Cell	CO5
11.	Plot and validate performance characteristics of capacitive level sensor.	CO5
12.	Perform and distinguish Liquid Level Measurement using Tubular Level Gauge and ultra-sonic sensor.	CO5
13.	Plot the static characteristics of different proximity sensors.	CO6
14.	Demonstrate the Humidity measurement.	CO6

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

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on ISC 302 Transducer-I

Term Work:

1) Minimum of **Ten** experiments covering all cos can be conducted during the semester for term work and practical examination.
2) Assignments based on syllabus which will help students to understand the Topic can be given during the semester as a support to Evaluate Term work.

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL302	Analog Electronics-Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL302	Analog Electronics- Lab	--	--	--	--	25	25	--	50

Subject Code	Subject Name	Credits
ISL302	Analog Electronics-Lab	1
Course Objectives	**The course is aimed** 1. To familiarize the student with basic electronic devices and circuits. 2. To modal and analyze applications of diodes, bipolar and MOSFET, DC biasing circuits, AC analysis and low and high Frequency response, 3. To experiment with differential and multistage amplifier. 4. To design different types of power supply.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. DC analysis of BJT. 2. Analyze BJT biasing techniques and frequency response. 3. Plot and evaluate parameters using FET characteristics. 4. Draw and evaluate parameters of MOSFET characteristics. 5. Implement and simulate Differential amplifier configuration 6. Design of power supply.	

Syllabus: Same as that of Subject ISC303 Analog Electronics.

List of Experiments:

Sr. No	Contents	CO mapping
1.	Design the Diode circuit as Clipper and Clamper.	CO1
2.	Verify the input -output characteristics of BJT in CE configuration.	CO1
3.	Implementation of a biasing circuit for BJT and estimate the parameters.	CO1
4.	Plot and validate the frequency response of BJT amplifier.	CO2
5.	Analyse the JFET circuit and validate its transfer characteristics.	CO3
6.	Plot and validate the frequency response of FET amplifier.	CO3
7.	Analyse the MOSFET circuit and validate its transfer characteristics.	CO4
8.	Plot the frequency response of MOSFET amplifier	CO4
9.	Simulate the multistage amplifier and analyse its frequency response with the help of simulation software.	CO5
10.	Simulate the differential amplifier and analyse its frequency response with the help of simulation software.	CO5
11.	Simulate the class A power amplifier and analyse with the help of simulation software.	CO6
12.	Design of fixed voltage regulator using adjustable regulator IC.	CO6

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

Practical/Oral Examination:
Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on **ISC303 Analog Electronics.**.

Term Work:

Term work shall consist of minimum 08 Experiments covering all COs and any 02 practical should be verified with simulation software**.**

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL303	Digital Electronics- Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL303	Digital Electronics- Lab	--	--	--	--	25	25	--	50

Subject Code	Subject Name	Credits
ISL303	Digital Electronics- Lab	1
Course Objectives	**The course is aimed** 1. To provide an understanding of the principles of digital electronics and use of number systems. 2. To give knowledge about combinational circuits, 3. To describe working and design methods of sequential circuits. 4. To familiarize with the basics of asynchronous sequential circuits and design techniques. 5. To provide understanding of memory devices and state machines. 6. To make the students understand basic logic families and their applications.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Demonstrate numerical values in various number systems and perform number conversions between different number systems. 2. Exemplify operation of logic gates using IEEE/ANSI standard symbols. Analyze and design, digital combinational circuits. 3. Design and validate sequential logic circuits. 4. Design and verify asynchronous sequential logic circuits. 5. Demonstrate nomenclature and technology in memory devices. 6. Analyze logic families and their application to design the digital system.	

Syllabus: Same as that of Subject ISC304 Digital Electronics.

List of Experiments:

Sr. No	Detailed Contents	CO Mapping
1	Implement conversion of Gray/Binary code.	**CO1**
2	Truth table verification and implementation of all gates using Universal gates.	**CO2**
3	Implementation of half/ full adder/ Subtractor.	**CO2**
4	Implementation of magnitude comparator.	**CO3**
5	Realise full adder using 2:1 Multiplexer.	**CO3**
6	Realise full Subtractor using 2:1 Multiplexer.	**CO3**
7	Implementation of various flip-flops.	**CO4**
8	Design and implement RS flip flop into other flip flops.	**CO4**
9	Design and implement JK flip flop into other flip flops.	**CO4**
10	Design and implement modulo-n counter.	**CO5**
11	Design and implement ring counter.	**CO5**
12	Design and implement universal shift register.	**CO5**
13	Implement BCD to seven segments display.	**CO6**
14	Design finite state machine for a digital lock	**CO6**

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

Practical/Oral Examination:
Practical Examination will be based on performing one Experiment in the Laboratory from the list of Experiments given in the syllabus & the Oral Examination will be based on **ISC304 Digital Electronics.**.

Term Work:

Term work shall consist of minimum 08 Experiments covering all COs and any 02 practical should be verified with simulation software**.**

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 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			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL304	Object Oriented Programming - Lab	-	3#	-	-	1.5	-	1.5

Subject Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
ISL304	Object Oriented Programming- Lab	-	-	-	-	25	25	-	50

out of 3 hours, 1 hours theory shall be taught to entire class and 2 hours practical in batches.

Subject Code	Subject Name	Credits
ISL304	Object Oriented Programming- Lab	1.5
Course Objectives	**The course is aimed** 1. To learn the object-oriented programming concepts 2. To study various java programming constructs like multithreading, exception handling, packages etc. 3. To explain components of GUI based programming	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Apply fundamental programming constructs. 2. Illustrate the concept of packages, classes and objects. 3. Elaborate the concept of strings arrays and vectors. 4. Implement the concept of inheritance and interfaces. 5. Implement the notion of exception handling and multithreading. 6. Develop GUI based application	

Prerequisite: Structured Programming Approach

Details of Syllabus:

Module	Contents	Hrs.	CO Mapping
1	**Introduction to Object Oriented Programming** **OO Concepts:** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. **Features of Java, JVM** **Basic Constructs/Notions:** Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	**02**	**CO1**
2	**Classes, Object and Packages** Class, Object, Method. Constructor, Static members and methods Passing and returning Objects Method Overloading, Packages in Java, creating user defined packages, access specifiers.	**03**	**CO2**
3	**Array, String and Vector** Arrays, Strings, String Buffer, Wrapper classes, Vector	**02**	**CO3**
4	**Inheritance and Interface** Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, Implementing interfaces, extending interfaces	**02**	**CO4**
5	**Exception Handling and Multithreading** Error vs Exception, try, catch, finally, throw, throws, creating own exception, Thread lifecycle, Thread class methods, creating threads, Synchronization	**02**	**CO5**
6	**GUI programming in JAVA** **Event Handling:** Event classes and event listener **Introduction to AWT:** Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Checkbox and Radio Buttons.	**02**	**CO6**

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. Dietal and Dietal, 'Java: How to Program', 8/e, PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.

List of Experiments/ Assignments:

Sr. No.	Detailed Contents	CO mapping
1.	Program on various ways to accept data through keyboard and unsigned right shift operator.	**CO1**
2.	Program on branching, looping, labelled break and labelled continue.	**CO1**
3.	Program to create class with members and methods, accept and display details for single object.	**CO2**
4.	Program on constructor and constructor overloading	**CO2**
5.	Program on method overloading	**CO2**
6.	Program on passing object as argument and returning object	**CO2**
7.	Program on creating user defined package	**CO2**
8.	Program on 1D array	**CO3**
9.	Program on 2D array	**CO3**
10.	Program on String	**CO3**
11.	Program on String Buffer	**CO3**
12.	Program on Vector	**CO3**
13.	Program on single and multilevel inheritance (Use super keyword)	**CO4**
14.	Program on abstract class	**CO4**
15.	Program on interface demonstrating concept of multiple inheritance	**CO4**
16.	Program on dynamic method dispatch using base class and interface reference.	**CO4**
17.	Program to demonstrate try, catch, throw, throws and finally.	**CO5**
18.	Program to demonstrate user defined exception	**CO5**
19.	Program on multithreading	**CO5**
20.	Program on concept of synchronization	**CO5**
21.	Program to create GUI application without event handling using AWT controls	**CO6**
22.	Program to create GUI application without event handling using AWT controls	**CO6**
23.	Program to create GUI application without event handling using AWT controls	**CO6**
24.	Program to create GUI application with event handling using AWT controls	**CO6**
25.	Mini Project based on content of the syllabus. (Group of 2-3 students)	**CO1-CO6**

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

Practical and Oral Examination:

Practical and Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 20 programs from the list of suggested programs, two assignments covering whole syllabus and one Mini-project of your choice.

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

Laboratory work (Performing Experiments): 10 Marks

Laboratory work (programs/ journal) : 05 Marks

Mini Project : 05 Marks

Marks Attendance : 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISM301	Mini Project – 1 A	--	3[$]	--	--	1.5	--	1.5

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.					
ISM301	Mini Project – 1 A	--	--	--	--	25	--	25	50

Subject Code	Subject Name	Credits
ISM301	Mini Project – 1 A	1.5
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life long learning. 9. Demonstrate project management principles during project work.	

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

In this case in one semester students' group shall complete project in all aspects including,

- Identification of need/problem
- Proposed final solution
- Procurement of components/systems
- Building prototype and testing

Two reviews will be conducted for continuous assessment,

- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

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SEM IV

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC401	Engineering Mathematics-IV	3	--	1	3	--	1	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.					
ISC401	Engineering Mathematics-IV	20	20	20	80	25	--	--	125

Subject Code	Subject Name	Credits
ISC401	Applied Mathematics-IV	4
Course Objectives	**The course is aimed** 1. To study the line and contour integrals and expansion of complex valued function in a power series. 2. To understand the basic techniques of statistics for data analysis, Machine learning and AI. 3. To study the probability distributions and expectations. 4. To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems. 5. To familiarize with the concepts of Quadratic forms and Singular value decomposition. 6. To learn the concepts of Calculus of Variations.	
Course Outcomes	**On successful completion of course learner/student will be able to**: 1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. 2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI. 3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. 4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems. 5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications. 6. Find the extremals of the functional using the concept of Calculus of variation.	

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Module	Detailed Contents	Hrs.
01	**Module: Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations, Z- Transform.	CO-1 7
02	**Module: Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	CO-2 6
03	**Module: Probability Distributions** 2.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	CO-3 7
04	**Module: Linear Algebra: Vector Spaces:-** 4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence and Independence, QR decomposition.	CO-4 6

05	**Module: Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	CO-5 7
06	**Module: Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-** Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action, Several dependent variables.	CO-6 6

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5 Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
8..Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

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

Subject 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	Transducers-II	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Credits
ISC402	Transducers-II	4
Course Objectives	**The course is aimed** 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	**On successful completion of course learner/student will be able to:** 1. Explain working principle of strain gauges. 2. Demonstrate working principle of pressure transducers 3. Illustrate basic fundamentals of flow transducers. 4. List and identify flow transducers for flow measurement. 5. Describe the terminologies of electrochemical sensors and their applications in industry. 6. Select sensors for force measurement, density, humidity, pH measurement.	

Prerequisite: Units and standards of measurement, concept of transducers (resistive, piezoelectric, pressure, etc.), Knowledge of basic measurement.

Details of Syllabus:

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 and its sums.	**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. **Differential pressure measurement**: Materials, construction and working of DP Cell. **Pressure measurement using manometer**: U-tube types, well type, inclined type, micro manometer and its sums. **Vacuum Measurement** Units and relations, McLeod gauge, Pirani gauge, thermocouple gauge	**14**	**CO2**
3.	**Fundamentals of flow measurement** 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	**08**	**CO3**
4.	**Flow Measurement** **Head Type**: Orifice, Venturi, Nozzle, Pitot tube, Annubar, characteristics of head type flow meters and its sums. **Variable Area Type**: Rotameter **Velocity and Inertia based flowmeters**: Turbine, Electromagnetic, Ultrasonic, Positive displacement, Anemometers, **Mass flow measurement**: Coriolis and Vortex flow meter **Solid flow measurements.**	**14**	**CO4**
5.	**Electro-chemical Sensors:** Terminology, equations, units. pH measurement-electrodes, measuring circuits, maintenance, temperature compensation, calibration. Conductivity measurement-probes and measuring circuits	**06**	**CO5**
6.	**Force Measurement:** Strain gauge, LVDT, piezoelectric. Torque: Torsion bar, strain gauge. Density Measurement – Displacement and float type densitometers Hydrometers, Radiation and Ultrasonic densitometers Viscosity Measurement – Capillary tube viscometer, Efflux type viscometer, Variable area viscometer	**06**	**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.
6. The weightage for numerical should be of maximum 25%.

Text Books:

1. Nakra B.C., Chaudhary K.K., Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
2. Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2nd edition (2003) - 344 pages.
3. Sawhney A.K., Electrical and Electronic Measurement and Instrumentation, Dhanpatrai And Co.
4. 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	Signal Conditioning Circuit Design	3	--	--	3	--	--	3

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	Signal Conditioning Circuit Design	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Credits
ISC403	Signal Conditioning Circuit Design	3
Course Objectives	**The course is aimed** 1. To introduce the students the basic properties of OpAmp, analysis and design of electronic circuits using OpAmp. 2. To give the knowledge about the various components analog signal conditioning. 3. To impart knowledge of design considerations of analog signal conditioning of components. 4. To give the students knowledge about various components digital signal conditioning. 5. To make the students capable to apply knowledge to design various transducer signal conditioning circuits.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Describe op-amp parameters and types and derivation of operational amplifiers. 2. Design the various operation amplifier circuits for linear. 3. Formulate and design non-linear applications of op-amp. 4. Design of analog signal conditioning circuits. 5. Design of Digital signal conditioning circuits. 6. Apply signal conditioning concepts to design various transducers signal conditioning circuits.	

Prerequisite: Knowledge of various sensors and basic electronics.

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1.	**Fundamentals of Operational Amplifier** Block diagram of Operational amplifier, Ideal Op Amp, characteristics of op-amp, op-amp parameters, Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier.	**04**	**CO1**
2.	**Linear Applications of Operational Amplifier** Amplifiers: Adder, subtractor, difference amplifier, Integrator, and practical integrator, , Differentiator and practical differentiator, Current to Voltage converter, voltage to current converter (grounded and floating load), Instrumentation amplifier with three Op-amps, and application of Op-Amp in Transducer Measurement System.	**08**	**CO2**
3.	**Nonlinear Applications of Operational Amplifier** Comparator and its characteristics, Zero Crossing Detector (ZCD), Schmitt trigger, window detector, Sample and Hold Circuit, Peak to Peak Detector, Precision half wave and full wave rectifiers, Sine wave oscillators using op-amp.: Barkhausen criteria, Wein bridge oscillator, RC phase shift oscillator. Waveform Generators: Square wave generator and triangular wave generator, Design and applications of Multivibrators: Astable, Monostable using IC 555, PLL.	**08**	**CO3**
4.	**Analog Signal Conditioning** Standard analog signals, Signal Level and bias changes, Linearization, conversion, filtering and impedance matching, concept of loading. Voltage divider, Wheatstone bridge circuits, Active filter. Guidelines for analog signal conditioning design and design based problems.	**04**	**CO4**
5.	**Digital Signal Conditioning** Converters – ADCs and their different types, DACs and their different types, V to F and F to V converters. Characteristics of digital data – digitized value, sampled data system and linearization.	**07**	**CO5**
6.	**Transducer Signal Conditioning** Signal Conditioning of Temperature, Pressure, optical, strain gauges, Displacement and piezoelectric transducers signal conditioning. Data logger circuit, Data acquisition system (Block Diagram Level)	**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. Ramakant Gaikwad, *"Op-amp & Linear ICs",* PHI Pearson Education, 2003.
2. C. D. Johnson, *"Process Control Instrumentation Technology"*, 2016.
3. D. E. Pippenger and E. J. Tobanen, *"Linear and Interface Circuits Applications",* McGraw Hill, 1988.
4. William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson.

Reference Books:

1. Roy Choudhary, *"Linear Integrated Circuits",* Wiley Eastern, 1991.
2. Coughlin & Driscoll, *"Op-amp and Linear ICs"* 6th Edition, PHI 2002.
3. Sergio Franco, *"Design with op-amp analog ICs"* McGraw Hill, 1988.
4. Robert G. Seippel, *"Transducer Interfacing – Signal Conditioning for Process Control",* Prentice Hill, 2000.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC404	Feedback Control System	3	--	--	3	--	--	3

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.					
ISC404	Feedback Control System	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Credits
ISC404	Feedback Control System	3
Course Objectives	**The course is aimed** 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	**On successful completion of course learner/student will be able to:** 1. Identify open-loop and closed-loop control systems 2. Formulate mathematical model for the physical systems 3. Simplify representation of complex systems using reduction techniques. 4. Identify performance characteristics of first and second-order systems. 5. Apply root-locus technique for stability analysis. 6. Analyze performance characteristics of systems using frequency response methods.	

Prerequisite: Knowledge of mathematics and network theory.

Details of Syllabus:

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	**04**	**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.	**06**	**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, effect of feedback, effect of disturbances signals.	**09**	**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 close loop pole location and the dominant condition.	**08**	**CO4**
5	**Stability Analysis and Root Locus** Concept of stability, definitions, bounded input-bounded output stability, relative stability, necessary and sufficient conditions for stability, Routh stability criterion, relative stability analysis, root locus technique, applications, concept, construction of root loci, root loci of different systems, electrical RLC circuits, etc.	**06**	**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, polar, definitions and significance of gain margin and phase margin.	**06**	**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.

Textbooks

1. Nagrath I. G., Gopal M., *Control System Engineering*, New Age International (P) Ltd. Publishers 2000
2. Kuo Benjamin C., "Automatic Control Systems", 6th ed., 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 ed., John Wiley and Sons, Inc.-2000.
3. Lewis Paul H., Chang Yang, "Basic Control Systems Engineering", Prentice Hall International, Inc. 1997.
4. Raymond T. Stefani, Bahram Shahian, Clement J. Savant and Gene H. Hostetter, "Design of Feedback Control Systems", 4th ed., Oxford University Press, New Delhi, 2001.
5. Dhanesh N. Manik, "Control System", Cengage Lerning India, 1st edition, 2012

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC405	Control System Components	4	--	--	4	--	--	4

Subject 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	Control System Components	20	20	20	80	--	--	--	100

Subject Code	Subject Name	credits
ISC405	Control System Components	4
Course objective	**The course is aimed** 1. To impart knowledge of different control system components like Hydraulic, Pneumatic, Electrical & Electronics and their comparison. 2. To make the students to learn different types of Transmitters. 3. To make the students to understand concept of control valve, different types, their working & selection criteria. 4. To make the students to learn various Auxiliary process control components and its applications. 5. To give the students an overview of Industrial Control components & their Need in Instrumentation.	
Course Outcome	**On successful completion of course learner/student will be able to:** 1. Explain and select various pneumatic system components and circuits. 2. Select and compare various control systems like Hydraulic, pneumatic and electric. 3. Apply knowledge to classify, select and use various transmitters. 4. Classify and select various control valves and their accessories. 5. Describe and select industrial components and study their usage. 6. Demonstrate auxiliary process components.	

Prerequisite: Knowledge of sensors, Measurement system, basic control system and Electrical Engineering.

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1	**Pneumatic system components** Pneumatic System Components: ISA symbols, Instrument Air and Plant Air. Air compressor system and its accessories. Directional control valves and special types of pneumatic valve such as Pilot-operated valves, Non-return valves, Flow control valves, Sequence valves, and Time delay valve, Linear actuators- Single-acting, Double-acting, and special type of double-acting cylinder, Rotary actuators- Air motors. Process Control Pneumatics: Volume boosters, Air relays, Pneumatic logic gates, Pneumatic Circuits-Standard Symbols used for developing pneumatic circuits, Sequence diagram.	**10**	**CO1**
2	**Hydraulic System Components:** Hydraulic pumps(centrifugal, gear , lobe), Pressure regulation method, Loading valves, Hydraulic valves, Electro Hydraulic actuators, speed control circuits for Hydraulic actuators, Selection and comparison of pneumatic, hydraulic and electric systems.	**04**	**CO2**
3	**Transmitters** Need, specifications and classification of transmitters, Need for Standardization of signals, concept of live zero and dead zero, 2-wire; 3-wire and 4-wire transmitters and its calibration, Electronic versus pneumatic transmitters, Electronic type transmitters - temperature; Pressure (gauge); differential pressure; level(capacitive type); flow transmitter (magnetic); SMART /Intelligent transmitter; Block schematic and Comparison with conventional transmitter; applications of transmitters, **Multivariable transmitter.**	**12**	**CO3**
4	**Process Control Valves & converters** Need and specifications of Control Valve; Control valve terminology; Control valve constructional details; Air to Open(AO), Air to Close (AC); MOC (Material of construction); classification of control valve; applications, advantages, disadvantage of - Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid; Flow characteristics (Inherent and Installed); Valve positioners: necessity, types-motion balance and force-balance, Effect on Performance of control valve; Control Valve Actuators - Electrical, Pneumatic, Hydraulic, Electro-mechanical, and piston actuators; selection guidelines for control valve. Converters: Need for Converters and types, working of Pneumatic to Electrical and Electrical to Pneumatic converters. Feeders and dampers. Working of safety valve, relief valve and their application.	**14**	**CO4**

5	**Industrial Control Components** **Panel Switches**: Construction, symbolic representation, working, application of Toggle switches, Push buttons, Selector switches, DIP switches, Rotary switches, Thumbwheel switches, Drum switch, Limit switches, emergency push button, Tactile switch, Switch specifications. CAM SWITCHES MAGNETIC contactors, PILOT Light. **Industrial switches:** Temperature, Flow, Level and, Pressure Switch, Vibration switch. **Control Relays:** Construction, working, specifications, and applications of Electro-mechanical relay, Solid state relays. Interposing relays and Overload relays. **Contactors/starters:** Construction, working, specifications and applications of starters and contactors. Comparison between relays and starters /contactors.	**08**	**CO5**
6	**Auxiliary Process Control Components** Alarm annunciators and its sequences; Temperature regulator, Flow regulator, stepper motor (working principle)	**04**	**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 weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Text Books Recommended:

1. Andrew Parr, Hydraulic &pneumatics; A Technicians & Engineers Guide, Second Edition
2. Control Valve Handbook – Forth Edition, Fisher.
3. Pneumatics workbook Basic Level - FESTO
4. C.L.Albert and D.A. Coggan, “Fundamentals of Industrial Control”, ISA, 1992.
5. Bela G. Liptak, “Instrument Engineer’s Hand Book – Process Control”, Chilton Company, 3rd Edition, 1995.
6. Andrew Williams, “Applied instrumentation in the process industries”, 2nd Edition, Vol. 1 & 3, Gulf publishing company.
7. Guy Borden, Paul G Friedman , style Editor Control Valves- ISA
8. Process Instruments & Control Handbook, Douglas. M.Considine, McGraw-Hill

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL401	Process Control Components – Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL401	Process Control Components – Lab	--	--	--	--	25	25		50

Course Objectives	**The course is aimed** 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 3. To impart knowledge of different control system components like Hydraulic, Pneumatic and Electrical and their comparison. 4. To make the students to learn different process components and auxiliary process control components.
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Explain working principle of strain gauges, pressure transducers 2. Learn Basic fundamentals of flow transducers identify types of flow and use different transducers for flow measurement. 3. Explain the terminologies of electrochemical, density, humidity, pH measurement sensors, and their applications in industry. 4. Study, select and implement various pneumatic, hydraulic and electro-pneumatic system components and circuits. **5.** Apply knowledge to classify, select and use various Transmitters, control valves and their accessories 6. Describe the Need of Auxiliary process control components and study their industrial usage.

Syllabus: Same as that of Subject ISC402 Transducers-II and ISC405 Control System Components.

List of the 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	**CO1**
3.	Study measurement of pressure using bellows, diaphragm, bourdon tube, manometer.	**CO1**
4.	Test and calibration of pressure gauges using dead weight tester.	**CO1**
5.	Measurement of flow using orifice/venturi tube/nozzle/pitot tube.	**CO2**
6.	Measurement of flow using rotameter/ electromagnetic flow meter.	**CO2**
7.	Study and characterization of pH meter/ conductivity meter.	**CO3**
8.	Measurement of Density/Viscosity	**CO3**
9.	Study of various pneumatic / hydraulic control system components.	**CO4**
10.	Study of various electro-pneumatic control system components.	**CO4**
11.	Study operation and calibration of flow/ level/ temperature transmitter	**CO5**
12	Study of different types of control valve actuator.	**CO5**
13	Calibration of I to P and / P to I converter.	**CO5**
14.	Study characteristics of control valve	**CO5**
15.	Study different types and operation of control valve and valve positioner.	**CO6**
16.	Study of pressure/temperature/level/flow switches and control relays.	**CO6**

Note:

1. Minimum of **Ten** experiments can be conducted during the semester for term work and practical examination.
3) Factory visit is advised to understand the working of the control system components.
4) Assignments based on syllabus which will help students to understand the Topic can be given during the semester as a support to Evaluate Term work.

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on Entire subject.

Term Work:
Term work shall consist of minimum **Ten** Experiments **covering all COs.**

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL402	Signal Conditioning Circuit Design - Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL402	Signal Conditioning Circuit Design - Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL402	Signal Conditioning Circuit Design- Lab	1
Course Objectives	**The course is aimed** 1. To introduce the students the basic properties of OpAmp, analysis and design of electronic circuits using OpAmp. 2. To give the knowledge about the various components analog signal conditioning. 3. To impart knowledge of design considerations of analog signal conditioning of components. 4. To give the students knowledge about various components digital signal conditioning. 5. To make the students capable to apply knowledge to design various transducer signal conditioning circuits.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Evaluate op-amp parameters and design of basic op-amp amplifier circuits. 2. Design and Implement various linear applications using op-amp. 3. Design and Implement various non-linear applications using op-amp. 4. Apply principles of analog signal conditioning for op-amp based circuit design. 5. Apply concepts of digital signal conditioning for op-amp based circuit design. 6. Design and develop signal conditioning circuits for different transducers.	

Syllabus: Same as that of Subject ISC403 Signal Conditioning Circuit Design.

List of Experiments:

Sr. No	Detailed Contents	CO Mapping
1.	Demonstrate use of Op-Amp as inverting and non-inverting amplifier	CO1
2.	Determination of opamp parameters- CMRR, Slew Rate, Offset Voltages & currents	CO1
3.	Adder and Subtractor using Op-amp	CO2
4.	Design Instrumentation Amplifier using 3 Op-amps.	CO2
5.	Design and demonstrate I to V and V to I converter circuit	CO2
6.	Design and implement Astable and Monostable Multivibrator using IC 555	CO2
7.	Implementation of Precision rectifiers using Op-amp.	CO3
8.	Design and demonstrate integrator and differentiator using Op-amp.	CO3
9.	Design of Wein bridge oscillator using Op-amp	CO3
10.	Design of RC phase shift oscillator using Op-amp	CO3
11.	Design and demonstrate second order LPF and HPF.	CO4
12.	Design and demonstrate general signal conditioning circuit to convert sensor output to 0-5 V	CO4
13.	Design and demonstrate general signal conditioning circuit to convert sensor output to 4-20 mA	CO4
14.	Design and demonstrate Analog to Digital converter circuit or Digital to Analog converter circuit	CO5
15.	Design and demonstrate signal conditioning circuit for weight measuring system using strain gauge	CO6
16.	Study and Simulation of Data Acquisition System	CO6
17.	Design signal conditioning circuit for RTD	CO6

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on subject **ISC403 Signal Conditioning Circuit Design**.

Term Work:

Term work shall consist of minimum 08 experiments (any 5 Experiments from 1 to 10 plus any 3 experiments from remaining list of experiments) covering all COs and out of that 02 experiment should be simulation software.

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

Laboratory work (Experiments/assignments)	: 10 Marks
Laboratory work (journal)	: 10 Marks
Attendance (class Room plus Lab Practice)	: 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL403	Feedback Control System- Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL403	Feedback Control System -Lab	--	--	--	--	25	25	--	50

Subject Code	Subject Name	Credits
ISL403	Feedback Control System- Lab	1
Course Objectives	**The course is aimed** 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	**On successful completion of course learner/student 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 the way to obtain the transfer function and validate transient and steady-state response using test signals such as step, ramp, and parabolic. 4. Validate the effect of damping factor on response of second order system. 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 ISC404 Feedback Control System.

List of the Laboratory Experiments:

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

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

Practical and Oral Examination:

Practical Examination will be based on performing one Experiment in the laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on subject **ISC404-** Feedback Control System.

Term Work:

Term work shall consist of minimum **Eight** experiments to cover all COs of this Lab Practice Course.

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 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			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL404	Virtual Instrumentation - Lab	--	3#	--	--	1.5	--	1.5

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL404	Virtual Instrumentation - Lab	--	--	--	--	25	25	--	50

Subject Code	Subject Name	Credits
ISL404	Virtual Instrumentation Lab	1.5
Course Objectives	**The course is aimed** 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	**On successful completion of course learner/student 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. Plot the generated data and also able to export the data outside the programming environment 4. Select the data acquisition card or simulated software module and make user interface in the field of engineering. 5. Describe the concepts of different analysis tool. 6. Design and develop real world applications using graphical programming software.	

out of 3 hours, 1 hours theory shall be taught to entire class and 2 hours practical in batches.

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

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1	**INTRODUCTION** Virtual Instrumentation: Historical perspective, block diagram and Architecture of a virtual instrument, Conventional Instruments versus Virtual Instruments, data-flow techniques, graphical programming in data flow.	2	CO1
2	**VI PROGRAMMING TECHNIQUES** Data types, VIs and sub-VIs, Structures (For, While etc.) arrays, clusters, shift registers, case and sequence structures, formula nodes. Debugging techniques	2	CO2
3	**PLOTING AND EXPORT DATA** Strings, File I/O, Plotting data: graphs and charts, report generation.	2	CO3
4	**DATA ACQUISITION** Introduction to data acquisition on PC, Digital I/O, counters and timers, Software and Hardware installation, Calibration, Resolution, Data acquisition interface requirements, VISA programming.	3	CO4
5	**MEASUREMENT ANALYSIS TOOLS** Use of analysis tools for measurement of max, min, peak to peak voltage. Time period of signal, correlation methods. Design of oscilloscope, digital multimeter.	2	CO5
6	**APPLICATIONS** System development for a process. Development of Graphical User Interface (GUI). Implementation of various controllers (ON / OFF control, PID control) for a process. Simulation of a simple second order system.	2	CO6

List of Experiments:

Module	Contents	CO mapping
1.	To develop a VI to calculate speed, convert degree Celsius to Fahrenheit	CO1
2.	To develop a Sub VI to implement Half adder and Full ADDER	CO2
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.	Applications of Graphical Programming Software in digital electronics—binary to decimal conversion etc.	CO1, CO2
7.	To develop a VI for storing all the points of simulated signal using File I/Os	CO3
8.	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.	CO3

9.	Measurement of AC/ DC voltage and current using DAQ cards.	**CO4**
10.	Develop the VI, to On/Off the LED's using DAQ devices (Arduino, Raspberry Pi etc.)	**CO4**
11.	Applications of Graphical Programming Software in process tank level / temperature control, alarm annunciator, batch process control etc.	**CO5**
12.	To create VI to simulate bottle filling plant using Sequence structure.	**CO5**
13.	Applications of Graphical Programming Software in control —simulate first and second order system response, effect of damping factor etc.	**CO6**
14.	To create VI to simulate traffic light control, stirred tank heater etc. using Sequence structure	**CO6**

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on subject ISL404 **Virtual Instrumentation Lab.**

Note:

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

Term Work:

Term work shall consist of minimum 10 programs from the list of suggested programs.

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

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 Marks

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

Reference Books:

1. Jovitha Jerome, "Virtual Instrumentation", PHI, 2018.
2. Robert Bishop, "Learning with LabVIEW TM 7 express", Pearson Education, 2005.
3. Gupta S, "Virtual Instrumentation Using LabVIEW", Tata McGraw Hill Publishing Company Limited.
4. Labview for everyone, - Lisa K. Wells & Jettrey Travis Prentice Hall, New Jersey, 1997.
5. LabVIEW users manual.

Website: www.ni.com

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISM401	Mini Project – 1 B	--	3$	--	--	1.5	--	1.5

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.					
ISM401	Mini Project – 1 B	--	--	--	--	25	25	--	50

Subject Code	Subject Name	Credits
ISM401	Mini Project – 1 B	1.5
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life long learning. 9. Demonstrate project management principles during project work.	

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including, ○ Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication