UNIVERSITY OF MUMBAI

Bachelor of Engineering

Instrumentation Engineering (Third Year – Sem. V & VI),
Revised course
(REV- 2012) from Academic Year 2014 -15,
Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean's Desk:

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

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

Semester 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. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

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

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

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare students to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare students to demonstrate ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare students for successful career in industry, research and development.
- To develop the ability among students for supervisory control and data acquisition for power system application.
- To provide opportunity for students to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list to support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

Semester V

Subject Code	Subject Name	Teaching Scheme		Credits Assigned		
		Theory	Pract./ Tut.	Theory	Pract./ Tut.	Total
ISC501	Signals and Systems	4	2	4	1	5
ISC502	Applications of Microcontroller -I	4	2	4	1	5
ISC503	Control System Design	4	2	4	1	5
ISC504	Signal Conditioning Circuit Design	4	2	4	1	5
ISC505	Control system components	4	2	4	1	5
ISC506	Business Communication and Ethics	-	2*+2	-	2	2
		20	14	20	7	27

Subject Code	Subject Name	Examination scheme							
		Theory Marks					Term work	Pract./ Oral	Total
		Internal Assessment			End Sem exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ISC501	Signals and Systems	20	20	20	80	03	25	-	125
ISC502	Applications of Microcontroller -I	20	20	20	80	03	25	25	150
ISC503	Control System Design	20	20	20	80	03	25	-	125
ISC504	Signal Conditioning Circuit Design	20	20	20	80	03	25	50+	175
ISC505	Control system components	20	20	20	80	03	25	25+	150
ISC506	Business Communication and Ethics	-	-	-	-	-	50	-	50
Total				100	400	--	175	100	775

+ Includes both Practical and Oral examination,

*** Theory for entire class to be conducted**

Semester VI

Subject Code	Subject Name	Teaching Scheme		Credits Assigned		
		Theory	Pract./ Tut.	Theory	Pract./ Tut.	Total
ISC601	Process Instrumentation Systems	4	2	4	1	5
ISC602	Power Electronics and Drives	4	2	4	1	5
ISC603	Digital Signal Processing	4	2	4	1	5
ISC604	Applications of Microcontroller -II	4	2	4	1	5
ISC605	Industrial Data Communication	3	2	3	1	4
ISC606	Analytical Instrumentation	3	2	3	1	4
	Total	22	12	22	6	28

Subject Code	Subject Name	Examination scheme							
		Theory Marks					Term work	Pract./ Oral	Total
		Internal Assessment			End Sem exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ISC601	Process Instrumentation Systems	20	20	20	80	03	25	25	150
ISC602	Power Electronics and Drives	20	20	20	80	03	25	25*	150
ISC603	Digital Signal Processing	20	20	20	80	03	25	25	150
ISC604	Applications of Microcontroller -II	20	20	20	80	03	25	25*	150
ISC605	Industrial Data Communication	20	20	20	80	03	25	-	125
ISC606	Analytical Instrumentation	20	20	20	80	03	25	-	125
Total				120	480	--	150	100	850

*** Includes both Practical and Oral examination**

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ISC501	Signals and Systems	4	2	--	4	1	--	5

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg					
ISC501	Signals and Systems	20	20	20	80	25	--	--	125

Subject Code	**Subject Name**	**Credits**
ISC501	**Signals and System**	**5**
Course Objectives	• To introduce students to the idea of signal and system analysis and characterization in time and frequency domain. • To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.	
Course Outcomes	• Students will be able to understand significance of signals and systems in the time and frequency domains. • Students will be able to interpret and analyze signal and report results. • Students will be able to evaluate the time and frequency response of continuous and discrete time, system which is useful in understanding behavior of communication and control systems.	

Module	**Topics**	**Hours**
1	**Introduction:** Definition of signal, Singular Functions, Basic Operations on signal such as: Addition, Multiplication, Time Scaling, Time Shifting, Folding, and Amplitude Scaling. Classification: C.T. D.T, Periodic, aperiodic, / non-periodic, Even/Odd, Energy/ Power, causal and anticausal signals. Classification of System: Static and dynamic, time invariant and time variant, Linear and Non linear, Causal and Non causal stable and unstable invertible and non invertible.	10
2	**Linear Time Invariant System:** Linear differential equations, Impulse response Representation of signals by a continuum of impulses.	07

	Convolution for continues time and discrete time (Linear and Circular) Properties of LTI System.	
3	**Fourier Series** Orthogonal functions, definitions, Approximation, Co-efficient calculation on the basis of min. Mean square error. Representation of Fourier series in terms of trigonometric, exponential, complex. Gibbs phenomenon.	04
4	**Fourier Transform** Continuous and Discrete time Fourier transform Properties. Linearity, time shifting, time reversal, frequency shifting, Scaling, Convolution in time domain, diff. in time domain. Differentiation in freq. domain parsevals relation. Relationship between Z, Laplace and Fourier transform.	06
5	**Laplace Transform:** Definition ROC concept, Properties, Inverse LT Transient and steady state response of LTI system. Stability & Causality of system.	07
6	**Z-Transform:** Definition, Convergence, properties and inversion (PFE long division Residue method) of Z-Transform. Concept of single and double sided Z-Transform. Analysis of discrete time system using Z-Transform. Stability and Causality.	14

List of Tutorials / Experiments:

1. Difference between continuous time and discrete time signals, classification, problems on Signal classification.
2. Difference between continuous time and discrete time signals, classification, problems on Systems classification.
3. Problems on Basic Operations on signals.
4. Singular functions, Impulse function and its approximation, I/O systems. Difference equation formulation.
5. Problems on convolution Integral, convolution sum and correlation.
6. Problems on Laplace and its properties.
7. Concept of Z-Transform (Single and Double Sided), analysis, relation between Laplace Transform and Z-Transform.
8. Fourier series representation, properties, problems on Fourier series and Fourier Transform.
9. Fourier Transform, properties, problems on Fourier Transform.
10. Relation between Fourier and Laplace, Solutions to differential equations

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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight tutorials. The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignments)	:10 marks
Laboratory work (Programs / Journal)	:10 marks
Attendance (Practical and Theory)	:05 marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Oppenhelm, Wilsky and Nawab, *Signals and Systems*, PHI / Pearson Education, 2nd edition, 2002.
2. S. P. Xavier, *Signals and Systems*, 2nd Edition, S. Chand and Co., 1998.
3. J.B. Gurung, *Signals and Systems*, 1st Edition, PHI, 2009.

Reference Books:

1. Reddy and Prasad, *Signals Processing*, TMH, Vol. II, 1994.
2. Taylor, *Principles of Signals and Systems*, McGraw Hill, 1994.
3. Haykin, Simon S., *Signals and Systems*, John Wiley, New York, 1978.
4. Lathi B. P., *Signals Processing and Linear Systems*, Oxford University Press,2003.
5. I. J. Nagrath, *Signals and Systems*, 1st Edition, TMH, 2000.
6. Douglas K. Lindner, *Introduction to Signals and Systems*, TMH, 1999.
7. Rodger E. Ziemer, William H. Tranter, *Signals & Systems – Continuous and Discrete*, Pearson Education, 4th Edition, 2002.

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC502	Applications of Microcontroller - I	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg					
ISC502	Applications of Microcontroller - I	20	20	20	80	25	25	--	150

Subject Code	**Subject Name**	**Credits**
ISC502	**Applications of Microcontroller - I**	**5**
Course Objectives	• To make the students understand the fundamentals of 8051 Microcontroller. Students should understand the working of these systems and should be able to determine hardware and software interfacing with real time systems. They should further understand how to design any application based on these systems.	
Course Outcomes	The students will be able to • Define Microprocessor and Microcontroller family with comparison. • Understand working of 8051/8052and MCS251 Microcontrolle Architecture and Programming model. • Understand the concept of Timer, Interrupt, I/O Port interfacing with 8051 Microcontroller. • Understand the concept of Interfacing with Real time System.	

Module	**Topics**	**Hrs.**
1	**Introduction** Microprocessor Definition ,Microcontroller Definition Operation of ALU, Evolution of Microprocessors ,Block Diagram of microprocessor based system and development cycle ,RISC and CISC processors	05
2	**MCS-51 microcontroller** Architecture of MCS 51 family of microcontroller, and its Variants and comparison. Comparison of microprocessor &microcontroller. CPU timing and machine eye le. Memory organization, SFRS. Integrated peripherals such as Timers/Counters, Serial port, parallel I/O pins. Interrupt Structure. Memory interfacing. Power saving & power down mode.	09
3	**Advanced MCS-51 architecture**	06

	8052 enhancements Indirect Memory access,Timer2 ,PCA Architecture of MCS151 Architecture of MCS251	
4	**Programming & Tools** 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. Assembly language Programming practice using assembly & C compiler	12
5	**Serial communication protocols** Operation of serial port. Programming for implementation of asynchronous serial communication. Buses like I2C RTC –DS1307 EEPROM Memory -24C256 SPI – MCP3201	06
6	**Interfacing & Case Studies** Interfacing to LCD, 7 segment display, ADC, DAC, relay, opt isolator. Data acquisition systems, Digital weighing machine, Washing machines, PID temperature controller ,Speed Control of DC motors and similar system design	10

List of Experiments:

1. 16 bit Arithmetic operations (addition, subtraction ,multiplication)
2. Logical operation
3. Code conversion
4. Generating square wave on port pins.
5. Generation of square wave using timer
6. Interfacing keyboard, 7 segments displays.
7. Interfacing LCD display
8. Serial Communication with PC.
9. Interfacing RTC
10. Interfacing DAC and its application
11. Temperature Controller
12. Speed control of DC Motor
13. Frequency measurement
14. Implementing PID controller
15. Stepper motor control.

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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term Work:

Term work consists of minimum eight tutorials. The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignment)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Madizi M.A., The 8085 Microcontroller & Embedded systems, Pearson Educatio Second edition.
2. Kenneth Ayala, Penram International Publishing (India) Pvt. Ltd. Second Edition.

Reference Books:

1. Rajkamal, Embedded Systems, TMH, Second Edition.
2. Tony Givargis, Wiley Student Edition.
3. Manoharan et.al , Microcontroller based system design, Scitech Publications (India) Pvt. Ltd.
4. 8051 / MC151 / MCS251 Datasheets

Websites:

1. www.atmel.com
2. www.microchip.corn
3. www.nXp.com

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC503	Control System Design	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC503	Control System Design	20	20	20	80	25		-	125

Subject Code	**Subject Name**	**Credits**
ISC503	**Control system Design**	**5**
Course Objectives	• To make students understand the concept of state –space analysis ,to design the compensator in time and frequency domain, to design the PID compensator.	
Course Outcomes	The students will be able to • Represent any system in any canonical form. • Determine response of system • Design Lead, Lag and Lead –lag compensator using frequency domain method or time domain method. • Design PID compensator.	

Module	**Topics**	**Hours**
1.	Review: Time and Frequency domain specifications, error constants, effect of addition of poles and zeros on the system response, stability analysis using bode plot and root-locus techniques.	2
2.	**State-Space Analysis of Control system:** Concept of state-space and state model for Linear systems-SISO and MIMO systems, Linearization, State model for Linear continuous time system, State-space representation using phase variables, phase variable formulation for transfer function with poles and zeros, State-space representation using Canonical variables, derivation of transfer function from state model. Diagonalizaion, eigenvalues and eigenvectors, Solution of State equations - properties of state transition matrix, computation of state transition matrix using Laplace Transformation, Cayley – Hamilton theorem.	12

3.	**Controller Design using State-Space:** Concept of controllability and observability, definitions, phase variable form, properties, effect of pole-zero cancellation in transfer function , **State Feedback and Pole placement –** Stabilizability, choosing pole locations, limitations of state feedback **Tracking Problems:** Integral control **Controller design -** for phase variable form, by matching coefficients, by transformation.	8
4.	**Introduction to Compensator:** Analysis of the basic approaches to compensation, cascade compensation, feedback compensation, Derivative and integral error compensation, Limitations of actuator saturation on controller design. **Compensator Design using Root-locus:** Improving steady-state error and transient response by feedback compensation, cascade compensation, integral, derivative compensation, Lag, Lead, Lag-Lead compensation,	11
5.	**Compensator Design using Frequency response:** Steady-state error characteristics of Type 0,1, and 2 systems, Time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.	8
6.	**PID Compensator Design:** PID controller tuning: Cohen-coon method, Ziegler-Nichols method, Performance analysis of designed controllers based on optimal performance indices like ISE,ITAE,IAE and MSE. Designing PID controller using Root-Locus and Bode plot technique.	7

List of Laboratory Experiments(Using MATLAB/Scilab or any equivalent software):

1. Design of Lead Compensator in Time domain.
2. Design of Lag Compensator in Time domain.
3. Design of Lag-Lead Compensator in Time domain.
4. Design of Lead Compensator in Frequency domain.
5. Design of Lag Compensator in Frequency domain.
6. Design of Lag-Lead Compensator in Frequency domain.
7. Design of PID in Time domain.
8. Design of PID in Frequency domain.
9. Design of state feedback controller in state space using pole placement.
10. Verification of controllability and observability.

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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments two case studies.
The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignment)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Case Study:

1. Design a controller using time-domain/frequency domain/pole placement approach for an inverted pendulum on a cart and simulate the same using MATLAB/ Scilab.
2. Design a controller using time-domain/frequency domain/pole placement approach for speed control of DC motor and simulate the same using MATLAB/ Scilab.
3. Design a controller using time-domain/frequency domain/pole placement approach for Magnetic levitation system and simulate the same using MATLAB/ Scilab.
4. Design a controller using time-domain/frequency domain/pole placement approach for any other physical system available in laboratory (Flow loop, pressure loop, level loop etc.) and simulate the same using MATLAB/ Scilab.

Text Books:

1. K. Ogata, *Modern Control Engineering,* Prentice Hall of India, 4th edition, 2002.
2. Norman S. Nise, *Control Systems Engineering,* John Wiley and Sons, Inc. 2000.

Reference Books:

1. M. Gopal, *Control Systems Principles and Design,* TMH, New Delhi, 2nd edition,2002.
2. Stefani, Shahian, Savant, Hostetter, *Design of Feedback Control Systems,* Oxford University Press, 4th Edition, 2007.
3. Richard C. Dorf, Robert H. Bishop, *Modern Control Systems,* Addition-Wesley,1999.
4. I. J. Nagrath and M. Gopal, *Control System Engineering,* 3rd Edition, New Age International (P) Ltd., Publishers - 2000.
5. B.C. Kuo, FaridGdna Golnaraghi, *Automatic Control Systems,* PHI, 7th edition, 2003.
6. Jacqueline Wilkie, Michael Johnson, Reza Kalebi, *Control Engineering – an Introductory Course,* Palgrave, 2002.
7. M. N. Bandopadhay, *Control Engineering - Theory & Practice,* PHI, 2003

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC504	Signal Conditioning Circuit Design	5*	2	-	4	1	-	5

* Out of 5 Theory lecture hours – 4 hours would be Lectures and 1 hour would be for Miniproject (for entire class)

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral (miniproject)	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC504	Signal Conditioning Circuit Design	20	20	20	80	25	25	50*	175

Subject Code	**Subject Name**	**Credits**
ISC504	**Signal Conditioning Circuit Design**	**5**
Course Objectives	• To make students understand the working principle and design of various analog and digital signal conditioning circuits used in industrial applications.	
Course Outcomes	The students will be able to • Understand principle of working of various signal conditioners used with Temperature, Displacement, Optical and various miscellaneous other sensors. • Design signal conditioning circuits for various transducers. • Understand applications of various signal conditioners used in industry. • Capable of selecting best suited signal conditioners for any given application.	

Module	**Topics**	**Hrs.**
1	**Components of Analog Signal Conditioning:** Standard analog signals, Signal Level and bias changes, Linearization, conversion, filtering and impedance matching, concept of loading. **Passive signal conditioners** – Voltage divider, Wheatstone bridge circuits (Current, Voltage, Balanced and Unbalanced), RC filters.	8
2	**Analog signal conditioners and their design**: Practical applications of Op-amp based circuits with design - Differentiators and Integrator, 3 op-amp Instrumentation amplifier with applications, Precision rectifiers – Half wave, full wave, absolute value circuit, Log and anti-log amplifier with temperature	10

	compensation and applications, Active filters, sample and hold circuit , peak detector, threshold detector, zero crossing detector, window detector and Phase locked loops. Guidelines for analog signal conditioning design and design based problems.	
3	**Components of Digital Signal Conditioning** : Converters – ADCs and their different types, DACs and their different types, V to F and F to V converters. 555 Timer – modes of operation with applications. Characteristics of digital data – digitized value, sampled data system and linearization. Data acquisition system design, Encoders and Data logger circuit.	8
4	**Thermal and Pressure Transducer Signal conditioning Design:** Thermal sensor signal conditioning – design considerations and applications for RTD, Thermistor, thermocouple and solid state temperature sensors. Pressure sensor signal conditioning - design considerations and applications for various pressure sensors.	8
5	**Optical and Other Transducer Signal Conditioning Design:** Optical sensor signal conditioning – photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications. Other sensor signal conditioning – Potentiometer, LVDT, strain gauges, piezoelectric transducer and capacitive transducers.	8
6	**Power Supply Design:** 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.	6

List of Experiments:

1. To design general signal conditioning circuit to convert sensor output to 0-5 V
2. To design general signal conditioning circuit to convert sensor output to 4-20 mA
3. To design signal conditioning circuit for low level signals in micro-volts region
4. To design absolute value circuit for an application

5. To design signal conditioning circuit for weight measuring system using strain gauge
6. To design signal conditioning circuit for capacitive transducer
7. To design a second order LPF and HPF for any application
8. To design signal conditioning circuit for RTD
9. To design signal conditioning circuit for LDR
10. To design an analog-to-digital convertor circuit for an application
11. To design and implement Astable and Monostable Multivibrator using 555 timer
12. To design adjustable voltage regulators using IC723/ LM317

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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Miniproject/ Orals:

Students in group of 2-3 would perform a Mini-project on any one application of signal conditioning circuit design and appear for Oral examination of the same.

Term Work:

Term work shall consist of minimum eight experiments (04 experiments from experiment list of 1 to 6 and 04 experiments from experiment list of 7 to 12)

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

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Ramakant Gaikwad, "Op-amp & Linear ICs", PHI Pearson Education.
2. C. D. Johnson, "Process Control Instrumentation Technology (VIII Edition)".

Reference Books:

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

Sub code	Subject Name	Teaching Scheme (Hrs)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC505	Control System Components	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)							
		Internal Assessment (out of 20)			End sem Exam	Term Work	Pract. and oral	Oral	Total
		Test 1	Test 2	Avg.					
ISC505	Control System Components	20	20	20	80	25	25*	-	150

Subject Code	**Subject Name**	**Credits**
ISC505	**Control System Components**	5
Course Objectives	• This course develops the students approach to identify different Control system components like Hydraulic, Pneumatic, Electrical and Electronic. • Students are expected to learn different types of Transmitters. • Students are expected to understand concept of Control Valve, different types of Control valve, their schematic, operation, etc. • They should able to understand different auxiliary process components like feeders, dampers etc.	
Course Outcomes	• The students will demonstrate different control system components like pumps, compressors, flapper nozzle. • The students will demonstrate working of different pneumatic circuits like Single acting cylinder, Double acting cylinder, hydraulic braking systems by using directional control valves. • The students will demonstrate the knowledge of different transmitters, how to use SMART transmitter. • The students will demonstrate the knowledge of control valves, installation, different valve accessories. • The students will learn importance of Alarm annunciators system, square root extractor , pressure and level switches	

Module	Topics	Hrs.
1	**Pneumatics** Pneumatic System Components: ISO symbols Instrument Air and Plant Air ,Air supply system and its components, Air compressors, Pressure regulation devices, air dryers , 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: Flapper Nozzle system, Volume boosters, Air relays, Pneumatic transmitters and controllers, Pneumatic logic gates , Pneumatic Circuits- Standard Symbols used for developing pneumatic circuits, Sequence diagram, dynamic modeling of pneumatic circuits.	10
2	**Hydraulics** Hydraulic System Components: Hydraulic pumps, Pressure regulation method, Loading valves, Hydraulic valves, Hydraulic actuators (cylinder and motor) , Speed control circuits for hydraulic actuators , Selection and comparison of pneumatic, hydraulic and electric systems.	03
3	**Transmitters** Need of transmitter, Need for Standardization of signals, concept of live zero and dead zero, 2-wire; 3-wire and 4-wire current transmitters, Electronic versus pneumatic transmitters, Electronic type transmitters -temperature; pressure; differential pressure; level; flow transmitter, SMART (Intelligent) Block schematic and Comparison with conventional transmitter, Buoyancy transmitter and their applications, Converters- Pneumatic to Electrical and Electrical to Pneumatic converters.	06
4	**Process Control Valves** Control valve terminology: Rangeabilty, Turndown; Valve size; control valve capacity and valve gain, Air to Open(AO), Air to Close (AC) ,selection criterion etc. MOC (Material of construction), type of actuation, applications, advantages, disadvantage of - Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid, Smart control valves, and special designs of Globe valves. 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 Digital actuators. Selection criteria of valve actuators.	14
5	**Auxiliary Process Control Components** Construction, working & application area of- Synchros (Transmitter and Receiver), error detector, Alarm annunciators Fire and gas detectors (types –flame, gas, fire and gas siren), Square root extractor, Feeders, Dampers, Temperature regulator, Flow regulator, Temperature , Flow, Level and, Pressure Switch, Relief valves, safety valves and rupture disk, Thermostats and Humidistat, Steeper motor	4

6	**Industrial Control Components** Switches: Construction, symbolic representation, working, application of Toggle switches, Push buttons, Selector switches, DIP switches, Rotary switches, Thumbwheel switches , Drum switch, Limit switches- contact, non contact- type, Switch specifications. Control Relays: Construction, working, specifications, selection criteria and applications of Electro-mechanical relay, Reed relay, hermetically sealed 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. RFID - basic principles, frequencies, Active and passive RFID systems , mode of communication, various technologies for In house and outdoor RFID systems, Basic theory and devices for vision components, sensors and systems, Image processing and multi camera systems,	14

List of Experiments:

1. Study of various pneumatic and hydraulic system components.
2. Development, implementation and testing of pneumatic circuits.
3. Development, implementation and testing of hydraulic circuits.
4. Study of operation and calibration of 2-wire DP transmitter for flow and level control.
5. Design of a two-wire temperature transmitter.
6. Study of cut-view section of pneumatically operated control valve.
7. Calibration of I to P and P to I converters.
8. Study of control valve Flow characteristics.
9. Study of valve positioner.
10. Study of different types of control valve actuator.
11. Study of pressure/temperature/level/flow switches.
12. Study of square root extractor.
13. Study of different types of control relay.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question 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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term Work:

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

Laboratory work (Experiments)	: 10 Marks
Journal	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Andrew Parr, *Hydraulics and Pneumatics- A technician's and engineer's guide*, Jaico Publishing House, Mumbai.
2. C.D.Johnson, *Process Control and Instrument Technology*, TMH.
3. P. Harriot, *Process Control*, Tata McGraw Hill, 2001.
4. E. B. Jones, *Instrument Technology,* vol-III, Butterworth Publication.
5. D.P. Ekman, *Automatic Process Control*, Wiley Eastern, 1990.
6. Thomas E. Kisell, *Industrial Electronics*, 3rd Edition, PHI.
7. I. J. Nagrath , M. Gopal , Control System Engineering, 5th Editiom, Anshan Publishers, 2008

Reference Books:

1. Pneumatics, Festo Didactic.
2. Hydraulics, Festo Didactic
3. Bella G. Liptak, *Process Control and Optimization, Instrument Engineer's Handbook*, 4th Edition, CRC Press.
4. WG Andrews and Williams, Applied *Instrumentation in the process Industries*, Vol. - I and II, Gulf Publication.
5. Less Driskell, *Control Valve Selection and Sizing*, ISA.
6. J. W. Hatchison, *ISA Handbook of Control Valves*, 2nd Edition, ISA, 1990

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC601	Process Instrumentation Systems	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)							
		Internal Assessment (out of 20)			End sem Exam	Term Work	Pract. and oral	Oral	Total
		Test 1	Test 2	Avg.					
ISC601	Process Instrumentation Systems	20	20	20	80	25	-	25	150

Subject Code	**Subject Name**	**Credits**
ISC601	**Process Instrumentation Systems**	**5**
Course Objectives	• The objective of the course is to make the students familiar with different process dynamics in Process industries and different control schemes generally used to get best output. It also makes students aware of various analysis and design methods for multivariable systems. In addition, the subject also introduces about discrete state process control and Batch process.	
Course Outcomes	• The students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables. • The students will be able to handle different types of controller like electronic, pneumatic and hydraulic. • The students will be able to implement different control schemes to various processes. • The students will be able to design relay logic for various processes. • The students will be able to understand batch process with an example.	

Module	**Topics**	**Hrs.**
1	**Process dynamics** 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.	04
	Process Control Action Elements of process control, Controller Principle, Process Characteristics, Control system parameters, discontinuous, continuous and composite	10

	controller modes/actions (P,I,D,PI,PD and PID).	
3	**Process Controllers and Tuning** General features, construction and working of Pneumatic, Hydraulic and Electronic controller. Process reaction curve method, Zigler-Nichols method, Cohen-coon correction for quarter amplitude, Frequency response method, Relay based tuning.	11
4	**Control Schemes** Feedback, feedforward, cascade, ratio, split range, selective control, adaptive control, and model based control.	08
5	**Multivariable Control** Block diagram analysis of multivariable systems, Interaction, Tuning of Multivariable controllers, relative gain analysis, Decoupler design	05
6	**Discrete-State process control** Discrete state process control characteristics of the system, variables, process specification and event sequence description, Physical ladder diagram-elements and examples. Introduction to Batch Process with example.	10

List of Experiments:

1. Study of ON-OFF Controller.
2. Study of controller modes (pure and composite) on a PID controller with a recorder.
3. Study of specifications and wiring of an electronic PID controller with alarm annunciator.
4. Tuning of a PID controller.
5. Study of feedback feed forward controller.
6. Study of Cascade control (wiring, settings and tuning).
7. Study of split range control.
8. Study of Ratio control.
9. Interaction analysis using RGA for a MIMO process.

Note: All above experiments should be performed on a pilot plant for real time I/Os

Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 Marks.
2 Total 4 question 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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term Work:

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

Laboratory work (Experiments / Assignments)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

6. Curtis D. Johnson, *Process Control Instrumentation Technology*, PHI /Pearson Education 2002.
7. George Stephenopolos, *Chemical process control*, PHI-1999.

Reference Books:

1 M.Chidambaram, *Computer Control of Processes*, Narosa, 2002.
2 Deshpande P.B and Ash R.H, *Elements of Process Control Applications*, ISA Press, New York,1995.
3. D. Patranabis, *Principles of Process Control*, Second edition, TMH.
4. F.G. Shinsky, *Process Control System*, TMH.
5. N.E. Battikha,Condensed Handbook of Measurement and Control,3rd Ed., ISA Publication.
6. Donald P. Eckman, Automatic Process Control, Wiley Eastern Ltd.
7. Franklyn W. Kirk, Nicholas R. Rimboi, *Instrumentation*, First edition,1996, D. B. Taraporewala Sons and co. pvt ltd. – 1996

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC602	Power Electronics and Drives	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)							
		Internal Assessment (out of 20)			End sem Exam	Term Work	Pract. and oral	Oral	Total
		Test 1	Test 2	Avg.					
ISC602	Power Electronics and Drives	20	20	20	80	25	25*	-	150

Subject Code	**Subject Name**	**Credits**
ISC602	Power Electronics and Drives	**5**
Course Objectives	• To equip the students with the basic knowledge of Power semi conductor Devices • To study the controlled Rectifiers, Inverters and DC to DC converters . • To Understand the working AC and DC Drives. • To Study the application of Power Electronics.	
Course Outcomes	Students will be able to • Understand the working of Power Electronics Devices. • Understand working of Controlled Rectifiers ,Inverters and DC to DC converters. • Understand the Working of AC/DC Drives .	

Chapter no.	**Contents**	**Hours**
1	**POWER SEMICONDUCTOR DEVICES**: Introduction to construction, characteristics, ratings & applications of power diodes, power BJT, power MOSFET & IGBT. Study of Thyristors: construction, characteristics, ratings of SCR, TRIAC, GTO. Switching/ triggering methods: switching methods/types of triggering devices like DIAC, UJT & PUT Thyristor commutation Tech. (basic concepts),protection scheme against over-current, over voltage, dv/dt cooling technique	12
2	**THYRISTOR APPLICATION:** Controlled rectifiers: Principles of operations of phase controlled converters, single phase half bridge, semi converter & bridge converters, effect of source inductance on fully controlled bridge converter, performance parameters Design of SCR based DC power circuits	10

	including UJT as triggering device AC power control using SCR-UJT & TRIAC-DIAC like universal speed controller fan regulator Design of SCR/TRIAC based AC power control circuits including UJT/DIAC as a triggering device	
3	**INVERTER** Principles of operation of inverters, PWM inverter, bridge inverter ,basic circuit scheme of IGBT/ power MOSFET based inverter circuits harmonic reduction in inverter output. Inverter circuits using H bridge for 3-phase output.	8
4	**DC to DC Converters** Basic operation of choppers, study of diff. types of chopper circuits like step up, step down chopper, four quadrant operation of chopper, Basic concept of SMPS and Analysis of various conduction modes of Buck, Boost, Buck-Boost, Cuk converter; design and selection of inductor and capacitor for converters.	7
5	**Drives** AC Motor Drives: Concept & requirement of drives, Current fed & Voltage fed drives, rotor resistance control & v/f control of AC motors DC Motor Drives : DC Drives for brushed/brushless motors	7
6	**INDUSTRIAL APPLICATIONS** Induction & dielectric heating process, block diagram, merits/demerits Applications of power electronics in traction	4

List of Laboratory Experiments:

1. SCR Characteristics.
2. TRIAC & DIAC characteristics.
3. Study of various triggering circuits
4. Half wave & full wave controlled rectifier
5. IGBT based inverter
6. SCR/TRIAC based AC power control circuit
7. DC motor speed control using chopper
8. PWM drive for Induction motor using IGBT

Theory Examination:

1. Question paper will consist of total 6 questions carrying 20 marks each.
2. Only 5 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:
Term work consists of minimum eight experiments from the list, two simulations of Power Electronics Circuits and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments / Assignments)	:10 marks
Laboratory work (Programs / Journal)	:10 marks
Attendance (Practical and Theory)	:05 marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Text Books:

1. P.S. Bhimbra, Power Electronics, Khanna publishers, 2004
2. M. H. Rashid, Power Electronics, 2nd Edition, PHI, 2005
3. Power Electronics & its applications, by Alok Jain, PENRAM International Publishing(India) Pvt.Ltd.
4. T.J.E.Miller.'Brushless magnet & Reluctance motor drives' Claredon Press London Power Electronics &Variable frequency drives- Technology & Application , Bimal Bose

Reference Books:

1. P.C. Sen, Power Electronics, Tata McGraw Hill, 2005
2. Mohan Undeland Robbins, Power Electronics- Converters application & Design, Wiley Eastern,1996
3. Dubey, Dorald, Thyristorised Power Controller,Wiley Eastern Ltd.1993
4. G.K. Dubey, Power Electronics & control, PHI 1986
5. S.K. Bhattacharya, Industrial Electronics & Control, TATA McGraw Hill, 2007
6. P.C. Sen Modern Power Electronics, Wheeler Publication
7. Modern Electric Traction by Pratab ,Dhanpat Rai and sons ,Delhi
8. Power Electronics by Cyril W. Lander, Mc Graw Hill Europe
9. Fundamentals of power Electronics with MATLAB, by Randall Shaffer,Book News, INC,Portland(E-book Avaliable)
10. Advanced Electric Drives-Analysis, control & modeling using SIMULINK, Ned Mohon, MNPER-2001
11. Modern Power Electronics & AC Drives, B.K. Bose, Pearson Education Inc.2002

Sub Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /oral	Tutorial	Total
ISC603	Digital Signal Processing	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination Scheme							
		Theory(Out of 100)				Term Work	Prac and Oral	Oral	Total
		Internal Assessment (out of 20)			End Sem Exam				
		Test-I	Test-I	Avg					
ISC603	Digital Signal Processing	20	20	20	80	25	25	-	150

Subject Code	Subject Name	Credits
ISC603	**Digital Signal Processing**	**5**
Course Objectives	• The principle of the syllabus is to give an introduction to basic concepts of system transforms, fundamental principles and applications of signals and filters. • This subject provides understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.	
Course Outcomes	Upon successful completion of this subject, student will be able to, • Determine the frequency response of FIR and IIR filters. • Understand the relationship between poles, zeros, and stability. • Determine the spectrum of a signal using the DFT, FFT, and spectrogram. • Design, analyze, and implement digital filters in Matlab and C,C++.	

Module	Contents	Hours
1	**Brief review:** Discrete time signals and systems, difference equations, Fourier series & Transform, Z-Transform, theorems, properties etc. **Introduction to digital signal processing:** Block diagram of DSP, Advantages, and Sampling Theorem, Classification of Digital Filter (IIR and FIR).	5
2	**Discrete Fourier Transform:-**Introduction to DTFT, Fourier representation of finite duration sequences, the Discrete Fourier Transform, properties of	14

	the DFT, Linear convolution using the DFT and IDFT. **Computation of the Discrete Fourier Transform: -** Decimation in frequency (DIF) algorithms, Decimation in time (DIT) algorithms for Radix 2, 3 composite. Overlap add and save Methods.	
3	**Analysis of Digital Filter: -** Classification of filter on their pole zero diagram. Frequency response of IIR filters frequency response analysis of all types of linear phase system. Difference between IIR and FIR Filters. **Realization of systems: -**Realization of IIR systems by Direct form-I, Direct form-II, Cascade and Parallel. Realization of FIR systems by Direct form, cascade and linear phase system.	11
4	**Digital Filter Design Techniques**:-Properties of IIR filter Discritization Methods like IIT and BLT. Design of Butterworth and Chebyshev-I IIR filter.	8
5	**FIR filter Design:-**Design of FIR filter by using Different Windowing Technique. By using Frequency Sampling. Realization of system by using Frequency Sampling Technique.	4
6	**Multi rate Signal Processing:-**Sampling rate reduction: decimation by integer factors, Sampling rate increase: interpolation by integer factors, sampling rate conversion by non integer factors. **Introduction to Digital Hardware and Applications:-**Digital signal processor series Texas 320, Motorola 56000. Applications to speech, Radar, CT scanner and Digital touch tone receiver.	6

List of experiments:

(Experiments 1 to 6 Using C or C++ and verifying the results using MATLAB)

1. Program for finding linear convolution.
2. Program for finding circular convolution.
3. Program for finding linear convolution using circular convolution.
4. Program for finding correlation (auto and cross).
5. Program for finding DFT's. & IDFT.
6. Implementation of FFT algorithms (DIT, DIF) etc.
7. Program on filter designing.(FIR) (Using MATLAB only).
8. Program on Filter Designing. (IIR) (Using MATLAB only).
9. Minimum two assignments based on structure realizations (IIR, FIR).
10. Study of any DSP processor series and their differences.

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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

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

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. A.V.Oppenhiem & R.W. Scheirer, Discrete signal processing, (PHI) 1999.
2. Johny Johnson, Introduction to D.S.P., (PHI), 1996.

Reference Books:

1. Rabnier Gold, Theory and application of DSP, (PH[EEE edi.) 1996.
2. Proakis and Manoliakis, Digital signal processing. (PHl 3rd) 1997.
3. Sanjit. K. Mitra, Computer aided approach t0 DSP, TMH, 1998.
4. A Antoniou, Digital filter analysis, design and application, TMH pub. **2nd.** 1993.
5. B. Vankataramani & M. Bhaskar, Digital Signal Processors, Tala 1cGraw Hill.2002.
6. Emmauel c: Ifeachor & Barrie W. Jervis, Digital Signal Processing, Pearson Education, 2ndedition, 2000.
7. Ashok Arnbardar, Analog and Digital Signal Processing, Thomson Learning, 2nd edition, 1999.
8. Thonas J. Cavicchi, Digital Signal Processing, Jhon Wiley 20001.
9. Digital Signal Processing by Chen, Oxford University Press

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC604	Applications of Microcontroller - II	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC604	Applications of Microcontroller - II	20	20	20	80	25	25*	--	150

Subject Code	**Subject Name**	**Credits**
ISC604	**Applications of Microcontroller - II**	**5**
Course Objectives	• To make the students understand the fundamentals of PIC Microcontroller. Students should understand the working of these systems and should be able to determine hardware and software Interfacing with real time systems. They should further understand how to design any application based on these systems.	
Course Outcomes	The students will be able to • Define Embedded system and its Applications in industry. • Understand working of PIC 18F Microcontroller Architecture and Programming model. • Understand the concept of Timer, Interrupt, I/O Port interfacing with PIC 18F Microcontroller. • Understand the concept of Interfacing with Real time System.	

Module	**Topics**	**Hrs.**
1	**Embedded systems**: Definition, embedded system overview, classifications, Design challenges, processor technology, IC technology and Design Technology and tradeoffs. Examples of embedded system.	04
2	**PIC 18F Microcontroller architecture Hardware** PIC 18F Microcontroller family, PIC18F architecture, features PIC18F4520 , Block diagram, Oscillator configuration, power saving modes Memory model, EEPROM and RAM , Program Memory. Hardware multiplier, Interrupts, I/O ports, Timer, capture/compare/PWM (CCP) module, ECCP module. Master syschronous Master Synchronous Serial Port (Mssp) Module, Enhanced Universal Synchronous Asynchronous Receiver Transmitter (Eusart), Analog-To-Digital Converter (A/D) Module, Comparator Module.	10

3	**PIC 18F Software**: PIC 18F Instruction set, Instruction format, Integrated Development Environment(IDE), Assembling, Debugging, and Executing a program Using MPLAB IDE in assembly and embedded C, Data copy operation ,Arithmetic operation, Branch and Skip operation, Logic operations, bit Operation, Stack and Subroutine, Code conversion programs and Software Design.	12
4	**Case Study:** I/O port Interfacing, Interfacing O/P peripherals such as seven segment LED, LCD, Interfacing I/P peripheral such as push button keys, Matrix keyboard, interfacing sensors using Analog to Digital convertor module, D/A convertor module, Interfacing a temperature sensor to the A/D convertor module. PWM generation for different applications.	10
5	**Serial I/O:** Basic concept in serial communication, EIA-232 and PIC 18 serial communication module ,USART, SPI, I²C(Inter-Integrated Ckt) Protocol.	06
6	**Real Time Operating System (RTOS)** Introduction to RTOS concept. RTOS Scheduling models. Task scheduling examples using different algorithms. Interrupt latency and response times of the tasks as performance metrics. Example of any tiny RTOS.	06

List of Experiments:

16. 16 bit Arithmetic operations (addition, subtraction ,multiplication)
17. Logical operation
18. Code conversion
19. Generating square wave on port pins.
20. Generation of square wave using timer
21. Interfacing keyboard, 7 segments displays.
22. Interfacing LCD display
23. Serial Communication with PC.
24. Interfacing RTC
25. Interfacing DAC and its application
26. Temperature Controller
27. Speed control of DC Motor
28. Frequency measurement
29. Implementing PID controller
30. Stepper motor control.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question 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.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term Work:

Term work consists of minimum eight tutorials. The distribution of the term work shall be as follows,

Laboratory work (Experiments)	: 10 Marks
Laboratory work (programs / journal)	: 10 Marks
Attendance (Theory and Practical)	: 05 Marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Madizi M.A., PIC 18F *Microcontroller & Embedded systems,* Pearson Education Second edition.
2. Ramesh Gaokar,Fundamentals of Microcontrollers and applixcation in Embedded sytem(With PIC 18 Microcontroller family)Penram International Publishing.

Reference Books:

1. Rajkamal, *Embedded Systems*, TMH, Second Edition.
2. Tony Givargis, Embedded system design Wiley Student Edition.
3. Peatman,Design with PICMicrocontroller,Pearson Education.
4. Han-way Huang,PIC Microcontroller,India Edition

Websites:

1. www.microchip.com
2. www.atmel.com
3. www.nxp.com

Sub code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC605	Industrial data communication	4	2	-	4	1	-	5

Sub code	Subject Name	Examination Scheme							
		Theory(out of 100)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISC605	Industrial data communication	20	20	20	80	25	-	-	125

Subject Code	Subject Name	Credits
ISC605	**INDUSTRIAL DATA COMMUNICATION**	**5**
Course Objectives	• To make students understand the OSI reference model, LAN network, different Open control network, Networks at different levels such as sensor level, device network control, HART, Foundation field bus, Wireless technologies	
Course Outcomes	The students will be able to • Understand basic reference model, LAN for networking. • Understand various architecture/working of different protocol. • Make comparative study of various wireless technology. • Understand applications of various protocols in industry.	

Module	Contents	Hours
1	**Introduction:** OSI reference model, LAN architecture and topology Transmission media:UTP cable,STP cable,co-axial cable,fiber optics,wireless media Data Link Layer,MAC sublayer(media access algorithums),error detection and correction code Network components: repeaters, bridge, hub, switch, router, gateways	09
2	**Open control network:** RS232, RS422, EIA 485, Ethernet- MODBUS – structure, function codes and implementation, General Purpose Instrument Bus, specifications. **Proprietary control network**: MODBUS plus, data highway plus.	07
3	**Networks at different levels:** Sensor level network: AS-i, CAN, Devicenet, Interbus and LON	08

	Device network: Foundation Fieldbus –H1, HART, PROFIBUS-PA Control network: BACnet, ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP	
4	**HART:** Architecture – physical, data link, application layer, communication technique, normal and burst mode of communication, troubleshooting, benefits of HART.	06
5	**Foundation fieldbus:** Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process. **OPC Architecture**	12
6	**Wireless technologies:** Satellite systems, Wireless LANs (WLANs), WiFi, VPAN, Zigbee, bluetooth GPRS and – their comparison, limitations and characteristics.	06

Theory Examination:

1. Question paper will consist of total 6 questions carrying 20 marks each**.**
2. Only 4 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term Work:

Term work consists of minimum eight experiments based on above syllabus, two assignment. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :10 marks
Test (at least one) :10 marks
Attendance (Practical and Theory) :05 marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted

by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Deon Reynders, Steve Mackay ,Edwin Wright, *Practical Industrial Data Communications*, 1st edition ELSEVIER, 2005.
2. Lawrence M Thompson, *Industrial data Communication*, 2nd edition, 1997.

Reference Books:

1. Daniel T Miklovic, *Real time control network*, ISA 1993.
2. Bela G Liptak, *Process software and digital networks*, 3rd edition, 2002.
3. Andrew S. Tanenbaum, *Computer Networks*, 4th Edition, PHI/Pearson Education, 2002.
4. Behrouz A. Forouzan, *Data Communications and Networking*, 2nd update Edition, Tata McGraw Hill Publishing Company, New Delhi, 2000.
5. Douglas E. Comer, *Computer Networks and Internets*, 2nd Edition, Pearson Education Asia, 5th Indian reprint, 2001.

Subject code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
ISC606	Analytical Instrumentation	3	2	--	3	1	--	4

Subject code	Subject Name	Examination Scheme							
		Theory(out of 100)					Term Work	Oral	Total
		Internal Assessment (out of 20)			End sem Exam	Exam duration (inHrs)			
		Test 1	Test 2	Avg					
ISC606	Analytical Instrumentation	20	20	20	80	03	25	-	125

Subject Code	Subject Name	Credits
ISC606	**Analytical Instrumentation**	**4**
Course Objectives	To introduce the basic concept of qualitative and quantitative analysis of a given sample. To study various spectroscopic techniques and its instrumentation. To study the concept of separation science and its applications. To study the concept of industrial analyzers and its applications.	
Course Outcomes	• The students get well versed with the principle, construction and working of various analytical instruments. • Students get detailed information about the applications of analytical techniques in medicine, industry etc.	

Module	Contents	Hours
1	**Introduction:** Introduction to analytical process, selection of instruments for application in industries. Compare classical analytical techniques with instrumental techniques. **Fundamentals of Spectroscopy:** Nature of Electromagnetic Radiation, Electromagnetic spectrum, Numerical on EMR and laws of photometry. Introduction to spectroscopic methods, Instrumentation of spectroscopic analytical system – Radiation sources, filters and monochromators, diffraction grating, detectors, signal processors and readout modules.	05
2	**Molecular Spectroscopy:** Molecular Energy levels, correlation of energy levels with transitions. **a) Electronic transitions and Vibrational transitions –** Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications. Fluoroscopy, Phosphoroscopy and Raman Spectroscopy – basic principle, components and its instrumentation. Basic principle	10

	of IR absorption spectroscopy. **b) Nuclear/Rotational transitions** – Nuclear Magnetic Resonance (NMR), spectroscopy, basic principle and its instrumentation, constructional details of NMR, numerical. Basic principle of ESR.	
3	**Atomic Spectroscopy:** Atomic Energy levels, Atomic absorption spectroscopy – components, working and absorption spectra. Atomic Emission spectroscopy – components, working and emission spectra, comparison between AAS and AES.	03
4	**Separation Science:** **a) Chromatography:** Fundamentals of chromatographic separations, classification. Solid, liquid, gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram. **b) Mass Spectrophotometers:** Components of Mass Spectrometer, Types of mass spectrometers, sample handling techniques for liquids and solids, resolution, numericals on resolution. Interfacing Chromatography and Mass spectrometry.	10
5	**Radio Chemical Instrumentation:** Radio chemical methods, radiation detectors – Ionization chamber, Geiger Muller counter, proportional counter, scintillation counter, semiconductor detectors, pulse height analyzer. **X-ray spectroscopy and Gas analyzers:** Production of X-ray spectra, Instrumental methods, detectors, X-ray absorption meters.	06
6	**Industrial Gas Analyzers:** Oxygen, carbon dioxide (CO2), carbon monoxide (CO), NOx analyzers, Gas density analyzer, online gas analyzers.	02

List of Laboratory Experiments:

1. Photoelectric Colorimeter
2. Nephalo-turbidity meter
3. Densitometer
4. Refractometer
5. Single beam Spectrometer for UV/VIS range.
6. Double beam Spectrometer for UV/VIS range.
7. Gas Chromatograph
8. Atomic absorption spectrometer
9. Balance Cell Calorimeter
10. Spectroflourimeter
11. Geiger Muller Counter.
12. Scintillation Counter.

Theory Examination:

1. Question paper will consist of total 6 questions carrying 20 marks each.
2. Only 4 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.

4. Remaining questions will be mixed in nature and weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

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

Laboratory work (Experiments / Assignments)	:10 marks
Laboratory work (Programs / Journal)	:10 marks
Attendance (Practical and Theory)	:05 marks

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

Assessment:

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

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

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

Reference Books:

1. Skoog, Holler, Nieman, *Thomson Principles of Instrumental Analysis*, Books-Cole publications, 5th ed..
2. Ewing Galen W., *Instrumental Methods of Chemical Analysis*, McGraw-Hill Book Company, 5th ed.
3. Braun Robert D., *Introduction to Instrumental Analysis*, McGraw-Hill Book Company.

4. Sherman R.E., *Analytical Instrumentation*, ISA Publication.