UNIVERSITY OF MUMBAI

Bachelor of Engineering

Instrumentation Engineering (Third Year –VI),
Revised course

(REV- 2012) from Academic Year 2014 -15,
Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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**

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)				Term Work	Pract. and oral	Oral	Total
		Internal Assessment (out of 20)			End sem Exam				
		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, 2nd edition, 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.