

**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)**

AC - 29/6/2021

Item No. 6.7

**UNIVERSITY OF MUMBAI****Syllabus for Approval**

Sr. No.	Heading	Particulars
1	Title of the Course	T.Y of B.E in Instrumentation Engineering
2	Eligibility for Admission	<b>After Passing Second Year Engineering as per the Ordinance 0.6242</b>
3	Passing Marks	<b>40%</b>
4	Ordinances / Regulations ( if any)	<b>Ordinance 0.6242</b>
5	No. of Years / Semesters	<b>8 semesters</b>
6	Level	<del>P.G. / U.G./Diploma / Certificate</del> (Strike out which is not applicable)
7	Pattern	<del>Yearly / Semester</del> (Strike out which is not applicable )
8	Status	<del>New</del> / Revised <b>REV- 2019 'C' Scheme</b>
9	To be implemented from Academic Year	<b>With effect from Academic Year: 2021-2022</b>

Date: 29/6/2021

Dr. S. K. Ukarande  
Associate Dean  
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Dr. Anuradha Majumdar  
Dean  
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## 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.

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## **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.

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## 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. Mukesh 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 2021-2022)**

**Scheme for Semester- V**

Course Code	Course Name	Teaching Scheme ( Contact Hours)		Credits Assigned					
		Theory	Pract.	Theory	Pract.	Total			
ISC501	Electrical Machines and Drives	3	--	3	--	3			
ISC502	Applications of Microcontroller	3	--	3	--	3			
ISC503	Control System Design	3	--	3	--	3			
ISC504	Process Instrumentation System	3	--	3	--	3			
ISDOC501X	Department Optional Course-1	3	--	3	--	3			
ISL501	Electrical Machines and Drives Lab	--	2	--	1	1			
ISL502	Applications of Microcontroller Lab	--	2	--	1	1			
ISL503	Process Instrumentation and Control System Design Lab	--	2	--	1	1			
ISL504	Professional Communication and Ethics-II	--	2*+2	--	2	2			
ISM501	MiniProject-2 A	--	4 <sup>\$</sup>	--	2	2			
<b>Total</b>		<b>15</b>	<b>14</b>	<b>15</b>	<b>07</b>	<b>22</b>			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR &OR	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
Test1	Test2	Avg							
ISC501	Electrical Machines and Drives	20	20	20	80	3	--	--	100
ISC502	Applications of Microcontroller	20	20	20	80	3	--	--	100
ISC503	Control System Design	20	20	20	80	3	--	--	100
ISC504	Process Instrumentation System	20	20	20	80	3	--	--	100
ISDOC501X	Department Optional Course- 1	20	20	20	80	3	--	--	100
ISL501	Electrical Machines and Drives Lab	--	--	--	--	--	25	25	50
ISL502	Applications of Microcontroller Lab	--	--	--	--	--	25	25	50
ISL503	Process Instrumentation and Control System Design Lab	--	--	--	--	--	25	25	50
ISL504	Professional Communication and Ethics-II	--	--	--	--	--	25	25 (Internal)	50
ISM501	MiniProject-2 A	--	--	--	--	--	25	25	50
<b>Total</b>		--	--	<b>100</b>	<b>400</b>	--	<b>125</b>	<b>125</b>	<b>750</b>

\* Theory class to be conducted for full class

\$ indicates workload of Learner (Not Faculty), for Mini Project

**Department Optional Course – 1 (Semester- V)**

ISDOC5011	Analytical Instrumentation	<b>No Lab work</b>
ISDOC5012	Data Structures and Algorithms	
ISDOC5013	Mechatronics	
ISDOC5014	Advanced Sensors	

muquestionpapers.com

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC501	Electrical Machines and Drives	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.					
ISC501	Electrical Machines and Drives	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC501	Electrical Machines and Drives	3
<b>Course Objectives</b>	1. To learn the basic concept and characteristics of Electrical motors. 2. To equip the students with the knowledge of semiconductor devices & their applications.	
<b>Course Outcomes</b>	Students will be able to: 1. Explain working of DC motors and study their characteristics. 2. Describe the working principle of 3-phase I.M. 3. Discuss the constructional features of single-phase I.M. 4. Compare basic characteristics and ratings of power electronic devices. 5. Use controlled rectifiers, Inverters & choppers with different loads. 6. Illustrate working of AC & DC drives.	



Module	Contents	Hours	CO Mapping
<b>Prerequisite:</b>			
Knowledge of Faraday's laws, Lenz's law. Semiconductor devices such as diodes and transistors and their characteristics.			
1.	<b>DC Machines</b> Types of DC motors, EMF equation generating & motoring action. Characteristics of DC motors. Speed control methods of DC motors (Numerical Based on Speed control and torque calculation). A selection criterion of DC motors for various applications.	07	CO1
2.	<b>3-Phase Induction Motors</b> Construction & working principle of 3-phase IM. Slip, rotor frequency torque slip characteristic, power stages in IM, Numericals based on torque calculation.	06	CO2
3.	<b>Fractional Horse Power (HP) Motors</b> Construction & working principle of 1-phase I. M. split phase IM. Shaded pole IM Basic, concepts of Stepper Motor, Servomotor, BLDC Motor.	04	CO3
4.	<b>Semiconductor Devices</b> Introduction, characteristic, ratings & applications of power diode, power BJT, power MOSFET & IGBT Construction & characteristic, ratings of SCR, TRIAC. Triggering methods of Thyristors using DIAC, UJT & PUT only, Commutation methods of Thyristors.	06	CO4
5.	<b>Applications of Power Semiconductor Devices</b> Controlled Rectifier: Principle of operation of 1-phase controlled converters, 1-phase half bridge & full bridge converter performance with R-L load. Basic operation of 3-phase converter. AC power control with TRIAC-DIAC Inverter: Principle of operation of basic inverter, bridge inverter, PWM inverter DC-to-DC Converter: Basic operation of chopper, study of different types of chopper circuit like step up & step down chopper.	10	CO5
6.	<b>Drives</b> DC motor drives: 1-phase & 3-phase converter drives for continuous & discontinuous operation, chopper fed drive. AC motor drives and control: Control strategies of IM like stator voltage control & frequency control. Variable frequency VSI drives. Variable frequency CSI drives.	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.Nagrath I.J., Kothari D.P., Electrical Machines, second edition, Tata McGraw Hill, New Delhi.
- 2.B. L. Theraja, Fundamentals of Electrical & Electronics, S.Chand, Technical.
- 3.V.K. Mehta, Rohit Mehta, Principles of Electrical Engg. & Electronics, S.Chand
- 4.P.S. Bhimbra, Power Electronics, Khanna publishers, 2004
- 5.M. H. Rashid, Handbook of Power Electronics, 2nd Edition, PHI, 2005.
- 6.M.D. Singh, Khanchandani, Power Electronics, Tata Mcgraw-Hill Education.

**Reference Books:**

1. Say M. G., The performance & Design of Alternating Current Machines, 3rd edition, Oxford University
2. P.C. Sen, Power Electronics, Tata McGraw Hill, 2005
3. Mohan Undeland Robbins, Power Electronics- Converters application & Design, Wiley Eastern, 1996
4. Dubey, Dorald, Thyristorised Power Controller, Wiley Eastern Ltd. 1993
5. S.K. Bhattacharya, Industrial Electronics & Control, TATA McGraw Hill, 2007
6. B.K. Bose, Modern power Electronics & AC Drives Pearson Education Inc. 2002.

Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
			Theory	PR	Tut.	Theory	PR	Tut.
ISC502	Applications of Microcontroller	Theory						
			3	-	-	3	-	-

Subject Code	Subject Name	Examination scheme								
		Theory Marks (100)					Term work	PR and OR	Oral	Total
		Internal Assessment			End Sem Exam					
		Test1	Test2	Avg.						
ISC502	Applications of Microcontroller	20	20	20	80	-	-	-	100	

Subject Code	Subject Name	Credits
ISC502	Applications of Microcontroller	3
<b>Course objectives</b>	<ol style="list-style-type: none"> <li>To give overview of embedded systems and make aware of design challenges and technology.</li> <li>To impart knowledge of fundamentals of MCS-51 microcontroller family and working of the system.</li> <li>To make the students understand various programming tools and development of software using assembly and higher level language.</li> <li>To give knowledge of integrated hardware of MCS-51</li> <li>To give knowledge of interfacing of MCS-51 with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc.</li> <li>To make the students capable to develop application using learned concepts of hardware, software and interfacing.</li> </ol>	
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ol style="list-style-type: none"> <li>Identify the technology in the area of embedded systems.</li> <li>Explain the comparative study of various microcontrollers and microprocessors.</li> <li>Outline the knowledge of operation of integrated hardware components.</li> <li>Explain programming tools and design software programs in assembly or C language.</li> <li>Solve and construct interfacing of peripheral components with MCS51 and Arduino.</li> <li>Investigate, recommend and design the sophisticated application based on MCS-51 such as Traffic light control, Digital weighing machine etc.</li> </ol>	

**Details of Syllabus:****Prerequisite:** Knowledge of Digital Electronics, Programming skills.

Module	Content	Hrs	CO Mapping
1	<b>Introduction to Embedded systems</b>  Overview of embedded system and examples, Design trends in Embedded systems. RISC and CISC processors.  Introduction to Embedded platforms like MCS51, Arduino, Raspberry PI, ARM and PIC development boards	05	CO1
2	<b>MCS-51 Microcontroller</b>  Architecture of MCS51 family of microcontroller, and its Variants and comparison. Memory organization and SFRS. Programming model.	04	CO2
3	<b>MCS 51 Programming and tools</b>  Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers. Merits & demerits of above tools.  Assembly language programming process. Programming tools. Instruction set, addressing modes. Programming practice using assembly & C compiler.	10	CO3
4	<b>Integrated peripherals of MCS 51</b>  Integrated peripherals such as Timers/Counters, Interrupt, serial port and programming.	05	CO4
5	<b>MCS 51 Interfacing</b>  Interfacing with Memories, 7 segment display, LCD, ADC, DAC, relay, opto-isolator, DC motor and Stepper Motor.  <b>Arduino Interfacing</b>	10	CO5
6	<b>Case Studies</b>  Data acquisition systems, Digital weighing machine, Washing machines, Traffic light controller, Home automation and irrigation	05	CO6

**Internal Assessment:**

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

**End Semester Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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. Mazidi M.A., The 8051 Microcontroller & Embedded systems, Pearson Education Second edition. 2006
2. Kenneth Ayala, The 8051 Microcontroller, Thomson Delmar Learning, Third Edition. 2005
3. Steve Heath, Embedded Systems Design, Newness publication, Second edition, ISBN 0 7506 5546

**Reference Books:**

1. David Simon, Embedded Software Primer, Pearson Education, ISBN 81-7808-045-
2. Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Student Edition. ISBN No. 812650837X
3. P.S. Manoharan, P. S. Kannan, Microcontroller based system design, SciTech Publications (India) Pvt. Ltd. ISBN No. 8183715982
4. 8051 / MC151 / MCS251 Datasheets
5. Microcontrollers-Architecture, Programming, Interfacing and System Design, Pearson Education India; Second edition (2011), ISBN-10: 8131759903.

**Websites:**

1. [www.atmel.com](http://www.atmel.com)
2. [www.microchip.com](http://www.microchip.com)
3. [www.nxp.com](http://www.nxp.com).

Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
			PR	Tut.	Theory	PR	Tut.	Total
ISC503	Control System Design	Theory	PR	Tut.	Theory	PR	Tut.	Total
		3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme								
		Theory Marks (100)					Term work	PR and OR	Oral	Total
		Internal Assessment (20)			End Sem Exam					
		Test1	Test2	Avg.						
ISC503	Control System Design	20	20	20	80	-	-	-	100	

Subject Code	Subject Name	Credits
ISC503	Control System Design	3
<b>Course objectives</b>	<ol style="list-style-type: none"> <li>1. To develop the skills to represent the system in state space form.</li> <li>2. To impart knowledge required to design state feedback controller and state estimator.</li> <li>3. To develop the skills to design the compensator in time and frequency domain and to design the PID compensator.</li> </ol>	
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ol style="list-style-type: none"> <li>1. Obtain state-space model of electrical circuits, translational/rotational mechanical systems and electromechanical systems etc with emphasis on linear time-invariant systems</li> <li>2. Obtain solution of state equations by using Laplace transform methods, Cayley Hamilton method etc.</li> <li>3. Examine system for its stability, controllability and observability and design controller and observer with given transient specifications.</li> <li>4. Design Lead, Lag and Lead –lag compensator using time domain method.</li> <li>5. Design Lead, Lag and Lead –lag compensator using frequency domain method.</li> <li>6. Study the PID controller tuning by Ziegler Nicholas and Cohen-coon methods</li> </ol>	

## Details of Syllabus:

**Prerequisite:** Knowledge of Matrix algebra, Root-locus, Bode-plot and Nyquist stability criterion.

Module	Content	Hrs	CO Mapping
1	<b>State Space Representation of Continuous Time Systems:</b> Terminology of state space representation, advantages of state space representation over classical representation, physical variable form, phase variable forms: controllable canonical form (companion I), observable canonical form (companion II), diagonal/Jordan canonical form (parallel realization), cascade realization, conversion of state model to transfer function. Similarity transformation for diagonalization of a plant matrix, Vander Monde matrix.	08	CO1
2	<b>Solution of State Equation:</b> State Transition Matrix and its properties, computation of state transition matrix using Laplace transformation method, state solution to the homogeneous & non homogeneous differential equations	04	CO2
3	<b>Analysis and Design of Control System in State Space:</b> Controllability, and observability properties. Necessary and sufficiency conditions for complete state controllability and observability. State feedback structure, Pole placement design using state feedback. State observers – Full state observer. (Numerical examples on full-state observer are avoided)	07	CO3
4	<b>Introduction to Compensator:</b> Derivative and integral error compensation, Analysis of the basic approaches to compensation, cascade compensation, feedback compensation <b>Compensator Design using Root-locus:</b> Improving steady-state error and transient response by feedback compensation, cascade compensation, Lag, Lead, Lag-Lead compensation	08	CO4
5	<b>Compensator Design using Frequency response:</b> Systems with time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.	08	CO5
6	<b>PID Controller Design:</b> PID controller tuning: Ziegler-Nichols method, Cohen-coon method, Designing PID controller using Root-Locus.	04	CO6

**Internal Assessment:**

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

**End Semester Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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. K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002
2. M. Gopal, Control Systems Principles and Design, TMH, New Delhi, 2nd edition, 2002

**Reference Books:**

1. Norman S. Nise, Control Systems Engineering, John Wiley and Sons, Inc. 2000.
2. Francis Raven, Automatic Control Engineering, 5th edition McGraw-Hill International Edition,
3. G. C. Goodwin, S. F. Graebe, M.E. Salgado, Control System Design, Pearson education
4. B. C. Kuo "Automatic control systems", Prentice Hall of India.
5. M. Gopal, Control Systems Principles and Design, TMH, New Delhi, 2nd edition, 2002.
6. Stefani, Shahian, Savant, Hostetter, Design of Feedback Control Systems, Oxford University Press, 4th Edition, 2007.
7. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Addition-Wesley, 1999.
8. I.J. Nagrath and M. Gopal, Control System Engineering, 3rd Edition, New Age International (P) Ltd., Publishers - 2000.
9. B.C. Kuo, Farid Gdn Golnaraghi, Automatic Control Systems, PHI, 7th edition, 2003.
10. M. N. Bandopadhyay, Control Engineering - Theory & Practice, PHI, 2003.



Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
			PR	Tut.	Theory	PR	Tut.	Total
ISC504	Process Instrumentation System	Theory	.					
		3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme								
		Theory Marks (100)					Term work	PR and OR	Oral	Total
		Internal Assessment			End Sem Exam					
		Test 1	Test2	Avg.						
ISC504	Process Instrumentation System	20	20	20	80	-	-	-	100	

Subject Code	Subject Name	Credits
ISC503	Control System Design	3
<b>Course Objectives</b>	<ol style="list-style-type: none"> <li>To make the students to familiar with different Process Dynamics &amp; process control actions.</li> <li>Students are expected to learn classification &amp; working of Controllers &amp; Tuning Methods.</li> <li>Students are expected to understand various control schemes.</li> <li>To familiarize concept of Multivariable Control &amp; Discrete state process control requirement.</li> </ol>	
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ol style="list-style-type: none"> <li>Understand &amp; Learn Process Control Terminologies, Process Dynamics &amp; their mathematical model.</li> <li>Understand different types of control actions &amp; their selection.</li> <li>Learn Features &amp; Classify controllers like electronic, pneumatic and Hydraulic &amp; their Tuning Techniques.</li> <li>Learn various process control schemes &amp; their applications and selection.</li> <li>Understand Multivariable Control systems &amp; their Interaction</li> <li>Develop relay logic for various processes &amp; symbols.</li> </ol>	

## Details of Syllabus:

**Prerequisite:** Measurement of physical parameters, sensors/transducers and basic control system.

Module	Content	Hrs	CO Mapping
1	<b>Introduction to Process Control</b> Process Control Terminology, Development of Typical Process Control loops like Pressure, Temperature, flow & Level. Process characteristics, control system parameters, Dynamic elements in a control loop, Dead time processes and smith predictor compensator. Inverse response behavior of processes and compensator. Dynamic behavior of first and second order systems. Interacting and non-interacting systems. Development of Mathematical Model for first & second order system with Example.	08	CO1
2	<b>Process Control Actions</b> Types-Discontinuous, continuous (P, I, D) and composite control actions (PI, PD, and PID), Effects of control actions, selection criteria.	04	CO2
3	<b>Process Controllers and Tuning</b> Need for controller, General features, specifications, classification & working of Pneumatic, Hydraulic and Electronic controllers. Need for controller Tuning. Tuning Methods-Process reaction curve method, Ziegler-Nichols method, Cohen conon correction for quarter amplitude, Frequency response method, Relay based tuning. Concept of Auto Tuning. Introduction to Model based Controller.	10	CO3
4	<b>Control Schemes</b> Feedback, Feed forward, cascade, Ratio, split range, selective control, adaptive control, inferential control, and selection Guidelines.	06	CO4
5	<b>Multivariable Control</b> Introduction to MIMO systems, Block diagram analysis of multivariable systems, Interaction, relative gain analysis, Decoupler design	04	CO5
6	<b>Discrete-State process control</b> Need for Discrete state process control systems, process specification and event sequence description, Relay Logic symbols, Development of Relay ladder Logic diagram and case study examples.	07	CO6

**Internal Assessment:**

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

**End Semester Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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.

**Books Recommended:****Text Books:**

1. Curtis D. Johnson, "Process Control Instrumentation Technology", PHI /Pearson Education 2002.
2. George Stephanopoulos, "Chemical process control", PHI-1999.

**Reference Books:**

1. Bela G. Liptak, "Instrument Engineer's Hand Book – Process Control", Chilton Company, 3<sup>rd</sup> Edition, 1995.
2. M.Chidambaram, "Computer Control of Processes", Narosa, 2002.
3. Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.
4. D. Patranabis, "Principles of Process Control", Second edition, TMH.
5. F.G. Shinsky, "Process Control System", TMH.
6. N.E. Battikha, "Condensed Handbook of Measurement and Control", 3<sup>rd</sup> Edition., ISA Publication.
7. Donald P. Eckman, "Automatic Process Control", Wiley Eastern Ltd.
8. Franklyn W. Kirk, Nicholas R. Rimboi, "Instrumentation", First edition, 1996, D.

Subject Code	Subject Name	Teaching	Credits Assigned					
			Theory	PR	Tut.	Theory	PR	Tut.
ISDOC 5011	Analytical Instrumentation	Theory						
			3	-	-	3	-	-

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	PR and OR	Oral	Total
		Internal Assessment (20)			End Sem Exam				
		Test1	Test2	Avg.					
ISDOC 5011	Analytical Instrumentation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5011	Analytical Instrumentation	3
<b>Course objectives</b>	<ol style="list-style-type: none"> <li>1. Introduce the basic concept of qualitative and quantitative analysis of a given sample.</li> <li>2. Study various spectroscopic techniques and its instrumentation.</li> <li>3. Study the concept of separation science and its applications.</li> <li>4. Study the concept of radiochemical analysis along with industrial analyzers.</li> </ol>	
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ol style="list-style-type: none"> <li>1. Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis.</li> <li>2. Discuss the terms, principle, instrumentation, operation and applications of Molecular spectroscopic techniques.</li> <li>3. Differentiate between principle, instrumentation and operation of Atomic absorption and emission Spectroscopy.</li> <li>4. Explain the various Separation techniques and its instrumentation.</li> <li>5. Describe the principle and working of various Radiation detectors.</li> <li>6. Discuss the principle and working of various Gas analyzers.</li> </ol>	

**Details of Syllabus:****Prerequisite:** Knowledge of sensors and analog electronic circuits.

Module	Content	Hrs	CO Mapping
1	<p><b>Introduction:</b> Introduction to analytical Instrumentation.</p> <p><b>Fundamentals of Spectroscopy:</b> Nature of Electromagnetic Radiation, Electromagnetic spectrum, Beer Lambert's Law statement and derivation. Deviations from Beer's law.</p> <p>Numerical on EMR and laws of photometry.</p> <p>Interaction of radiation with matter. Instrumentation of spectroscopic analytical system – Radiation sources, Wavelength selectors, Detectors, signal processors and readout modules.</p> <p>Scintillation detector</p>	9	CO1
2	<p><b>Molecular Spectroscopy:</b> Molecular Energy levels, correlation of energy levels with transitions.</p> <p><b>Electronic transitions and Vibrational transitions –</b></p> <p>Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications.</p> <p>Basic principle, components and instrumentation of Fluorimeters, Phosphorimeters and Raman spectrometers.</p>	9	CO2
3	<p><b>Molecular Spectroscopy – Nuclear/Rotational transitions –</b> Nuclear Magnetic Resonance (NMR) spectroscopy, basic principle and numerical problems based on NMR principle, instrumentation and constructional details of NMR Spectrometer.</p> <p><b>Electron Spin Resonance (ESR) Spectroscopy –</b> Basic principle and construction of ESR spectrometer.</p>	4	CO3
4	<p><b>Atomic Spectroscopy:</b> Atomic Energy levels, Atomic absorption spectrometers- components, working and absorption spectra.</p> <p>Atomic Emission spectrometers – components, working and emission spectra, comparison between AAS and AES.</p>	3	CO4
5	<p><b>Separation Science:</b></p> <p><b>Chromatography:</b> Fundamentals of chromatographic Separations, Classification, Gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram.</p> <p>HPLC – Its principle and instrumentation.</p> <p><b>Mass Spectrometers:</b> Basic principle, components and types of mass spectrometers, sample handling techniques for liquids and solids, resolution and numerical problems based on resolution.</p>	9	CO5
6	<p><b>Industrial Gas Analyzers:</b></p> <p>Oxygen Analyzer, Combustion Gas Analyzers (COX, NOX, SOX, hydrocarbons), Gas density analyzer</p>	5	CO6

**Internal Assessment:**

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

**End Semester Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers & Distributors, New Delhi, 7th Edition.
2. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw-Hill Publications, 3rd Edition.

**Reference Books:**

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC 5012	Data Structure and Algorithm Analysis	03	-	-	03	-	-	03

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.					
ISDOC 5012	Data Structure and Algorithm Analysis	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5012	Data Structure and Algorithm Analysis	3
<b>Course Objectives</b>	<ol style="list-style-type: none"> <li>To improve the logical ability</li> <li>To teach efficient storage mechanisms of data for an easy access.</li> <li>To design and implementation of various basic and advanced data structures and algorithm analysis.</li> <li>To introduce various techniques for representation and analysis of the data in the real world.</li> <li>To develop application using data structures and algorithm and analysis.</li> <li>To teach the concept of protection and management of data.</li> </ol>	
<b>Course Outcomes</b>	<p>Student will be able to:</p> <ol style="list-style-type: none"> <li>Choose appropriate data structure as applied to specified problem definition and analyse the algorithm.</li> <li>Handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures and algorithm analysis.</li> <li>Apply concepts learned in various domains like DBMS, compiler construction etc.</li> <li>Use linear and non-linear data structures like stacks, queues, linked list etc.</li> <li>Assess different sorting algorithms and select depending on application.</li> <li>Apply graph algorithms to solve real-world challenges</li> </ol>	

**Details of Syllabus:**

<b>Module</b>	<b>Contents</b>	<b>Hrs.</b>	<b>CO mapping</b>
1	<b>Introduction:</b> Introduction, Mathematics Review, Exponents, Logarithms, Series, Modular Arithmetic, The P Word, A Brief Introduction to Recursion, Recursion and Induction.  Algorithm Analysis: Mathematical Background, Model, What to Analyse, Running Time Calculations, General Rules, Solutions for the Maximum Subsequence Sum Problem, Logarithms in the Running Time, Euclid's Algorithm, Exponentiation, Checking Your Analysis, A Grain of Salt.	6	CO1
2	<b>Stacks, Queues and List:</b> Stacks, Queues, Linked Lists, Double-ended Queues. Abstract Data Type (ADT), The List ADT, Simple Array Implementation of Lists, Linked Lists, Programming Details, Common Errors, Doubly Linked Lists, Circularly Linked Lists, Examples, Cursor Implementation of Linked Lists, The Stack ADT, Implementation of Stacks, Applications, The Queue ADT, Array Implementation of Queues, Applications of Queues.	9	CO2
3	<b>Trees and Search Trees:</b> Tree, Implementation of Trees, Tree Traversals with an Application, Binary Trees, Expression Trees, the Search Tree ADT-Binary Search Trees, AVL Trees, Single Rotation, Double Rotation, Red-Black Trees, External searching in B-Trees, Tree Traversals, B-Trees	9	CO3
4	<b>Priority queues:</b> The priority queues Abstract data Type, Implementing a Priority queues with a List, Heaps, Adaptable priority queues.	4	CO4
5	<b>Sorting Sets, and Selection:</b> Insertion Sort, Shellsort, Heapsort, Quicksort, Bucket Sort, Merge Sort and radix Sort, and A Lower Bound on comparison-based Sorting and radix Sort, the complexity of some sorting algorithms, comparison of Sorting Algorithms, The Set ADT and union / file Structures	4	CO5



6	<p><b>Graphs:</b></p> <p>The graph Abstract Data Type, Data Structures for Graphs, Graph Traversals, Directed Graphs, Weighted Graphs, Shortest Paths, and Minimum spanning Trees.</p> <p>Applications of DFS and BSF, Shortest-Path Algorithms, Dijkstra's Algorithm, Graphs with Negative Edge Costs, Acyclic Graphs, Network Flow Problems, Minimum Spanning Tree</p>	7	CO6
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**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. Mark Allien Weiss, Data Structure and Algorithm Analysis in C, Pearson.
2. Micheal Goodrict, Roberto Tamassia, Data Structure and Algorithm in C++, Wiley India
3. Richard F. Gilberg&Behrouz A. Forouzan, Data Structures A Pseudo code Approach with C, second edition, CENGAGE Learning.
4. Rajesh K. Shukla, Data Structures Using C & C++, Wiley- India
5. ReemaThareja, Data Structures using C, Oxford University press.
6. Jean-Paul Tremblay, P. G. Sorenson, Introduction to Data Structure with Applications, Second Edition

**Reference Books:**

1. Ellis Horowitz, Sarataj Sahni, S.Rajsekar," Fundamentals of computer algorithm", University Press .
2. Mark Allen Weiss, "Data Structure & algorithm Analysis in C++", 3<sup>rd</sup> Edition, Pearson Education
3. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill
4. Balagurusamy, Data Structure Using C,
5. Prof. P.S. Deshpande, Prof. O.G. Kakde, C & Data Structures, , Dreamtech press.
6. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC5013	Mechatronics	3	-	-	3	-	-	3

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.					
ISDOC5013	Mechatronics	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5013	Mechatronics	3
<b>Course Objectives</b>	1. To present architecture of the mechatronics system design 2. To study on broad spectrum the characteristics of the mechanical and electrical actuators and their selection for mechatronic systems. 3. Development of process plan and templates for design of mechatronic systems.	
<b>Course Outcomes</b>	The students will be able to: 1. Examine key elements and design process of mechatronics system. 2. Apply the concept of system modeling to physical systems. 3. Identify the suitable sensor and actuator for a mechatronic system. 4. Examine feedback and intelligent controllers. 5. Illustrate mechatronics system validation. 6. Integrate the components in mechatronics system.	

## Details of Syllabus:

**Prerequisite:** Knowledge of sensors and mechanical and electronic components.

Module	Contents	Hrs.	CO mapping
1	<b>Introduction to mechatronics systems:</b> Definition and evolution levels of mechatronics, integrated design issues in mechatronics, key elements of mechatronics, mechatronics design process- modeling and simulation, prototyping, deployment /life cycle, advanced approaches in mechatronics.	05	CO1
2	<b>Modeling and Simulation of physical systems:</b> Simulation and block diagrams, Analogies and impedance diagrams, mechanical translational and rotational systems-sliding block with friction, elevator cable system, mass-damper system, automobile suspension system, mechanical lever system, geared elevator system, electromechanical coupling- DC motor,	07	CO2
3	<b>Electrical actuation:</b> A.C and DC motors, stepper motors, mechanical switches and solid state switches. <b>Mechanical Actuation:</b> types of motion, kinematic chain, cams, gears, ratchets and pawl, belt and chain drives, bearings, mechanical aspects of motor selection, piezoelectric actuators, magnetostrictive actuators, memory metal actuators, Programmable Logic Controller	07	CO3
4	<b>Intelligent control:</b> Automatic control methods, Artificial Neural Network (ANN) – Modeling, basic model of neuron, characteristics of ANN, perceptron, learning algorithms, Fuzzy logic – propositional logic, membership function, fuzzy logic and fuzzy rule generation, defuzzification, time dependent and temporal fuzzy logic.	08	CO4
5	<b>Components based modular design and system validation:</b> Components based modular design view, system validation, validation methodology- integrated and design dependence, distributed local level, validation schemes, fusion technique	06	CO5
6	<b>Integration:</b> Advanced actuators, consumer mechatronic products, hydraulic fingers, surgical equipment, industrial robot, autonomous guided vehicle, drilling machine, 3D Plotter, Motion Control Systems-Printing machines, coil winding machines, machine tools, and robotics, IC, and PCB manufacturing.	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. 4 to 5 marks will be asked.
5. Remaining questions will be mixed in nature.
6. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**Text Books:**

1. Devdas Shetty and Richard Kolk, Mechatronics System Design, Thomson Learning, 2<sup>nd</sup> reprint, 2001.
2. W. Bolton, Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Ltd, 4<sup>th</sup> edition, 2010.
3. Stamatios V. Kartalopoulos, Understanding Neural Networks and fuzzy Logic, PHI, 3<sup>rd</sup> reprint, 2013.

**Reference Books:**

1. Nitaigour Mahalik, Mechatronics- Principles, Concepts and Applications, Tata McGraw Hill.
2. Zhijun Li, Shuzhi Sam Ge, Fundamentals in Modeling and Control of Mobile Manipulators, 2017, CRC Press.
3. Sergey Edward Lyshevski, Mechatronics and Control of Electromechanical Systems, 2017, CRC Press.
4. Bodgan Wilamowski, J. David Irwin, Control and Mechatronics, 2017, CRC Press.
5. Takashi Yamaguchi, Mitsuo Hirata, Justin CheeKiang Pang, High-Speed Precision Motion Control, 2017, CRC Press.
6. David Allan Bradley, Derek Seward, David Dawson, Stuart Burge, Mechatronics and the Design of Intelligent Machines and Systems, 2000, CRC Press.
7. Clarence W. de Silva, Farbod Khoshnoud, Maoqing Li, Saman K. Halgamuge, Mechatronics: Fundamentals and Applications, 2015, CRC Press.
8. Clarence W. de Silva, Mechatronics: A Foundation Course, 2010, CRC Press.
9. GENERAL CATALOGUE 2011 Motion & Drives, OMRON.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC5014	Advanced Sensors	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISDOC5014	Advanced Sensors	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5014	Advanced Sensors	3
<b>Course Objectives</b>	<ol style="list-style-type: none"> <li>To expose the students to the concepts of smart sensors and micro sensors</li> <li>To provide sufficient knowledge about the sensor fabrication.</li> <li>To create awareness about the various application fields of smart sensors.</li> </ol>	1.
<b>Course Outcomes</b>	<p>The students will be able to -</p> <ol style="list-style-type: none"> <li>Explain the various principles employed in transducers.</li> <li>Examine the methods of fabricating a sensor.</li> <li>Apply knowledge in designing smart sensors.</li> <li>Discuss the techniques of fabrication and application of MEMS.</li> <li>Describe the various applications of smart sensors.</li> <li>Discuss advanced sensing technology.</li> </ol>	

## Details of Syllabus:

**Prerequisite:** Fundamentals of transducers.

Module	Content	Hrs	CO Mapping
1	<b>Review of Fundamental of Sensors:</b> Principle of physical and chemical transduction, sensor classification, characterization of mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors, their calibration and determination of characteristics	07	CO1
2	<b>Sensor Fabrication:</b> Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details and latest trends in sensor fabrication. Thick film sensing and system design.	06	CO2
3	<b>Smart Sensors:</b> Smart sensor basics, signal conditioning and A/D conversion for sensors, examples of available ICs (DHT, Smart analog IC 500, ADXL345) and their applications.	07	CO3
4	<b>Micro Sensors:</b> Introduction, Intrinsic characteristics of MEMS, common fabrication techniques, application of MEMS in sensing systems including pressure sensors, accelerometers, gyroscopes and strain gauges.	06	CO4
5	<b>Advanced Sensor Applications:</b> Temperature & Humidity measurement using DHT Sensor in environment monitoring, Acceleration measurement using ADXL345 for automotive industry, MEMS Temperature sensors for automotive applications, MEMS chemical sensors for survey meters, MEMS pressure sensors for medical applications	07	CO5
6	<b>Advanced Sensing Technology:</b> Sensors, instruments and measurement techniques for emerging application areas such as environmental measurement like DO (dissolves oxygen),BOD (biological oxygen demand), COD (chemical oxygen demand), TOC (total organic carbon), Cox (carbon dioxides), NOx (nitrogen oxide), for navigation and inertial measurements, for agricultural measurements such as soil moisture, wind speed, leaf wetness duration, sensors for food processing like smell or odour,taste.	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 20Marks.
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:**

1. Chang Liu, Foundations of MEMS, Pearson Education Inc.,2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication,2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, Tata Mc Graw Hill, New Delhi,2002.
4. Jacob Fraden, Handbook of Modern Sensors, 5<sup>th</sup> Edition, Springer .
5. S. M. Sze, Semiconductor Sensors, Wiley
6. M J Usher, Sensors and Transducers, MacMillan,1985.

**References:**

1. Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, The MEMS Handbook, CRC press Boca Raton,2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD,2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher,2005.
5. Thomas M. Adams and Richard A.Layton, Introduction to MEMS, Fabrication and Application, Springer,2010.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL501	Electrical Machines and Drives 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.					
ISL501	Electrical Machines and Drives Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL501	Electrical Machines and Drives Lab	1
<b>Course Objectives</b>	1. To learn the basic concept and characteristics of Electrical motors. 2. To equip the students with the knowledge of semiconductor devices & their applications.	
<b>Course Outcomes</b>	Students will be able to:  1. Explain working of DC motors and study their characteristics. 2. Describe the working principle of 3-phase I.M. 3. Discuss the constructional features of single-phase I.M. 4. Compare basic characteristics and ratings of power electronic devices. 5. Use controlled rectifiers, Inverters & choppers with different loads. 6. Illustrate working of AC & DC drives.	

**Syllabus: Same as that of Subject ISL501 Electrical Machines and Drives.**



**List of Laboratory Experiments:**

<b>Sr. No</b>	<b>Detailed Contents</b>	<b>CO Mapping</b>
01	Speed control methods of DC motor.	CO1
02	Starting of 3-phase IM by DOL/Autotransformer/rotor resistance method.	CO2
03	Load Test on DC Motor/ Induction Motor.	CO1/CO2
04	Plot V-I characteristics of SCR.	CO4
05	Triggering Methods of SCR.	CO4
06	Plot V-I characteristics of Diac.	CO4
07	Plot V-I characteristics of Triac.	CO4
08	Plot V-I characteristics of IGBT.	CO4
09	Triac based AC power control circuit.	CO5
10	Half wave & full wave controlled rectifier.	CO5
11	SCR Based Inverter	CO5
12	MOSFET/IGBT Based Inverter	CO5
13	Step UP-Step Down Chopper.	CO5
14	DC motor speed control drive	CO5
15	AC drive for I.M.	CO6

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

**Practical Oral Examination:**

Oral examination will be based on entire syllabus.

**Term Work:**

Term work shall consist of minimum eight experiments and any two using software.

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

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs /journal)	: 10 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			Credits Assigned			
		Theory	PR	Tut.	Theory	PR/ OR	Tut.	Total
ISL502	Applications of Microcontroller Lab	-	2	-	-	1	-	1

Subject Code	Subject Name	Examination scheme							
		Theory Marks(100)				Term work	PR and Oral	Oral	Total
		Internal Assessment(20)			End Sem Exam				
		Test 1	Test2	Avg.					
ISL502	Applications of Microcontroller Lab					25	25	-	50

Subject Code	Subject Name	Credits
ISL502	Applications of Microcontroller Lab Practice	1
<b>Course objectives</b>	<ol style="list-style-type: none"> <li>To explain the assembly and, c" programming concepts.</li> <li>To explain addressing modes and instruction set of MCS-51 and develop programs using instructions.</li> <li>To give knowledge of integrated hardware of MCS-51</li> <li>To study different SFRs associated with integrated peripherals and to give knowledge of interfacing of MCS-51 and Arduino with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc.</li> <li>To develop simple application board using MCS-51 and Arduino.</li> <li>To make the students capable to develop application using learned concepts of hardware, software and interfacing</li> </ol>	
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ol style="list-style-type: none"> <li>Design and develop programs using instructions learned from instructions in assembly or, c" language.</li> <li>Explain Integrated timers and Counters implantation.</li> <li>Outline the knowledge of operation of integrated hardware components.</li> <li>Designs of programs in assembly or, C" language.</li> <li>Solve and construct interfacing of peripheral components with MCS 51 and Arduino.</li> <li>Investigate, recommend and design the sophisticated application based on MCS-51 such as Traffic light control, Digital weighing machine etc.</li> </ol>	

**Syllabus:** Same as that of Subject ISC502 Applications of Microcontroller.

**List of Laboratory Experiments/Assignments:**

<b>Sr. No.</b>	<b>Detailed Content</b>	<b>CO Mapping</b>
<b>1</b>	To develop a program to perform 16 bit Arithmetic and Logical operations	<b>C01</b>
<b>2</b>	To develop a program to perform Code conversion	<b>C01</b>
<b>3</b>	To develop a program for generating square wave on port pin with and without timer.	<b>C02</b>
<b>4</b>	To develop a program for interfacing 7 segments/ LCD displays with MCS-51	<b>C04</b>
<b>5</b>	To develop a program for Serial Communication with PC.	<b>C03</b>
<b>6</b>	To develop a program for interfacing DAC and its application.	<b>C05</b>
<b>7</b>	To develop a program for Speed control of DC Motor	<b>C06</b>
<b>8</b>	To develop a program for Stepper motor control	<b>C06</b>
<b>9</b>	To develop a program for implementing traffic light controller.	<b>C06</b>
<b>10</b>	To develop a program for interfacing Switch, LED, LDR with Arduino	<b>C05</b>
<b>11</b>	To develop a program for interfacing 7 segments/ LCD displays with Arduino	<b>C05</b>
<b>12</b>	To develop a program for interfacing LM35, DHT11, accelerometer with Arduino	<b>C05</b>
<b>13</b>	To develop a program for interfacing of DC Motor/ Stepper motor with Arduino	<b>C05</b>

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

**Practical/Oral Examination:**

Practical/Oral examination will be based on entire syllabus.

**Term Work:**

Term work shall consist of minimum 10 experiments and two assignments. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments) : 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL503	Process Instrumentation Systems and Control System 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.				
ISL503	Process Instrumentation Systems and Control System Design Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL503	Process Instrumentation and Control System - Lab	1
<b>Course Objectives</b>	<ol style="list-style-type: none"> <li>1. To make students familiar with different dynamics and process control actions.</li> <li>2. To understand various control schemes.</li> <li>3. To understand concept of Multivariable Control &amp; Discrete state process control Requirement.</li> <li>4. To develop the skills needed to represent the system in state space form.</li> <li>5. To impart knowledge required to design state feedback controller and state estimator.</li> <li>6. To design the compensator in time and frequency domain.</li> </ol>	
<b>Course Outcomes</b>	<p>Students will be able to –</p> <ol style="list-style-type: none"> <li>1. To relate the working of different types of control actions, controllers and their tuning methods.</li> <li>2. To analyze various control schemes and their application.</li> <li>3. To evaluate interaction of multivariable control systems &amp; to develop ladder logic for discrete state process contro</li> <li>4. Obtain state model of a system from transfer function and study similarity transformation.</li> <li>5. Verify the controllability and observability of the given system and design the controller and observer for the given system with transient specifications.</li> <li>6. Design lead, lag, and lag-lead compensator using root-locus and bode-plot techniques with given transient specifications.</li> </ol>	

**Syllabus: Same as that of Subject ISC503 Control System Design and ISC504 Process Instrumentation System**

### List of Laboratory Experiments:

Sr. No	Detailed Contents	CO Mapping
01	Study Features & operation of ON-OFF Control action & its Application.	CO1
02	Study of flow rate control using P, PI, PD and PID controller modes.	CO1
03	Study of Ratio control system.	CO2
04	Study of Multivariable control system.	CO3
05	Study of discrete state process control system.	CO3
06	Obtain a state-space model in different canonical forms of a given transfer function.	CO5
07	Investigate controllability and observability of system , then accordingly design controller and observer.	CO5
08	Design of Lead Compensator using Root-locus technique.	CO6
09	Design of Lag Compensator using Root-locus technique	CO6
10	Design of Lag-Lead Compensator using Root-locus technique	CO6
11	Design of Lead Compensator using Bode-plot technique.	CO6
12	Design of Lag Compensator using Bode-plot technique	CO6
13	Design of Lag-Lead Compensator using Bode-plot technique	CO6

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

#### **Practical Oral Examination:**

Oral examination will be based on entire syllabus.

#### **Term Work:**

Term work shall consist of minimum eight experiments and any two using software.

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

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs /journal)	: 10 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.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL504	Professional Communication & Ethics-II							
		--	2*+ 2 Hours (Batch-wise)	--	--	2	--	02

\*Theory class to be conducted for full class.

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg .							
ISL504	Professional Communication & Ethics-II (abbreviated PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ISL504	Professional Communication & Ethics-II	02
<b>Course Rationale</b>	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
<b>Course Objectives</b>	<ol style="list-style-type: none"> <li>1. To discern and develop an effective style of writing important technical/business documents.</li> <li>2. To investigate possible resources and plan a successful job campaign.</li> <li>3. To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.</li> <li>4. To develop creative and impactful presentation skills.</li> <li>5. To analyze personal traits, interests, values, aptitudes and skills.</li> <li>6. To understand the importance of integrity and develop a personal code of ethics.</li> </ol>	

<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ol style="list-style-type: none"> <li>1. plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.</li> <li>2. strategize their personal and professional skills to build a professional image and meet the demands of the industry.</li> <li>3. emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.</li> <li>4. deliver persuasive and professional presentations.</li> <li>5. develop creative thinking and interpersonal skills required for effective professional communication.</li> <li>6. apply codes of ethical conduct, personal integrity and norms of organizational behaviour.</li> </ol>
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Module	Contents	Hours
1	<p><b>ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)</b></p> <p><b>1.1 Purpose and Classification of Reports:</b>  <b>Classification on the basis of:</b></p> <ul style="list-style-type: none"> <li>• Subject Matter (Technology, Accounting, Finance, Marketing, etc.)</li> <li>• Time Interval (Periodic, One-time, Special)</li> <li>• Function (Informational, Analytical, etc.)</li> <li>• Physical Factors (Memorandum, Letter, Short &amp; Long)</li> </ul> <p><b>1.2. Parts of a Long Formal Report:</b></p> <ol style="list-style-type: none"> <li>1. Prefatory Parts (Front Matter)</li> <li>2. Report Proper (Main Body)</li> <li>3. Appended Parts (Back Matter)</li> </ol> <p><b>1.3. Language and Style of Reports</b></p> <ol style="list-style-type: none"> <li>1. Tense, Person &amp; Voice of Reports</li> <li>2. Numbering Style of Chapters, Sections, Figures, Tables and Equations</li> <li>3. Referencing Styles in APA &amp; MLA Format</li> <li>4. Proofreading through Plagiarism Checkers</li> </ol> <p><b>1.4. Definition, Purpose &amp; Types of Proposals</b></p> <ul style="list-style-type: none"> <li>• Solicited (in conformance with RFP) &amp; Unsolicited Proposals</li> <li>• Types (Short and Long proposals)</li> </ul> <p><b>1.5. Parts of a Proposal</b></p> <ol style="list-style-type: none"> <li>1. Elements</li> <li>2. Scope and Limitations</li> <li>3. Conclusion</li> </ol> <p><b>1.6. Technical Paper Writing</b></p> <ul style="list-style-type: none"> <li>• Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and</li> </ul>	06

	<p>References)</p> <ul style="list-style-type: none"> <li>• Language and Formatting</li> <li>• Referencing in IEEE Format</li> </ul>	
2	<p><b>EMPLOYMENT SKILLS</b></p> <p><b>2.1. Cover Letter &amp; Resume</b></p> <ul style="list-style-type: none"> <li>• Parts and Content of a Cover Letter</li> <li>• Difference between Bio-data, Resume &amp; CV</li> <li>• Essential Parts of a Resume</li> <li>• Types of Resume (Chronological, Functional &amp; Combination)</li> </ul> <p><b>2.2 Statement of Purpose</b> Importance of SOP Tips for Writing an Effective SOP</p> <p><b>2.3 Verbal Aptitude Test</b></p> <ul style="list-style-type: none"> <li>• Modelled on CAT, GRE, GMAT exams</li> </ul> <p><b>2.4. Group Discussions</b></p> <ul style="list-style-type: none"> <li>• Purpose of a GD</li> <li>• Parameters of Evaluating a GD</li> <li>• Types of GDs (Normal, Case-based &amp; Role Plays)</li> <li>• GD Etiquettes</li> </ul> <p><b>2.5. Personal Interviews</b></p> <ul style="list-style-type: none"> <li>• Planning and Preparation</li> <li>• Types of Questions</li> <li>• Types of Interviews (Structured, Stress, Behavioural, Problem Solving &amp; Case-based)</li> <li>• Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual</li> </ul>	06
3	<p><b>BUSINESS MEETINGS</b></p> <p><b>1.1. Conducting Business Meetings</b></p> <ul style="list-style-type: none"> <li>• Types of Meetings</li> <li>• Roles and Responsibilities of Chairperson, Secretary and Members</li> <li>• Meeting Etiquette</li> </ul> <p><b>3.2. Documentation</b></p> <ul style="list-style-type: none"> <li>• Notice</li> <li>• Agenda</li> <li>• Minutes</li> </ul>	02
4	<p><b>TECHNICAL/ BUSINESS PRESENTATIONS</b></p> <p><b>1.1 Effective Presentation Strategies</b></p> <ul style="list-style-type: none"> <li>• Defining Purpose</li> <li>• Analyzing Audience, Location and Event</li> <li>• Gathering, Selecting &amp; Arranging Material</li> <li>• Structuring a Presentation</li> <li>• Making Effective Slides</li> <li>• Types of Presentations Aids</li> <li>• Closing a Presentation</li> <li>• Platform skills</li> </ul>	02



	<b>1.2 Group Presentations</b> <ul style="list-style-type: none"> <li>• Sharing Responsibility in a Team</li> <li>• Building the contents and visuals together</li> <li>• Transition Phases</li> </ul>	
5	<b>INTERPERSONAL SKILLS</b> <b>1.1. Interpersonal Skills</b> <ul style="list-style-type: none"> <li>• Emotional Intelligence</li> <li>• Leadership &amp; Motivation</li> <li>• Conflict Management &amp; Negotiation</li> <li>• Time Management</li> <li>• Assertiveness</li> <li>• Decision Making</li> </ul> <b>5.2 Start-up Skills</b> <ul style="list-style-type: none"> <li>• Financial Literacy</li> <li>• Risk Assessment</li> <li>• Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)</li> </ul>	08
6	<b>CORPORATE ETHICS</b> <b>6.1 Intellectual Property Rights</b> <ul style="list-style-type: none"> <li>• Copyrights</li> <li>• Trademarks</li> <li>• Patents</li> <li>• Industrial Designs</li> <li>• Geographical Indications</li> <li>• Integrated Circuits</li> <li>• Trade Secrets (Undisclosed Information)</li> </ul> <b>6.2 Case Studies</b> <ul style="list-style-type: none"> <li>• Cases related to Business/ Corporate Ethics</li> </ul>	02

**List of assignments:**

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

- Cover Letter and Resume
- Short Proposal
- Meeting Documentation
- Writing a Technical Paper/ Analyzing a Published Technical Paper
- Writing a SOP
- IPR
- Interpersonal Skills
- Aptitude test (Verbal Ability)

**Note:**

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

**Assessment:****Term Work:**

Term work shall consist of minimum 8 experiments.

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

Assignment : 10 Marks

Attendance : 5 Marks

Presentation slides : 5 Marks

Book Report (hard copy) : 5 Marks

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

**Internal oral:**

**Oral Examination will be based on a GD & the Project/Book Report presentation.**

Group Discussion : 10 marks

Project Presentation : 10 Marks

Group Dynamics : 5 Marks

**Books Recommended:****Textbooks and Reference books:**

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISM501	Mini Project – 2A	--	4 <sup>\$</sup>	--	--	2	--	2

\$ indicates workload of Learner (Not Faculty)

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.					
ISM501	Mini Project – 2A	--	--	--	--	25	--	25	50

Subject Code	Subject Name	Credits
ISM501	Mini Project – 2 A	2
<b>Course Objectives</b>	<p><b>The course is aimed</b></p> <ol style="list-style-type: none"> <li>To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>To familiarize the process of solving the problem in a group.</li> <li>To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>To inculcate the process of self-learning and research.</li> </ol>	
<b>Course Outcomes</b>	<p><b>On successful completion of course learner/student will be able to:</b></p> <ol style="list-style-type: none"> <li>Identify problems based on societal /research needs.</li> <li>Apply Knowledge and skill to solve societal problems in a group.</li> <li>Develop interpersonal skills to work as member of a group or leader.</li> <li>Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>Analyze the impact of solutions in societal and environmental context for sustainable development.</li> <li>Use standard norms of engineering practices</li> <li>Excel in written and oral communication.</li> <li>Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>Demonstrate project management principles during project work.</li> </ol>	

## **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 shall 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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