Savitribai Phule Pune University

Department of Instrumentation Science

PROSPECTUS

For

M. Sc. Instrumentation Science (Choice based Credit System)

Savitribai Phule Pune University

Pune 411007.

BACKGROUND

All over the world the growth of an Industrial society in a Nation is measured by its use of Scientific Instruments. This is because the R & D achievements in research organizations and Industries depend on the availability of advanced instruments. Further the instruments can be utilized to its full capacity only if well trained manpower is available for design, development, usage and timely repair and maintenance. This is possible when the gap between Pure Sciences and Engineering; that is in effect the gap between Academic Society and Industrial Sector is bridged. This is a well-established fact today.

It is the requirement that has led to the emergence of Instrumentation Science – a new discipline of not only Science but technology as well and has become frontline area today. The discipline of Instrumentation Science necessarily needs the understanding of latest trends and achievements in the field of Physical, Chemical and Biological Sciences. The main objective of Instrumentation Science is to logically translate the proven research ideas into a reliable and effective but simple, elegant and handy instruments and gadgets. This will facilitate not only the development of high technology products in diverse fields but also the teaching of advanced techniques in the frontline research.

To fulfill these goals, Savitribai Phule Pune University instituted Department of Instrumentation Science and introduced M. Sc. Instrumentation Science course. This is an industry / R & D oriented professional course. It incorporates compulsory 3 to 4 month's practical training in an industry / R & D organization and a project therein of six months. This gives exposure to the student to day-to-day life environment. The seminar course develops communication skill. Few expert lectures on industrial and financial management are organized. Practicals in workshop techniques and skills are also arranged**.**

M. Sc. Instrumentation Science
(Two Years Master's Course in Instrumentation Science)

1. **ELIGIBILITY:** B.Sc. with Physics / Electronics / Instrumentation Science / Computer Science / Vocational Physics / Electronics or B.E. (E & TC) / (Instrumentation)

2. DURATION: Two years (Four semester course)

Note: This is Industry oriented TWENTY-FOUR months professional course.

3. COURSE STRUCTURE

SEMESTER - I:	4 Theory Courses	4 Credits each
	1 Theory Course	2 Credits
	2 Laboratory Courses	4 Credits each

SEMESTER - II:	4 Theory Courses	4 Credits each
	1 Theory Course	2 Credits
	2 Laboratory Courses	4 Credits each

After completion of Semester - II Industrial Training for Two Months.
(***15th May to 15th July)***

	Industrial Training	**06 Credits**

SEMESTER - III:	4 Theory Courses	4 Credits each
	1 Departmental Course	2 Credits
	2 Laboratory Courses	4 Credits each

SEMESTER - IV:	1 Theory Course	2 Credits each
	1 Project based Theory Course	4 Credits
	Industrial Project	**10 Credits**

Semester I – Overview

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 01	**Integrated Circuits and Linear Techniques**	**4**	**-**	**4**
IS1 UT 02	**Digital Electronics**	**4**	**-**	**4**
IS1 UT 03	**Test and Measuring Instruments**	**4**	**-**	**4**
IS1 UT 04*	**Open Course**	**4**	**-**	**4**
IS1 UT 05	**Basic Mathematical Techniques**	**2**	**-**	**2**
IS1 UP 01	**Analog and Digital Electronic Lab**	**-**	**4**	**4**
IS1 UP 02	**C programming Lab**	**-**	**4**	**4**

Semester II – Overview

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS2 UT 06	Sensors, Transducers and Signal Conditioning	4	-	4
IS2 UT 07	Power Electronics	4	-	4
IS2 UT 08	Microcontroller and Embedded Systems	4	-	4
IS2 UT 09	Feedback Control System	4	-	4
IS2 UT 10	Signals and Systems	2	-	2
IS2 UP 03	Application Software Practices	-	4	4
IS2 UP 04	Sensors, Signal Conditioning and Microcontroller Lab	-	4	4

Course duration:-15th May to 15th July

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UP 05	Industrial Training	-	6	6

Semester III – Overview

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UT 11	Process Control	4	-	4
IS3 UT 12	Industrial Automation	4	-	4
IS3 UT 13	Analytical Instrumentation	4	-	4
IS3 UT 14	Optical Instrumentation and Photonics	4	-	4
IS3 DT XX	Departmental Course	2	-	2
IS3 UP06	Analytical and Optical Instrumentation Lab	-	4	4
IS3 UP07	Process Control and Industrial Automation Lab	-	4	4

Semester IV – Overview

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS4 UT 15	**Industrial Product Design**	**2**	**-**	**2**
IS4 UT 16	**Course related to Industrial Project**	**4**	**-**	**4**
IS4 UP 08	**Industrial Project**	**-**	**10**	**10**

***IS1 UT 04 Open Course:**

This course will be choice of the students. Depending upon the background of maximum number of students (As they are coming from different specializations) one course will be finalized, which will be from the following list, but it is not mandatory that the course should be from the given list. **The course may be any other course related to the field.** The course will be design by the concerned teacher and will be approved by the faculty of the department. The assessment of the course will be done by the concerned teacher by giving assignments and tutorials, open book test, seminar etc. If the student is unable to suggest the course, department will finalize the course in consultation with student from given list.

1) Discrete circuit Design.
2) Semiconductor Physics and Devices.
3) Network Synthesis and Filter Design.
4) Electrical Technology and Instruments.
5) Basic Electrical Engineering.
6) Network Theory.
7) Materials and Fabrication Techniques.

*** **IS3 DT XX: DEPARTMENTAL COURSES:***

Any one of the theory courses mentioned in the list of Departmental (Specialization) courses will be conducted provided adequate number of students opts for it.

Important Note: Following, other departmental, courses will be offered depending upon availability of the staff and facilities. The detailed syllabi can be made available if required / asked for.

IS3 DT 01	Biomedical Instrumentation
IS3 DT 02	Instrumentation For Environmental Engineering
IS3 DT 03	Power Plant Instrumentation
IS3 DT 04	Digital Communication
IS3 DT 05	Solar cells and Photo Chemical Systems

IS3 DT 06	Agro based Instrumentation
IS3 DT 07	Robotics
IS3 DT 08	Optoelectronics

IS4 UT01: Industrial Product Design

IS4 UT01 courses will not be taught in the class room. However respective mentor/staff will guide the student in the preparation/study of this Course.

IS4 UT02: Course related to Industrial Project

IS4 UT02 courses will not be taught in the class room. However respective mentor/staff will guide the student in the preparation/study of this Course. The Course **related to Industrial Project** (i.e. **IS4 UT02**) will be designed by the Department faculty with reference to the list given below:

1) Embedded Systems and Applications
2) Renewable Energy Systems
3) Power Electronic System Design
4) Microcontroller Based Instrumentation
5) VLSI based system design
6) Soft computing Techniques
7) Advanced process control

Note: The content of the syllabus may be varying according to the concerned project.

Rules of Credit System for M. Sc. (Instrumentation Science)

1. M. Sc. Instrumentation science course has average 7 modular courses per semester.

2. For earning the degree of M. Sc. Instrumentation Science, every student will have to obtain 100 credits of which a minimum of 75% of the credits will have to be earned from the core / compulsory courses from the syllabus as defined by the Department of Instrumentation Science.

3. A student can opt for remaining 25% of the credits from the courses offered by other departments with proper cross matching. This cross matching can be carried out in consultation with the Departmental committee and concerned Head of Departments.

4. Assessment for each theory course is divided into two parts, Internal examination and External termend examination in the ratio of 50:50. Teacher may select any / combinations of the following methods for internal assessment.

    a) Series of internal tests

b) Seminar presentation
c) Assignments
d) Survey Excursion work
e) Group Discussion
f) Open book test
g) Report/Notes on research paper or study tour

5. The outline of the distribution of maximum marks for various aspects/mechanisms towards continuous assessment of the practical is as follows:
   a) Journals -10 marks
   b) Viva-voce at the time of submission of each practical-20 Marks
   c) Group Discussion of 5/6 students for testing the understanding level of a student – 10 marks.
   d) Attendance – 5 marks
   e) Additional practical work of in disciplinary approach – 5 marks

6. At least three experiments should be asked for the full course of 4/5 credits and at least two for 2/3 credits.

7. Certified Journal would be compulsory to appear for the ESE (ETE) practical course.

8. There shall be two experts from the parent Department and two examiners (one of which will be external) per batch.

9. Rules for granting term for theory / practical course consists of minimum 75 % attendance for the theory course and completion of Laboratory Journal for at least 75% practical in all respect.

10. Internal assessment for Industrial Training and Project will be carried out on the basis of assessment by the internal guide / staff during the visits, periodic reporting, presentations by the student and the confidential report from the Industry.

11. Granting of term for Industrial Training and Project will be decided on the basis of attendance, actual work carried out by the student, assessment by the internal guide / staff and confidential report from the Industry.

12. The external term end examination consists of

a) Theory course	Written examination
b) Practical course	Practical examination and viva-voce
c) Industrial Training	Oral presentation followed by the question answers
d) Project	Oral presentation followed by the question answers

13. For getting a credit for a particular course, student must obtain minimum 40% marks in total (internal assessment and external examination) for the course. For each course grade and grade points would be awarded as shown in the following table.

Marks Obtained %	Grade	Grade Points
80 - 100	O: Outstanding	10
70 - 79	A+**:** Excellent	9
60 - 69	A: Very Good	8
55 - 59	B+: Good	7
50 - 54	B: Above Average	6
45 - 49	C: Average	5
40 - 44	P: Pass	4
0 - 39	F: Fail	0
-	Ab: Absent	0

14. Final grade w. e. f. the AY 2015-16 (10 point scale):

GPA	Final Grade
09.00 - 10.00	O
8.50 - 08.99	A+
7.50 - 08.49	A
6.50 - 07.49	B+
5.50 - 06.49	B
4.25 - 05.49	C
4.00 - 04.24	P
00.00 - 03.99	F

Remark: B+ is equivalent to 55% marks and B is equivalent to 50% marks

15. **INDUSTRIAL TRAINING:** Industrial training is for the period of 2½ – 3 months, in an Industry / R & D organization nearby Pune.

16. **PROJECT:** The Project work must be carried out in an industry / R & D organization for a period of Six months (within PMC and PCMC limits).

17. **DEGREE AND CERTIFICATE:** A detailed Statement of Cumulative Grade point shall be provided as per the University procedure. The successful candidates will be awarded with the degree certificate as per the University rules.

18. **CLASS IMPROVEMENT:**

When student appeared for Class improvement, it is difficult to arrange for internal assessment. In such case student will appear for 100 mark question paper of each course and his total marks obtained will be divided equally into external marks and internal marks. Example: If student obtained X marks in the class improvement examination in

one course, then his marks will be divided into the internal and the external examination as shown below in that course.

i) Internal credit will be = X/2
ii) External credit will be = X/2

DETAILED SYLLABUS

NOTE: 1) The theory courses may be changed, and / or replaced by special topics to keep the pace with advances in instrumentation and technology.
2) Numbers in the bracket indicate tentative number of lectures

Semester – I

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 01	**Integrated Circuits and Linear Techniques**	**4**	**-**	**4**
Course Objectives	• To familiarize the student with basic electronic devices and circuits. • To provide understanding of operation of diodes, bipolar and MOS Transistors, DC biasing circuits, Transistors as switching device. • Operational amplifier circuits, Power circuits and systems.			
Course Outcomes	• Students will be able to analyze, simulate, and design amplifiers using BJT and MOSFETs. • Students will be able to design various circuits using operational amplifiers. Students will be able to do analysis of biasing techniques, frequency response, feedback, stability, noise, and nonlinearities associated with various devices and circuits.			

Unit I: **(15 Hrs)**

PN junction diode- IV characteristics – Rectifiers: Half Wall Rectifier , Full Wall Rectifier ,Bridge Rectifier, filters-Zener diode, junction transistor, Transistor construction, Input and output characteristics of CE, CB and CC configurations, Power transistors. FET – IV characteristics, VP, JFET, small signal model, LF and HF equivalent circuits , CS and CD amplifiers ,cascade and cascade , Darlington connection , MOSFET - Characteristics , enhancement and depletion

Unit II: **(15 Hrs)**

Basics of Operational Amplifiers: CE Amplifier, Differential Amplifier using transistor, Operational Amplifier- construction, working, characteristics, performance specifications (IC LM 741, LM 324, OP07), Operational Amplifier with negative feedback: Effect of

negative feedback on input resistance, output resistance, bandwidth, gain, offset voltage for inverting, non-inverting and differential amplifier.

Unit III: (15 Hrs)

Linear applications: summing, scaling, averaging, applications of Operational Amplifiers with inverting, non inverting and differential configurations, Instrumentation Amplifier, Differentiator, Integrator, V to I , I to V converter, Log Antilog configurations, Operational Amplifier with positive feedback: Effect of positive feedback on performance of amplifier, Oscillator, Wien Bridge, Phase shift, Comparators, Zero crossing detector, Schmitt trigger, Precision Rectifier, Applications of above configurations

Unit IV: (15 Hrs)

Timer: IC 555, internal block diagram, working, modes, specifications and its applications, 8038 pulse generator, Voltage Regulator: Theory, Performance specifications, Linear and Switch mode regulators, IC723, Theory and applications, IC 78XX, IC 79XX regulators, Power Supply Design

Text Books:

1. Ramakant Gaikwad, " Operational Amplifiers" Prentice-Hall of India, 4th edition, 2009

2. William D. Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education India, 4th edition, 2004.

3. Albert.P. Malvino, David Bates, "Electronic principles", McGraw-Hill, 8th Edition 2015.

Reference Books:

1. Paul Horowitz, Winfield Hill, "The Art of Electronics", Cambridge University press, 3rd edition, 2015.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 02	**Digital Electronics**	**4**	**-**	**4**
Course Objectives	• To teach principles of digital electronics. • To teach topics including Boolean algebra, basic gates, logic circuits, flip-flops, registers, arithmetic circuits, counters, interfacing with analog devices, and computer memory.			
Course Outcomes	• Students will be able to represent numerical values in various number systems and perform number conversions between different number systems. • Students will demonstrate the knowledge of operation of logic gates, Boolean algebra, Karnaugh map reduction method. • Students will demonstrate the knowledge of operation of basic types of flip-flops, registers, counters, decoders, encoders, multiplexers, and de-multiplexers. • Students will be able to analyze and design digital combinational circuits including arithmetic circuits (half adder, full adder, and multiplier). • Students will be able to analyze sequential digital circuits. Students will demonstrate knowledge of the nomenclature and technology in the area of memory devices: ROM, RAM, PROM, PLD, FPGAs, etc.			

Unit I: (15 Hrs)

Number System & Logic Design Minimization Techniques Introduction: Binary, Hexadecimal numbers, octal numbers, number conversion and their arithmetic,

Signed Binary number representation: Signed Magnitude, 1's complement and 2's Complement representation.

Binary, Octal, Hexadecimal Arithmetic: 2's complement, arithmetic.

Codes: BCD, Excess-3, Gray code, Error detecting & correcting Codes, ASCII Code and code, conversions., BCD Arithmetic.

Boolean algebra: Truth tables and Boolean algebra. Idealized logic gates and symbols. DeMorgan's rules Axiomatic definition of Boolean algebra, Basic theorems and properties of Boolean algebra.

Logic minimization: Representation of truth-table, SOP form, POS form, Simplification of logical functions, Minimization of SOP and POS forms, Don't care Conditions.

Reduction techniques: K-Maps up to 4 variables and Quine-McClusky techniques.

Unit II: (15 Hrs)

Logic Families Standard characteristics: Speed, power dissipation, fan-in, fan-out, current and voltage, parameters, noise margin, operating temperature etc.

ECL, NMOS, PMOS families: Basic circuits, Standard TTL characteristics, Operation of TTL NAND gate. TTL Configurations- Active pull-up, Wired AND, totem pole, open collector.

CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs, Detail comparison, of TTL & CMOS

Interfacing: TTL to CMOS and CMOS to TTL, Tristate Logic

Unit III: (15 Hrs)

Combinational Logic Circuits: - Half- Adder, Full Adder, Half Subtract or, Full Subtractor, BCD adder, look ahead and carry, parity generator and checker , magnitude comparator ,code convertors

Decoders- Working of decoder, implementation of expressions using decoders ,IC 74138 , BCD to 7 segment decoder circuits , BCD to 7 segment decoder/driver IC 7448/7447,

Encoders-- working of encoders, priority encoders, IC 74148

Multiplexers (MUX):- Working of MUX, Implementation of expression using MUX (IC 74153, 74151).

Demultiplexers (DEMUX):- Working of DeMUX, Implementation of expression using DEMUX

Unit IV: (15 Hrs)

Sequential Logic Introduction: Sequential Circuits. Difference between combinational circuits and Sequential circuits

Flip flop :-SR, JK, D, T; Preset & Clear, Master and Slave Flip Flops their truth tables and excitation tables, Conversion from one type to another type of Flip Flop.

Application of Flip-flops:- Switch Bounce Elimination

Registers: - Buffer register; shift register; IC 7495

Counters: definition of Modulus of counter, Asynchronous counters. Synchronous counters, state diagram representation, Design of Synchronous counters, Presettable and programmable counters, Decade/BCD counters, ring and Johnson counters, Divide by N counter, timing diagram of counters, Realization of counters using ICs 7490, 7492,7493 and 74193, Sequence Generator: using shift registers and counters

PLDs & Introduction to Microprocessor PLD: PLA- Input, Output Buffers, AND, OR, Invert/

Non-Invert Matrix Design Example: Any 4 Variables SOP function using PLDs, Study of basic Architecture of FPGA and CPLD

Applications of Digital circuits: Digital Clock, Frequency counter, Stepper motor sequence generator, Alarm announciator.

Memory: RAM, ROM, EEPROM, EPR, Flash Memory, bubble memory, CD ROM

Text Books:

1. Albert P Malvino and leach , " Digital Principles & Applications", Tata McGraw-Hill delhi, 8th Edition, 2015.
2. Thomas L Floyd "Digital Fundamentals", Pearson Education, 11th Edition, 2014.
3. R.S. Gaonkar, "Microprocessor Architecture Programming and Applications with 8085", Penram International Publishing**,** 6th Edition, **2013.**

Reference Books:

1. Thomas L Floyd, "Digital Fundamentals", Pearson Education, 11th edition, 2014.
2. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education Asia, 4th Edition 2011 / international Edition 2013

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 03	Test and Measuring Instruments	4	-	4

Course Objectives:

1. To study advanced electronic measuring instruments introduced in the market.
2. To understand the the functions, specifications of instrument and measurements using these instruments.
3. The main objective of this course is to introduce and expose the students to various measuring instrument, their block diagram, specifications and applications.

Course outcome:

1. Understand fundamental of measurements of various electrical parameters.
2. Aware and identify the control panels of measuring and generating instruments.
3. Understand and describe specifications, features and capabilities of electronic instruments.
4. Select appropriate instrument for the measurement of electrical parameter professionally.
5. Finalize the specifications of instrument and select an appropriate instrument for given measurement.
6. Make the required measurement using various instruments.

Unit I: **(15 Hrs)**

Static and Dynamic characteristics of instruments, dead zone, hysteresis, threshold, resolution, input & output impedance, loading effects, fundamentals of measurements, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors , calibration of instruments, traceability, calibration report & certification.

DC bridges: Wheatstone bridge and Kelvin bridge design, bridge sensitivity, errors in bridge circuits, null type and deflection type bridges, current sensitive and voltage sensitive bridges, applications of DC bridges

Unit II: **(15 Hrs)**

Signal Converters: I To P / P To I Converter, Temperature to Voltage Converter, Conversion To Frequency, Period, or Time Duration, Measurement of Phase Difference Using X-OR and SR Flip-Flop Method, Measurement of Active And Reactive Power of Supply Line, Lock-in Amplifiers, Variable Oscillators, Direct Sensor Microcontroller Interfacing.

Isolation Techniques: Transformer Isolation, Optical Isolation, Digital Techniques For Optical Isolation, Hall-Effect Principle and Measurement of Displacement, Current And Power Using Hall Sensors, Amplifications of Low Level Signals, Guarding, Shielding.

Unit III: **(15 Hrs)**

Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital voltmeter, Vector Voltmeter.

Digital Instruments: Block diagram, principle of operation, Accuracy of Measurement Digital Multimeter, Kilo Watt Hour meter, Phase meter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer, DSO, Frequency meter.

Unit IV: **(15 Hrs)**

Instrument for Generation and Analysis of Waveforms: Introduction, The Sine Wave Generator, Frequency Synthesized Signal Generator, Frequency Divider Generator, Signal Generator Modulation, Sweep Frequency Generator, Pulse and Square Wave Generator, Function Generator, Wave Analyzers, Harmonic Distortion Analyzer, Spectrum Analyzer.

Reference Books:

1. Helfrick Albert D., Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall India, 2nd Edition, 2008.
2. Sawhney A. K., "A Course in Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 11th Edition, 2005.
3. Kalsi H. S., "Electronic Instrumentation", Tata McGraw-Hill Education, 3rd Edition, 2010.
4. Bell David A., "Electronic Instrumentation and Measurements", Pearson Education, 3rd Edition, 2013.
5. Rangan C. S., Sarma G. R., Mani V. S. V., "Instrumentation Devices And Systems", Tata McGraw-Hill, 2nd Edition, 2001.
6. A. J. Bouwens, "Digital Instrumentation", McGraw-Hill, 1st Ed., 1997. 16th reprint 2008

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 04*	**Open Course**	**4**	**-**	**4**

IS1 UT 04 Open Course:

This course will be choice of the students. Depending upon the background of maximum number of students (As they are coming from different specializations) one course will be finalized, which is from the following list, but it is not mandatory to the given list. **The course may be any other course related to the field.** The course will be designed by the concerned teacher and will be approved by faculty of the department. The assessment of the course will be done by the concerned teacher by giving assignments and tutorials, open book test, seminar etc. If the student unable to suggest the course, department will finalized the course in concerned with student from given list.

1) Discrete circuit design
2) Semiconductor physics and Devices
3) Network synthesis and filter design
4) Electrical technology and Instruments
5) Basic Electrical Engineering
6) Network Theory
7) Materials and Fabrication Techniques

Note: The detailed syllabus of the above courses is given at the end of the document.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UT 05	**Basic Mathematical Techniques**	**2**	**-**	**2**
Course Objectives	• To teach principles basics of differential equations. • To teach basics of integral calculus, Fourier series.			
Course Outcomes	• Students will be able to solve differential equations. • Students will be able to know the use of differential equations and calculus.			

Unit-I **(15 Hrs)**

Differential equations: First order equation (linear and nonlinear); higher order linear differential equations with constant coefficients, method of variation of parameters, Cauchy's and Euler's equations, initial and boundary value problems, and solution of partial differential equations: variable separable method.

Unit-II **(15 Hrs)**

Calculus: Mean value theorems, theorems of integral calculus, partial derivatives, maxima and minima, multiple integrals, Fourier series, vector identities, line, surface and volume integrals, Stokes, Gauss and Green's theorems

Text books:

1. P. N. Wartikar, J. N. Wartikar, "A textbook of Applied Mathematic", Vol. I & II, Pune Vidyarthi Griha Prakashan.
2. Kanti B. Datta , "Mathematical Methods of Science and Engineering: Aided with MATLAB", 1st Edition, 2012 (Please check for correction)
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publication, 43rd Edition 2014.

Reference Books:

1. B. V. Ramana, "Higher Engineering Mathematics", Tata Mc-Graw Hill Publication 1st Edition, sixth reprint, 2008.

2. C. R. Wylie (Jr.)and Louis C. Barrett, "Advanced Engineering Mathematics", Tata McGraw Hill Publication, 6th Edition ,1995.
3. Erwin Kreysizg, "Advanced Engineering Mathematics", John Wiley & Sons Inc., 9th Edition, 2013.
4. Murray R Spiegel, **"**Schaum's outline of thoery and problems of laplace transforms / Schaum's outline of theory and problems of vector analysis and an introduction to tensor analysis" McGraw -Hill Publication, 2nd Edition, 2009.
5. George B Arfken, Hans-Jurgen Weber, "Mathematical methods for Physicists", Academic paper 7th edition, 2013.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UP 01	**Analog and Digital Electronic Lab**	**-**	**4**	**4**

List of Laboratory Experiments:

1. Study of input / output characteristics of BJT- CB, CE, and CC Configuration.
2. Study of input and transfer characteristics of FET.
3. BJT amplifier frequency response.
4. FET amplifier frequency response.
5. Measurement of operational amplifier parameters.
6. Clipper and Clamper circuits using Opamp.
7. Precision rectifiers using Opamp.
8. Adder and Subtrator using Opamp.
9. Wien bridge oscillator using Opamp.
10. RC phase shift oscillator using Opamp.
11. Implementing study of Gates and Logic Operations like, NOT, AND, OR, NR, OR and XNOR using (i) all NAND Gates (ii) all NOR Gates.
12. Implementing a binary to gray, gray to binary or binary to XS3 code converter using gate ICs.
13. Simplifying 3, 4 variable logic functions and implementing them using gate ICs AND/OR, OR/AND, ALL NAND and ALL NOR.
14. Implementation of Half and Full Adder Circuit.
15. Study of Multiplexer and Demultiplexer using ICs.
16. Constructing flip flops like SR, D, JK and T using all NAND gates and a de-bounce switch.
17. Designing a mod N counter.
18. Design a ripple counter/or a two bit comparator using gate ICs.
19. Building a ring counter and a twisted ring counter using D f/f ICs.
20. Any one of the following:
    i. Full Adder using Gates and using Decoder or a multiplexer.

ii. Using a counter ICs like 7490 or 7492 or 7493 as a BCD counter. Using a shift register as a sequence generator.

Note: The concerned faculty may conduct any other experiment based on the course apart from the given list. The number of experiments conducted must not be less than 12.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS1 UP 02	**C Programming Lab**	**-**	**4**	**4**

List of Laboratory Experiments:

1. Introduction to C language-Usage of data types and control statements.
2. Introduction to nested control statements.
3. Introduction to 1D array-sorting of array.
4. Introduction to multidimensional array-Matrix manipulation.
5. Introduction to User defined function.
6. Introduction to recursion.
7. Introduction to string-perform various manipulations on string.
8. Introduction to pointers.
9. Introduction to structures-Create database using structures.
10. Introduction to union.
11. Introduction to file handling in C.
12. Introduction to data structure: To implement queue data using singly link list (SLL).
13. Mini project based on C language.

Note: The concerned faculty may conduct any other experiment based on the course apart from the given list. The number of experiments conducted must not be less than 12.

Semester -II

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS2 UT 06	**Sensors, Transducers and Signal Conditioning**	**4**	**-**	**4**
Course Objectives	• To teach principles of different Sensors and Transducers. • To teach signal conditioning of resistive, capacitive sensors and optical devices.			
Course Outcomes	• Students will understand the basic principle of various sensors. • Students will be able to recognize sensors for different applications. • Students will understand the signal conditioning concepts related to resistive, capacitive sensors and optical devices.			

Unit I: (15 Hrs)

Introduction: Units and standards of measurement, functional elements of measurement system, static and dynamic characteristics or performance characteristics of transducer, Measurement and calibration systems- Requirement.

Displacement Transducers: Working principle of Resistance type, Capacitance type, Digital, Pneumatic (Flapper-Nozzle) displacement transducer.

Level Transducers: Working principle of Float, Displacer, Bubbler, Diaphragm box, DP cell, Ultrasonic, Capacitive, Radioactive, Resistance, Thermal, optical level sensors, solid level detectors, intelligent level measuring instruments.

Pressure Transducers: Primary pressure sensors, Electrical/Secondary Pressure Transducers, Manometers, High Pressure Measurement and Differential Pressure Measurement.

Unit II: (15 Hrs)

Flow Transducers: Working principle of Head Type, Variable Area Type, and Open channel flow measurement.

Temperature Transducers: Working principle of Thermometers, Resistance temperature detector (RTD), Thermistors, Thermocouples, and Pyrometers.

Electro-chemical Sensors: pH measurement, Conductivity measurement, ORP (Oxidation Reduction Potential) Measurement, Humidity measurement. Intelligent Sensors.

Unit III: (15 Hrs)

Need for signal conditioning, Current and Voltage standards.

Signal conditioning for Resistive sensors: RTD, Thermister, load cell, potentiometric sensors.

Signal conditioning for capacitive sensors: Level sensor, displacement sensor, proximity detector, humidity sensor, differential pressure cell.

Signal conditioning for inductive sensors: Displacement transducer (LVDT/RVDT),

proximity detector, inductive pick-up.

Unit IV: (15 Hrs)

Signal conditioning for optical devices: LEDs, Photo diode, LDR, PIN diode, photo transistor, photo cell, optical proximity switch.

Signal conditioning schemes for following devices: Thermocouple with cold junction compensation, ultrasonic detector for displacement, level (single and multiple liquid), pH and conductivity measurement, Hall sensor, Electromagnetic flow meter.

Text Books:

1. E. O. Doebelin, "Measurement System Application and Design", McGraw-hill International, 5th Edition, 2007.
2. D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill, 3rd Edition, 2010.
3. R.K.Jain, "Mechanical and Industrial Measurement", Khanna Publications, 9th print 2013.
4. C. D. Johnson, "Process Control Instrumentation Technology", Prentice-Hall of India, 8th Edition, 2009.
5. Sawhney A. K., "A Course in Electrical And Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 11th Edition, 2005.
6. D. V. S. Murthy, "Transducers and Instrumentation", Prentice-Hall of India, 2nd Edition, 2010.

Reference Books :

1. B. G. Liptak, "Process Measurement and Analysis", Butterworth Heinemann, 8th Edition, 2009.
2. B. E. Noltingk, "Jone's Instrument Technology" (Vol. 1 and Vol. 2),4th Edition 1985.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS2 UT 07	**Power Electronics**	**4**	**-**	**4**
Course Objectives	• To get an overview of different types of power semi-conductor devices • To understand the operation, characteristics and performance parameters of • Single phase and three phase controlled rectifiers. • To study the operation, switching techniques and basic topologies of DC-DC • Switching regulators. • To learn the different inverter to understand the harmonic reduction methods. • To study simple applications			
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.			

UNIT I **(15Hrs)**

Study of switching devices: Frame, Driver and snubber circuit of SCR, TRIAC, BJT, IGBT, MOSFET, Commutation circuits for SCR.

Step-down and step-up chopper, Time ratio control and current limit control Buck, boost, buck- boost converter, concept of Resonant switching - SMPS.

UNIT II **(15Hrs)**

Converters: Half controlled and fully controlled converters, single phase dual converters – power factor Improvements.

Three Phase Converters – Half controlled and fully controlled converters.

Design of SCR based DC power circuits 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.

UNIT III **(15Hrs)**

AC to AC Controllers: On Off controller, Single phase AC voltage controllers–single and three phase cycloconverters.

Inverters: Single phase and three phase (both 120^0 mode and 180^0 mode) inverters - Series resonant inverter - Current source inverter. UPS

UNIT IV **(15Hrs)**

Motors: Working principle, Types of AC motors and Characteristics of AC motors. DC motors working principle, types and characteristics. Stepper motors.

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

Industrial Applications: Induction & dielectric heating process block diagram, merits/demerits and applications of power electronics in traction.

Text Books:

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, 4th Edition, 2013.
2. P.S. bimbhra, "Power Electronics", Khanna publishers, 13th reprint, 2004.
3. Alok Jain, "Power Electronics & its applications", PENRAM International Publishing (India) Pvt. Ltd, 2nd Edition, 2008.

References:

1. Ashfaq Ahmed, "Power Electronics for Technology", Pearson Education, Indian Edition, 2003.
2. P.S. bimbhra "Power Electronics" Khanna Publishers,.13th reprint, 2004.
3. Ned Mohan, Tore.M. Undeland, William.P. Riobbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 3rd edition, 2003.

4. T.J.E.Miller, " Brushless magnet & Reluctance motor drives", Claredon Press London, 1st Edition, 1989 .
5. Bimal Bose, "Power Electronics &Variable frequency drives- Technology & Application", Wiley publication, 1st Edition, 1996
6. Philip T.Krein, "Elements of Power Electronics" Oxford University Press, 2012 Edition.

IS2 UT 08	**Microcontroller and Embedded Systems**	**4**	**-**	**4**
Course Objectives	• To make the students understand the fundamentals of PIC • To understand the different modules of PIC. • To understand these systems and should be able to determine hardware and software Interfacing with real time systems. • To understand the interfacing of the devices. • Introduction to features that build an embedded system. • To help the understanding of the interaction that the various components within an embedded system have with each other. • Techniques of interfacing between processors & peripheral devices related to embedded processing.			
Course Outcomes	The students will be able to • Define embedded system and its Applications in industry. • Understand working of PIC 16F Microcontroller Architecture and Programming model. • Understand the concept of Timer, Interrupt, I/O Port interfacing with PIC 16F Microcontroller. • Understand the concept of Interfacing with Real time System. • Understanding of functional building blocks of an embedded system for developing a real time system application.			

Unit I: (15 Hrs)

Introduction to microchip PIC microcontroller: PIC microcontroller features, scaling of PIC MCU families, overview of baseline, midrange, enhanced midrange, and high-end core devices.

Core architecture: PIC Architecture, Program memory, Addressing Modes, Instruction set. PIC MCU Hardware: reset, clock, control registers, register banks, program memory paging etc.

MPLAB IDE overview: Using MPLAB, Toolbars, Select Development Mode And Device Type, Project, Text Editor, Assembler, MPLAB Operations.

Unit II: (15 Hrs)

PIC resources: Port programming, interrupts, Timer and Counter, ADC module, watchdog timer, power up timer, sleep mode, state machine programming.

Interfacing with PIC: Switch, relay, Keypad, LCD display, Stepper motor, DAC, etc.
Overviews of PIC tools: Development software's, compilers, debug tools.

Unit III: (15 Hrs)

Introduction to Embedded Systems: Embedded System definition, Embedded Systems v/s general purpose computing systems, Classification of Embedded System, Embedded system applications, Embedded System components, microprocessors v/s microcontrollers, Von-Neumann v/s Harvard architectures, CISC and RISC architectures, memory, peripherals, reset circuits, oscillator circuits.

Unit IV: (15 Hrs)

Embedded System Development: Microcomputer Development Systems (MDS), MDS development steps, **Development Tools**: Integrated Development Environment (IDE), **IDE components:** Editor, Project wizard, Assembler, Compiler, Simulator, In Circuit Emulator (ICE)/On Chip Debugger (OCD), Logic Analyzer.

Text Books:

1. Ajay V Deshmukh, "Microcontrollers: theory and applications", Tata McGraw- hill. 1st Edition, 2008.
2. Myke Predko, "Programming & Customizing PIC micro Microcontrollers: Principal and Applications", Tata McGraw-Hill Education Private Limited, 3rd Edition, 2008.

Reference Books:

1. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers", Elsevier/BSP Books, 2nd Edition, 2010.
2. David W Smith, "PIC in Practice: A Project-based Approach", Newnes, 2nd Edition, 2006.
3. John Morton, "PIC: Your Personal Introductory Course", Newnes 3rd Edition,.2005
4. Qing Li, Caroline Yao, "Real-Time Concepts for Embedded Systems", CMP Books. 1st Edition, 2003
5. David E. Simon, "An Embedded Software Primer", Pearson Education, 2003.
6. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", McGraw-Hill Education, 2nd Edition, 2009 .
7. Jean J. Labrosse, "MicroC OS II: The Real Time Kernel", CMP Books, 2nd edition, 2002.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS2UT09	**Feedback Control System**	**4**	**-**	**4**
Course Objectives	• To familiarize students with concepts of control systems and mathematical modelling of the System. • To understand the concept of transient and steady-state response analysis for control systems and to assess the stability of control systems through the root-locus method and the frequency-response method.			
Course Outcomes	• Students will able to represent the mathematical model of a system and determine the response of different order systems. • Students will have the ability to analyse the stability of the system.			

Unit I: (15 Hrs)

Transfer Function of Physical Systems: Introduction to control systems, Introduction to design process, Industrial of feed forward and feedback control system. Uncertainty and disturbances. Review of Laplace and inverse Laplace transform, modeling of dynamic systems (mechanical, electrical, electromechanical systems) Equivalent Systems: Block diagram reduction techniques, signal flow graphs, Mason's gain formula, signal flow graph from block diagram, DC gain

Unit II: (15 Hrs)

Time Domain Analysis: System Equations, Differential Equations And Difference Equations, Partial and Ordinary Differential Equations, Time Variability and Time Invariance, Linear And Nonlinear Differential and Difference Equations, The Differential Operator and The Characteristic Equation, Linear Independence and Fundamental Sets, Solution of Linear Constant-Coefficient Ordinary Differential Equations ,The Free Response, The Forced Response, The Total Response, The Steady State and Transient Responses, Singularity Functions: Steps, Ramps, and Impulses, Second-Order Systems, State Variable Representation of Systems Described by Linear Differential Equations, Solution of Linear Constant-Coefficient Difference Equations,

Time response analysis (1 st , 2 nd order, higher order approximation), System response with additional poles. System response with additional zeros. Steady state errors for unity feedback systems, Static error constants and system type, Steady state errors for disturbances, Design system parameters from steady state errors

Unit III: (15 Hrs)

Graphical tool and Stability Analysis: Nominal sensitivity functions, closed loop stability based on characteristic Polynomial, Routh-Hurwitz criteria,

Root locus techniques: Introduction, Variation of Closed-Loop System Poles: The Root-Locus, Angle and Magnitude Criteria, Number of Loci, Real Axis Loci, Asymptotes, Breakaway Points, Departure and Arrival Angles, Construction Of The Root-Locus, The Closed-Loop Transfer Function and The Time-Domain Response, Gain and Phase Margins From The Root-Locus, Damping Ratio from The Root-Locus For Continuous Systems

Unit IV: (15 Hrs)

Frequency Domain Analysis

Bode Plot: Frequency domain design limitations, Frequency response analysis, Bode plot, Asymptotic approximations, Stability, Gain Margin, and Phase Margin via Bode plot.

Nyquist Plot: Relationship between time domain and frequency domain, Polar plot, Nyquist plot, Stability, Gain Margin, Phase Margin via Nyquist plot.

Text Books:

1. Norman Nise , "Control System Engineering", John Wiley & Sons International, 6th Edition, 2013.
2. Nagrath and Gopal , "Control System Engineering", New Age International Publication, 5th Edition, 2009.

Reference Books:

1. G. Goodwin, S.Graebe, Mario Salgado, "Control System Design", PHI, 1st Edition, 2015.
2. G. Franklin, J.Powell, A. Naeini, "Feedback Control of Dynamic Systems", Pearson Education, 7th Edition, 2015.

Subject Code	**Subject Name**	**Credits allotted**		**Total**
		Theory	**Pract.**	
IS2UT10	**Signals and Systems**	**2**	**-**	**2**
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 behaviour of communication and control systems.			

Unit I: (15 Hrs)

Introduction to Signals: Continuous time signals (CT signals), discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Exponential. Classification of CT and DT signals, CT systems and DT systems. Basic properties of systems

Analysis of CT Signals : Fourier series analysis, Spectrum of C.T. signals, Impulse response, Convolution integral, frequency response, Differential equation, Block diagram representation, Fourier Transform and Laplace Transform in Signal Analysis.

Unit II: (15 Hrs)

Analysis of DT Signals: Sampling of CT signals and aliasing, Impulse response, Convolution sum DTFT and its properties. Z Transform, Convergence of Z Transform, Properties of Z Transform, Inverse Z Transform. Difference equations, Block diagram representation, LTI systems analysis using DTFT and Z-transforms, Analysis of recursive and Non Recursive Systems.

Text Book:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, Signals and Systems, Pearson Education, 2nd Edition. 2015
2. Edward W Kamen & Bonnie's Heck, "Fundamentals of Signals and Systems", Pearson Education, 3rd Edition 2007.

References:

1. H P Hsu, Rakesh Ranjan" Signals and Systems", Schaum's Outlines, Tata McGraw Hill, Indian Reprint, 2007
2. Simon Haykins and Barry Van Veen, "Signals and Systems" John Wiley & sons , Inc, 1st Edition 2004.
3. S.Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", McGraw Hill International/ TATA MCGRAW HILL, 1st Edition 2007.

IS2 UP 03	**Application Software Practices**	**-**	**4**	**4**

List of Experiments

1. Study of multivariable control system.
2. Analysis of second order (R-L-C) system in time domain.
3. Verify the second order (R-L-C) using Matlab and Simulink.
4. Study of type 0 and type 1 system.
5. Verify type 0, type 1, type 2 system using Matlab and Simulink.
6. To find the transfer function of unknown system (electrical network).
7. Write a program to find Routh table and comment on its stability in Matlab.
8. Draw root locus in using basic commands Matlab.

9. Draw bode plot using basic commands in Matlab.
10. Draw Nyquist plot using basic command in Matlab.
11. Study of root locus tool for synthesis in Matlab.
12. Find Laplace transform and inverse using Matlab.
13. Pure software based experiments to explore the LabVIEW environment and its architecture.
    a. To develop a VI to calculate speed, convert degree Celsius to degree Fahrenheit, compute the given equations etc.
    b. To develop a VI to calculate factorial of a given number, addition of first 10 numbers etc. using structures.
    c. Build a VI to plot circle in XY graph, generate and plot random numbers on chart different colors in an intensity graph etc with graph, chart properties and options.
    d. To create VI student database, library database etc. using array and cluster functions.
    e. Develop a VI to storing all the points of simulated signal, storing all iterations from experiment etc. using File I/Os.
14. Applications of LabVIEW in analog electronics—simulation of RC circuit characteristics, diode characteristics etc.
15. Applications of LabVIEW in digital electronics—half adder, full adder, binary to decimal conversion etc.
16. Applications of LabVIEW in Sensor / Instrumentation / data acquisition lab – Design of temperature data acquisition and control system, design of LabVIEW data acquisition application of finite samples.
17. Applications of LabVIEW in process — tank level/temperature control, alarm Announciator, batch process control etc.
18. Application of LabVIEW in Digital Signal Processing – implementation of test signals, implementation of filters.

Note: The concerned faculty may conduct any other experiment based on the course apart from the given list. The number of experiments conducted must not be less than 12.

IS2 UP 04	**Sensors, Signal Conditioning and Microcontroller Lab**	**-**	**4**	**4**

List of Experiments:

1. Study Basic Measurements and Measuring Instruments.
2. Study Temperature Measurement using various Thermometers.
3. Study and plot characteristics of RTD.
4. Study and plot characteristics of various Thermocouples.

5. Study and plot characteristics of Thermistors.
6. Study Temperature Measurement with and without Thermowell.
7. Study Liquid Level Measurement using DP Cell.
8. Study Liquid Level Measurement using Capacitance Type Level Sensor.
9. Study Liquid Level Measurement using Tubular Level Gauge and Ultrasonic Level Sensor.
10. Study Displacement Transducer using LVDT.
11. Study and Plot Response curve for Flapper Nozzle system.

PIC Embedded Systems.

1. Logical operation
2. Code conversion
3. Generating square wave on port pins.
4. Generation of square wave using timer
5. Interfacing keyboard, 7 segments displays.
6. Interfacing LCD display
7. Serial Communication with PC.
8. Interfacing ADC
9. Interfacing DAC and its application
10. Temperature Controller
11. Speed control of DC Motor.
12. Stepper motor control

Note: The concerned faculty may conduct any other experiment based on the course apart from the given list. The number of experiments conducted must not be less than 12.

Semester-III

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UT 11	**Process Control**	**4**	**-**	**4**
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.

Unit I **(15 Hrs)**

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.

Process Control Action: Elements of process control, Controller Principle, Process Characteristics, Control system parameters, discontinuous, continuous and composite controller modes/actions (P,I,D,PI,PD and PID).

Unit II **(15 Hrs)**

Process Controllers and Tuning: General features, construction and working of Pneumatic, Hydraulic and Electronic controller. Process reaction curve method, Zigler-Nichols method, Cohencoon correction for quarter amplitude, Frequency response method, Relay based tuning.

Control Schemes: Feedback, feedforward, cascade, ratio, split range, selective control, adaptive control, and model based control.

Unit III **(15 Hrs)**

Analysis of Control Loop: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, Linearising a equal percentage valve, Variable pressure drop. Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control, SLPC-features, faceplate, functions, MLPC- features, faceplate, functions, SLPC and MLPC comparison.

Scaling: types of scaling, examples of scaling.

Nonlinear Systems: Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through: Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues.

Unit IV **(15 Hrs)**

Multivariable Control: Block diagram analysis of multivariable systems, Interaction, Tuning of Multivariable controllers, relative gain analysis, Decoupler design.

Intelligent Controllers:

Step analysis method for finding first, second and multiple time constants and deadtime.

Model Based controllers: Internal Model control, Smith predictor, optimal controller,

Model Predictive controller, Dynamic matrix controller (DMC). Self Tunning Controller.

Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If-Then Rules, Fuzzy Logic Applications, Neuro-FuzzyArtificial Neural networks and ANN controller,

Test Books:

1. Donald Eckman, "Automatic Process Control", Wiley Eastern Limited, 1st Edition, 1966
2. Thomas E Marlin, "Process Control- Designing processes and Control Systems for Dynamic Performance", McGraw-Hill International Editions, 1st Edition , 1995.
3. F.G.Shinskey, "Process control Systems", TATA MCGRAW HILL, 3rd Edition, 1988.
4. Krishna Kant, "Computer Based Industrial Control", Prentice hall of India, 2nd Edition, 2010.
5. B Liptek, "Instrument engineers handbook", Chilton book Co, 1st Edition, 1969.
6. P.W.Murrill, "Fundamentals of Process Control", International Society of Automation, 1st Edition, 2000.
7. Stephanopoulos George, "Chemical Process Control", Prentice hall of India, United States Edition, 1983.
8. P.W.Murrill, "Applications concepts of Process control", International Society of Automation, 3rd edition, 2012.
9. B.Wayne bequette, "Process Control:Modeling, Design and Simulation", Prentice hall of india, 1st Edition, 2002.

Reference Books:

1. Considine, "Process/Industrial Instruments and Controls Handbook", McGraw-Hill Professional, 5th Edition, 1999.
2. T.J.Ross, Fuzzy Logic with Engineering Applications, Wiley, 3rd Edition, 2011.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UT 12	**Industrial Automation**	**4**	**-**	**4**
Course Objectives	• To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA. • Students should understand the working of these systems and should be able to determine hardware and software requirements of PLC, DCS and SCADA. • They should further understand how to design any application based on these systems.			
Course Outcomes	The students will be able to • Define automation, it's importance, expectations from automation and applications in industry. • Understand working of PLC, I/O modules of PLC, Programming languages and instructions of PLC, design PLC based application by proper selection and sizing criteria, developing GUI and ladder program. • Understand evolution and architecture of DCS, hierarchical control in DCS, programming DCS through function Block Diagram (FBD) method. SCADA architecture, communication in SCADA, develop any application based on SCADA along with GUI using SCADA software.			

Unit I: **(15 Hrs)**

Introduction: Overview, OSI reference model, Transmission media : Copper cable, Coaxial cables, Twisted-pair cable, Connector standards, Earthing/grounding, Fiber-optic cable components, Fiber-optic cable parameters

Open control network: RS-232 overview, RS-232 interface standard, RS-232 troubleshooting, Typical RS-232 problems, RS-485 overview, The RS-485 interface standard, RS-485 troubleshooting Current loop and RS-485 converters overview, TCP/IP overview, Internet layer protocols (packet transport), Modbus overview, Modbus protocol structure, Modbus troubleshooting

Unit II: **(15 Hrs)**

Network at different level: AS-I, CAN, Devicenet, Industrial Ethernet overview, Profibus PA/DP/FMS overview, Foundation Fieldbus overview, The physical layer and wiring rules, HART overview, Introduction to HART and smart instrumentation.

Safety Instrumented System (SIS): Need for safety instrumentation- risk and risk reduction methods, hazards analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC61508

Unit III: **(15 Hrs)**

Automation Fundamentals: Automation and its importance, automation applications, expectations of automation. Process and factory automation. Types of plant and control – categories in industry, open loop and close loop control functions, continuous processes, discrete processes, and mixed processes. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control. Control system architecture – evolution and current trends, comparison of different architectures.

Programmable Logic Controller Hardware: Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications. DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface. Software Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC. Case study: PLC selection and configuration for any one process applications.

Unit IV: **(15 Hrs)**

Distributed Control System (DCS): Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS. Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task.

Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS. DCS. System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks. Introduction to DCS Programming, Function Block Diagram method for DCS programming.

Supervisory Control and Data Acquisition (SCADA): SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA , MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail SCADA as a real time system Communications in SCADA- types & methods used, components, Protocol structure and Mediums used for communications SCADA Development for any one typical application Programming for GUI development using SCADA software.

Text Books:

1 Samuel M. Herb, "Understanding Distributed Processor Systems for Control", International Society of Automation Publication, 1st Edition, 1999.
2. Thomas Hughes, "Programmable Logic Controller", International Society of Automation Publication, 4th Edition, 2004
3. Stuart A. Boyer, "SCADA supervisory control and data acquisition", International Society of Automation Publication, 4th Edtion, 2009.
4. Gruhn and Cheddie, "Safety Shutdown Systems", International Society of Automation, 2nd Edition, 2006.

Reference Books:

1. Poppovik Bhatkar, "Distributed Computer Control in Industrial Automation", CRC press, 2nd edition, 1990.
2. S.K.Singh, "Computer Aided Process Control", Prentice Hall of India, 1st Edition, 2004.
3. Krishna Kant, "Computer Based Process Control", Prentice Hall of India, 2nd edition, 2010.
4. N.E. Battikha, "The Management of Control System: Justification and Technical Auditing", International Society of Automation, 1st Edition, 1992.
5. Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, Pck edition, 2001.
6. John. W. Webb, Ronald A Reis, "Programmable Logic Controllers – Principles and Applications", Prentice Hall Inc, 5th Edition, 2002.
7. Bela G. Liptak, "Instrument engineers handbook- Process control", Chilton book company, 3rd edition, 1969.
8. D.J. Smith , K.G.L. Simpson, "Functional Safety: A Straightforward Guide to IEC61508 and Related Standards", Butterworth-Heinemann Publications, 2nd Edition, 2004.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UT 13	**Analytical Instrumentation**	**4**	**-**	**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.			

Unit I: (15 Hrs)

Introduction to Chemical instrumental analysis, advantages over classical methods, classification: Spectral, electro analytical and separative methods, Interaction of radiation with matter, Laws of photometry (Beer and Lambert's law), Deviation from Beer's law, working of filters, prism and grating monochromators, concept of design of analytical instrument. Introduction to Electroanalytical methods, potentiometry, voltametry, coulometry

Unit II: (15 Hrs)

Spectrometric Methods

A. Laws of Photometry, Instrument components, UV-visible instrument component, photocolorimeters, single and double beam instruments, various types of UV-visible spectrophotometers.

B. Atomic absorption spectrophotometer: Principle, working, hollow cathode lamp, atomizer, back-ground correction.

C. IR spectroscopy: Principle, IR sources, IR detectors, dispersive and Fourier Transform IR spectroscopy.

D. Atomic Emission Spectroscopy: Principle, types, Flame photometer, DC arc and AC arc excitation, plasma excitation.

Unit III: (15 Hrs)

Colorimeters, online colorimeter for process applications, turbidity meter, UV-Visible spectrophotometers and its types with its optical system design, IR spectrophotometers, X-ray spectroscopy

Emission Spectra, Quantitative measurements, Flame Photometer and its applications , concept of design atomic absorption spectrophotometer, spectrum interpretation, interferences, applications of atomic absorption spectrophotometer

Unit IV: **(15 Hrs)**

Separative Methods:

A. Mass Spectrometer(MS): Principle, ionisation methods, mass analyzer types - magnetic deflection type, time of flight, quadrupole, double focusing, detectors for MS.

B. Chromatography: Classification, Gas chromatography: principle, constructional details, GC detectors, High Performance Liquid Chromatography (HPLC): principle, constructional details, HPLC detectors

Radioactive instrumentation and Refractometry:

A. X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer: Bragg's law, Auger emission spectroscopy, Electron spectroscopy for chemical analysis(ESCA).

B. Radiation detectors: Ionisation chamber, Geiger-Muller counter, proportional counter, scintillation counters,

C. Refractometry: Principle, Abbe and Differential refractometer.

Text Books:

1. H. H. Willard, L. L. Merritt, J.A. Dean and Frank A. Settle, "Instrumental Methods of Analysis", CBS Publishers & Distributors, New Delhi, 7th sub Edition, 1988.
2. Galen W. Ewing, "Instrumental Methods of Chemical Analysis", McGraw-Hill Book Company, 5th edition, 1985.

Reference Books:

1. Robert D. Braun, "Introduction to Instrumental Analysis", McGraw-Hill Book Company, 1st Edition, 1986.
2. D. A. Skoog, F. J. Holler, Stanlay cronch, "Principles of Instrumental Analysis," Thomson brooks-cole publications, 6th Edition, 2006.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UT 14	**Optical Instrumentation and Photonics**	**4**	**-**	**4**
Course Objectives	• To expose the students to the basic concepts of optical fibres and their properties. • To provide adequate knowledge about the Industrial applications of optical fibres.			
Course Outcomes	The students will be able to: • Identify various sensors, Fiber optic and its specifications. • Understand principle of working of Fiber Optic used to measure Temperature, Displacement, Level, and various miscellaneous other sensors • Understand applications of Fiber Optics in industry.			

Unit I: **(15 Hrs)**

Introduction: Fundamentals of light Nature of light, electromagnetic optics spectrum, propagation of light, electromagnetic waves in dielectric media, polarization and

coherence, interactions of light with matter, absorption, scattering, dispersion, polarization, diffraction and interference.

Optical sources: Electromagnetic spectrum, types of spectra- line, band and continuous light sources, radiometry and photometry, natural sources, incandescent lamp, gas discharge lamp. Light-emitting diodes electroluminescent process, choice of LED materials, LED structures, infrared sources, semiconductor laser.

Optical detectors: Thermal detectors and Quantum detectors, bolometer, Photodiodes-PIN and avalanche photodiodes, phototransistors, photo multipliers, photovoltaic, IR detectors, Solar cells, CCD devices.

Unit II: (15 Hrs)

Optical components Filters: absorption filters and interference filter, gratings- equation of diffraction grating, resolving power, concave grating, volume diffraction grating, holographic grating. Lenses, Polarizer and Beam splitters, Monochromator

Optical instruments: Eye, telescopes, microscopes, optical projection systems, cameras, basic principles of Holography, OTDR, polarimeter.

Unit III: (15 Hrs)

Optical Fiber and Their properties: Ray theory, wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, optical fiber mode, single mode fiber, special fiber, fiber materials, fiber fabrication, transmission characteristics of fiber, absorption losses, scattering losses, dispersion, polarization, non-linear phenomena

Optical Fiber Measurements: Measurement of attenuation, dispersion, refractive index profile of fiber and cut off wavelength, numerical aperture, OTDR, Measurement of flow, pressure, Temperature, displacement, acceleration and fluid level vibration measurement.

Fiber Optic Sensing Principles and Techniques: Classification and principle of fiber optic sensors, fiber grating and fiber Bragg grating technology and distributed optical fiber sensing.

Unit IV: (15 Hrs)

Laser Fundamentals: Properties of laser, Laser modes- axial and transverse, single mode operation. Frequency stabilization. Mode locking, Mode hopping, Q-switching techniques.

Laser Types: Doped insulator lasers, Semiconductor lasers, Gas lasers, Liquid Dye lasers.

Laser safety: Biological effects, safety standards, risk of exposure, laser hazard classification and assessment, laser safety system, safe industrial laser laboratory, laser eye protection, laser accidents.

Applications of Laser: Biomedical, process, etc

Text Books:

1. J. Wilson, "Optoelectronics", Prentice-Hall of India.3rd Edition, 1988.
2. "Electro-Optical Instrumentation: Sensing and Measuring with Lasers", Pearson Education, Inc., 1st Edition, 2004.

3. Charles M. Vest, "Holographic Interferometry", John Wiley & sons, 1st Edition, 1979.
4. Joseph T Verdeyen, "Laser electronics", Prentice Hall of India , 3rd Edition, 1995.
5. J.M. Senior, "Optical fiber communications principles and practice", Prentice Hall of India, 3rd Edition, 2010.
6. H. Zanger and C. Zanger, "Fiber optics - communication and other application", McGraw Hill, 1st Edition, 1992.
7. Kao C.K., "Optical fiber systems, Technology, Design & Application", McGraw Hill, 1st Edition, 1982.
8. Allen H. Cherin, "Introduction to optical fibers", McGraw Hill., 1st Edition, 1983.
9. S.C.Gupta, "Text book on optical fiber Communication & other application", Prentice hall of India, 2nd Edition, 2012.
10. Dr. S. Kumar, "Basics of Remote Sensing & GIS", Laxmi publications, 1st edition, 2005.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 DT 01	**Biomedical Instrumentation**	**2**	**-**	**2**
Course Objectives	• To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement and application of these instruments in diagnosis, therapeutic treatment and imaging fields.			
Course Outcomes	The students will be able to • Identify various Bio-potential and their specifications in terms of amplitude ` and frequency. • Understand principle and working of various Biomedical Instruments for diagnosis applications. • Decide the applications of therapeutic instruments for treatment purpose. • Understand applications of imaging instruments and the modalities involved in each technique.			

Unit I: **(15 Hrs)**

Bio-Potential and Measurement: Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications. Measurement of RMP and AP. Electrode Electrolyte interface and types of bio-potential electrodes.

Cardiovascular Measurement: Blood Pressure- Direct and Indirect types, Blood Flow- Electromagnetic and Ultrasonic types, Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric), Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type, Heart sound measurement.

Life support Instruments: Pacemaker- Types of Pacemaker, mode of pacing and its application, Defibrillator- AC and DC Defibrillators and their application, Heart Lung machine and its application during surgery, Haemodialysis system and the precautions to be taken during dialysis.

Unit II: **(15 Hrs)**

Physiological Systems and Related Measurement: Respiratory system- Physiology of respiration and measurements of respiratory related parameters. Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias. Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and its measurement. Normal and abnormal EEG, evoked potential and epilepsy. Muscular system- Generation of EMG signal, specification and measurement. Design of ECG amplifier.

Significance of Electrical Safety: Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention.

Imaging Techniques: X-Ray- Generation, X-ray tube and its control, X-ray machine and its application, CT Scan- CT Number, Block Diagram, scanning system and application, Ultrasound Imaging- Modes of scanning and their application, MRI- Concepts and image generation, block diagram and its application.

Text Books:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd Edition, 1980.
2. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th Edition, 2010.
3. R. S. Khandpur, "Biomedical Instrumentation", Tata McGraw hill, 3rd Edition, 2014 .

Reference Books:

1. Richard Aston, "Principles of Biomedical Instrumentation and Measurements", Prentice Hall of India, 1st edition, 1990.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall of India, 4th Edition, 2001.
3. John E Hall, "Guyton's Medical Physiology", Saunders, 12th Edition, 2011.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 DT 02	Instrumentation For Environmental Engineering	2	-	2
Course Objectives	• To create awareness of sensors related to environment. • To study the sensors used in quality analysis of water and air.			
Course Outcomes	• The students get well versed with all sensors required for regulating environmental conditions. • Students also get thorough knowledge of Instrumentation involved in environment management.			

Unit I: **(15 Hrs)**

Introduction: Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.

Quality of water: Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design.

Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution.

Waste water monitoring: Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants.

Unit II: (15 Hrs)

Air pollution: definitions, energy environment relationship, importance of air pollution, air pollution from thermal power plant, their characteristics & control. Air sampling methods & equipments, analytical methods for air pollution studies. Control of air pollution.

Air monitoring: measurement of ambient air quality.

Flow monitoring: Air flow measurement, gas flow, non-open channel flow measurement, open channel waste water flow measurement.

Rain water harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water

References:

1. Walter J. Weber (Jr.), "Physicochemical Processes: For Water Quality Control John Wiley & Sons, 1st Edition, 1972.
2. M. N. Rao & H. V. N. Rao, "Air pollution engineering" McGraw Hill Higher Education, 1st Edition, 1989.
3. Wark & Warner, **"**Air pollution control technology", Pearson, 3rd Edition, 1997.
4. Randy D. Down, "Environmental Instrumentation & Analysis Handbook",Wiley, 1st Edition, 2004.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 DT 03	**Power Plant Instrumentation**	**2**	**-**	**2**
Course Objectives	• To create awareness of energy resources and its scenario in India. • To study the concept of power generation using various resources. • To study the role of Instrumentation in power plants. • To study and compare various power plants for optimal performance.			
Course Outcomes	• The students get well versed with all power generation plants. • Students also get thorough knowledge of Instrumentation involve in power plants.			

Unit I: (15 Hrs)

Introduction: Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources.

Thermal Power Plant: Method of power generation, layout and energy conversion process. Types of Turbines & their control. Types of Boilers and their control. Types of Generators and their control, Condensers. Types of Pumps and Fans, variable speed pumps and Fans, Material handling system, study of all loops-water, steam, fuel etc. Schematics of Gas turbine and Diesel power plant. Application of DCS in power plants.

Solar thermal energy system: Principle, solar collector and its types, solar concentrator and its types, safety. Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy.

Unit II: (15 Hrs)

Nuclear Power Plant: Concept of energy generation from nuclear fission, control of chain reaction. Schematics of Nuclear power plant, types of reactors, reactor control, safety measures.

Comparison of different types of power plant: thermal power plant, hydro electric power plant, wind, solar, nuclear power plant on the basis of: Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept.

Non-conventional Energy Resources: Wind Energy: Power in wind, Conversion of wind power, Aerodynamics of wind turbine, types of wind turbine and their modes of operation, power control of wind turbines, Betz limit, Pitch & Yaw control, wind mill, wind pumps, wind farms, different generator protections, safety. Solar Energy: Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, advantages and limitations.

Text Books:

1. P.K.Nag, "Power plant engineering", McGraw Hill, 4th Edition, 2014.

2. K.Krishnaswamy, M. Ponni Bala, "Power Plant Instrumentation", Prentice Hall India, 1st Edition, 2011.
3. R.K.Rajput, "A Textbook of Power Plant Engineering", Laxmi Publications, 1st Edition, 2010.

Reference Books:

1. Domkundwar, "Power Plant Engg.", Dhanpat Rai & Co. Pvt. Ltd, 1st Edition.
2. B. H. Khan, "Non-conventional energy resources", McGraw Hill, New Delhi, 2nd Edition,2009.
3. Chetan Singh Solanki, "Renewable energy Technology", Prentice Hall Publication, 1st Edition, 2008.
4. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill, New Delhi, 2nd Revised Edition,1997.
5. G. D. Rai, "Nonconventional energy sources" Khanna Publication, 1st Edition, 2004.
6. Dickinson & cheremisinoff, "Solar Energy Technology handbook vol I & II" Marcek Dekker Inc. 1st Edition, 1980.
7. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, "Wind Energy Handbook", John Wiley & Sons, 2nd Edition, 2011.
8. James Manwell, J. F. Manwell, J. G. McGowan, "Wind Energy Explained: Theory, Design and Application", John Wiley and Sons Ltd, 2nd Edition, 2009.
9. Z. Lubosny, "Wind Turbine Operation in Electric Power Systems", Springer-Verlag New York, Inc, 2003 Edition, 2003.
10. David Lindsey, "Power Plant control and instrumentation – control of boilers HRSG", Institution of Engineering and Technology, 1st Edition, 1999.
11. G.F. Gilman, "Boiler Control Systems Engineering", International Society of Automation, 2nd Edition, 2010.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 DT 06	**Agro based Instrumentation**	**2**	**-**	**2**
Course Objectives	• To create awareness of energy resources and its scenario in India. • To study the concept of power generation using various resources. • To study the role of Instrumentation in power plants. • To study and compare various power plants for optimal performance.			
Course Outcomes	• The students get well versed with all power generation plants. • Students also get thorough knowledge of Instrumentation involve in power plants.			

Unit I: (15 Hrs)

Necessity of instrumentation & control for agriculture, engineering properties of soil: fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures, stability & slopes, Sensors: introduction to sonic anemometers, hygrometers, fine wire

thermocouples, open & close path gas analyzers, brief introduction to various bio-sensors.
Flow Diagrams: Flow diagram of sugar plant & instrumentation set up for it, flow diagram of fermenter & control(batch process),flow diagram of dairy industry & instrumentation set up for it, juice extraction control process & instrumentation set up for it.

Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems & it's performance, comparison of different irrigation systems, soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block soil moisture sensor, irrigation scheduling, irrigation efficiencies, design considerations in irrigation channels.

Unit II: (15 Hrs)

Application of SCADA for DAM parameters & control, irrigation control management up-stream & down - stream control systems, green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control.

Automation in earth moving equipments & farm equipments, application of SCADA & PLC in packing industry and cold storage systems, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation.

Leaf area length evaportranspiration, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture, agrometrological instrumentation weather stations, surface flux measurement, soil water content measurement using time-domain reflectrometery(TDR),ground water occurrence confined & unconfined aquifers, evalution of aquifer properties, ground water recharge.

References:

1. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill, 2nd Edition 2005.
2. Bella Liptek, "Instrument engineers handbook", Chilton book Co., NY, 1st Edition, 1969.
3. C. D. Johnson, "Process Control Instrumentation Technology", Prentice hall of India, 8th Edition, 2009.
4. B.A.Wills, **"**Wills' Mineral Processing Technology", Butterworth-Heinemann, 8th Edition, 2015.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS3 UP06	Analytical and Optical Instrumentation Lab	-	4	4

List of Experiments:

1. To find out transmittance and absorbance of a given sample using colorimeter
2. Qualitative and quantitative analysis using UV-Visible spectrophotometer
3. To analyze a given water sample using turbidity meter
4. To detect hydrocarbon contents from a gas sample
5. To design low cost analytical instrument

Semester IV

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS4 UT 15	Industrial Product Design	2	-	2
Course Objectives	• To create awareness of energy resources and its scenario in India. • To study the concept of power generation using various resources. • To study the role of Instrumentation in power plants. • To study and compare various power plants for optimal performance.			
Course Outcomes	• The students get well versed with all power generation plants. • Students also get thorough knowledge of Instrumentation involve in power plants.			

Unit I: (15 Hrs)

Introduction: Stages in product design - Market survey, Product Specifications (Electrical, Mechanical, Environmental), R&D and Engineering Prototypes, Pilot Production Batch, Environmental testing, Documentation, Manufacturing. Electronic Products Classification- Consumer, Industrial and Military. Their peculiarities in terms of Cost/performance ratio and Reliability. Reliability- Bath tub curve, Measures taken (at Component and Product level and various soldering techniques including Surface Mount Technology) to improve reliability. Fundamentals of Communication System Design, criteria for selection of frequency bands, requirements of Voice and Multimedia Applications

Hardware designs- Analog

Analog Signal Conditioning- Factors affecting choice of OPAMPs in signal conditioning applications. Need for Instrumentation Amplifiers- Case study. Error budget analysis with Case study. ADCs- Interpretation of ADC specifications from design view point. Considerations in selecting References (Vref for ADC).DACs- Interpretation of DAC specifications from design view point.

Hardware design- Digital

Interface examples for- LED, HB LED, LCD, Keyboard, Touch Screen. Microcontrollers - Comparative study of different Microcontroller Architectures, Factors affecting choice of Microcontroller for particular application with Case study of one application. Introduction to buses and protocols used in Electronic Products- I2C, SPI.

Unit II: (15 Hrs)

Software design and testing for Electronic Product

Different approaches to development of application software for Electronic Product. Factors affecting choice between Assembly language and High level language like C and C++. Documentation practices and templates for above software.Debugging tools and techniques for software- Features and limitations of- Debuggers, Simulators, ICE, IDE. Hardware Test Programs.

PCB design and EMI/EMC

PCB Design practices for Analog and Mixed signal circuits- Ground Loops, Precision circuits, shielding and guarding. PCB Design Practices for High Speed Digital Circuits, Signal integrity and EMC. EMI/EMC testing standards and compliance.

Text Books

1. Bernhard E. Bürdek, "History,Theory, Practice of Product Design", Springer Science, 1st edition, 2005.
2. Paul Horowitz, "Art of Electronics", Cambridge University Press, 3rd edition, 2015.
3. Howard Johnson, Martin Graham, "High-speed Digital design- A Handbook of Black Magic", Prentice Hall Publication, 1st edition, 1993.
4. Proakis and Salehi, "Contemporary Communication Systems Using Matlab", Wadsworth Publishing Co Inc, 3rd edition, 2011.
5. G. Pahl andW. Beitz J. Feldhusen and K.-H. Grote, "Engineering Design - A Systematic Approach", Springer, 3rd edition, 2007.
6. Tim Williams, "EMC for Product Designers", Elsevier, 4th edition, 2007.

Reference Books

1. David Bailey, "Practical Radio Engineering and Telemetry for Industry", Elsevier, 1st Edition 2003.
2. Bernard Sklar , "Digital Communication" , Pearson Education, 2nd Edition, 2001.
3. Pressman , "Software Engineering - A Practitioner's Approach" McGraw-Hill Higher Education, 8th Edition, 2014.
4. Domine Leenaerts ,Johan van der Tang , Cicero S. Vaucher , "Circuit Design for RF Transceivers " Springer, 2001 Edition, 2011.

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS4 UT 16	Course related to Industrial Project	4	-	4

Subject Code	Subject Name	Credits allotted		Total
		Theory	Practical	
IS4 UP 08	Industrial Project	-	10	10

Syllabus for Open Course:

1. Discrete circuit Design:

Unit I: (15 Hrs)

Unregulated Power Supplies: Specification and ratings of diodes (P-N junction, Zener and power diode) and transistor (low power, high power and switching) . **Rectifiers:** Half wave, full wave: center tap and bridge type, analysis for different parameters: PIV, TUF, efficiency, ripple factor, regulation, etc. Filters: Need of filters, Types: capacitor, inductor, LC, CLC, Analysis for ripple factor and regulation. Design of unregulated power supply with and without filter.

Voltage Regulators: Need of voltage regulator, Stabilization factors, Analysis and Design of Shunt regulator (using Zener diode and BJT), series voltage regulator (using BJT) Series voltage regulator with Pre- regulator and Overload protection circuit.

IC Regulators: Study and design of regulators using ICs: 78XX, 79XX, 723, LM317, Switching regulator: Introduction, study of LM3524.

Unit II: (15Hrs)

Need of biasing, DC load line analysis, operating point, thermal runaway. Different biasing circuits: fixed bias, collector to base bias and voltage divider bias. Stability factor, General expression for stability factor, stability factor for all biasing circuits. Design of biasing circuits, Compensation techniques: Thermistor and diode compensation.

Multi Stage Amplifiers: Need of cascading, Parameter evaluation such as Ri , Ro, Av, Ai and Bandwidth for general multi-stage amplifier ,Analysis and design at low frequency and mid frequency of RC coupled, direct coupled and voltage series feedback (Two stage) amplifier.

Unit III: (15Hrs)

Feedback Amplifiers: General theory of feedback, reasons for negative feedback.Types of negative feedback in transistor circuits: Voltage series, Current series, Voltage shunt, Current shunt feedback amplifiers, Darlington pair, Darlington amplifier using bootstrapping principle,.(Numerical are expected) Design of Voltage series feedback amplifier.

Oscillators: Barkhausens criteria , Frequency and amplitude stability, Classi_cation, RC oscillators : RC phase shift and Wein bridge oscillator analysis and design using BJT and FET , LC oscillators: Colpits and Hartelys oscillators analysis and design using BJT, Crystal oscillator.

Unit IV: (15Hrs)

Wave Shaping Circuits: Low pass and high pass RC circuits (square and step response), High pass RC circuit as a differentiator, Low pass RC circuit as integrator. Clipping circuits: Classification, diode clippers, transistor clippers, Transfer characteristics, Design and analysis of clipper circuits. Clamping circuits: Classification, clamping operations, Clamping
circuit theorem, practical clamping circuits, Voltage multipliers: Doubbler, Trippler and Qudrappler circuits.

Multivibrators : Transistor as a switch, Different transistor switching parameters, classification of multivibrators, Analysis and design of Astable, Monostable, Bistable multivibrator and Schmitt trigger using BJT. Design of triggering circuits for Multivibrators.

2. Network Synthesis and Filter Design.

Unit I: (15Hrs)

Network Functions & Fundamentals of Network Synthesis: Network functions, properties of all types of network functions, Effect of poles and zeros on the system function, network synthesis problems, elements of reliability, causality and stability, Hurwitz's polynomial, Positive real function testing, elementary synthesis procedures.

Synthesis of One Port Networks: Properties of RC, RL and LC driving point functions and their synthesis in Foster and Cauer forms. Synthesis of RLC driving point functions in terms of partial fraction and continued fractions for simple driving point functions.

Unit II: (15 Hrs)

Synthesis of Transfer Functions: Properties of transfer function, zeros of transmission, synthesis of Y21 and Z21 with 1ohm termination. Synthesis of voltage transfer functions using constant resistance networks. Synthesis of open circuit transfer function (Ladder development).

Passive Filter Design: Introduction to various approximation techniques, Butterworth and Chebyshev approximation, derivation of normalized low pass filter transfer function upto 3^{rd} order by Butterworth approximation from basic principles. Evaluation of transfer function for Chebyshev filters from pole zero plots. Synthesis of above mentioned filters with 1ohm termination. Frequency transformation to high pass, band pass and band stop forms. Normalized low pass filters, frequency scaling and Impedance scaling.

Unit III: (15 Hrs)

Active Filter Design: Factored forms of the functions, cascade approach, Biquad topologies: positive and negative feedback topology, coefficient matching techniques for

obtaining element values. Sallen Key low pass circuits. RC to CR transformations for high pass filter design of Sallen Key band pass circuit. Substitution of passive elements by FDNR, Gyrator and GIC.

Unit VI : (15 Hrs)

Sensitivity and Performance Parameters

Definition of sensitivities. Sensitivity analysis of the above circuits with respect to parameters like Q, ω_o and component values. Multi-element deviation, Gain sensitivity. Factors affecting gain sensitivity, Contribution of the approximation functions, choice of the circuit and component types.

OP-AMP frequency characteristics and compensation techniques, Effect of Op-amp frequency characteristics on filter performance and other op-amp characteristics like Dynamic range, slew rate, offset voltage and currents, noise, common mode signals.

Text Books:

1. Franklin Kuo, "Network Analysis and Synthesis", Wiley international, 2nd Edition, 1968.
2. Gobind Daryanani, "Principles of Active Network Synthesis and Design", Wiley International, 1st Edition, 1976.

Reference Books:

1. M.E. Van Valkenburg , "Analog Filter Design", Holt, Rinehart and Winston, 1st Edition, 1982.
2. Wai-Kai Chen , "Passive and Active Filters, theory and implementations", John Wiley & Sons, 1st Edition, 1986
3. Lawrence Huelsman, "Active and Passive Analog Filter Design", McGraw-Hill Inc., 1st Edition, 1993

3. Network Theory.

Unit I: (15 Hrs)

Basic Circuit Analysis and Simplification Techniques: Voltage and Current laws (KVL/KCL).

Network Analysis: Mesh, Super mesh, Node and Super Node analysis. Source transformation and source shifting.

Network Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems, Millers Theorem and its dual.

Significance of Quality factor.

Series Resonance: Impedance, Phase angle variations with frequency, Voltage and current variation with frequency, Bandwidth, Selectivity. Effect of Rg on BW & Selectivity. Magnification factor.

Unit II: (15 Hrs)

Frequency Selective Networks: Parallel resonance: Resonant frequency and admittance

variation with frequency, Bandwidth and selectivity. General case: Resistance present in both branches.

Comparison and applications of series and parallel resonant circuits. Twin T and Wien Bridge Networks as Notch Filters.

Laplace Transform and Its Applications: Introduction to complex frequency, Definition of Laplace Transform, Basic Properties of Laplace Transform, Inverse Laplace Transform Techniques, Laplace Transform of Basic R, L and C components, Transient response of simple electrical circuits such as RL & RC.

Unit III: (15 Hrs)

Filters and Attenuators: Classifications: Symmetrical and Asymmetrical networks.

Properties of two port Network:

1. Symmetrical Networks (T and ∏ only). Z_0 and γ in terms of circuit components, open and short circuit parameter.
2. Asymmetrical Networks: Image Impedance and Iterative Impedance (L-Section only). Filters: Filter fundamentals, Constant K-LPF, HPF, BPF and BSF, m derived LPF and HPF, Terminating half sections, Concept of composite filters

Attenuators: Introduction to Neper and Decibel, Relation between Neper and Decibel, Symmetrical T and ∏ type attenuators.

Unit IV: (15 Hrs)

Two Port Network Parameters and Functions: Terminal characteristics of network: Z, Y, h, ABCD Parameters; Reciprocity and Symmetry conditions, Applications of the parameters. Network functions for one port and two port networks, Pole-zeros of network functions and network stability.

Transmission Line Theory: Types of Transmission lines, Transmission Line Equation, Equivalent circuits, Primary and Secondary line constants, Terminations of transmission lines, VSWR and Reflection Coefficient.

Text Books:

1. D Roy Choudhary, "Network and Systems", New Age International, 2nd edition, 2010.
2. John D. Ryder, "Network Lines and Fields" 2nd edition, Prentice hall of India, 1st Edition, 1997.
3. C.P. Kuriakose, "Circuit Theory Continuous and Discrete Time System, Elements of Network Synthesis", Prentice hall of India, 1st Edition, 2005.

Reference Books:

1. W.H. Hayt Kemmerly, "Engineering Circuit Analysis", Tata McGraw Hill Publications, 8th Edition, 2013.
2. M.E.VanValkenburg, "Network Analysis", Pearson, 3rd Edition, 2004.
3. Boylestad, "Introductory Circuit Analysis", Prentice Hall, 12th Edition, 2010.

4. “Royal Signal Handbook of Line Communication”, her majesty's stationery office, 1952.