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UNIVERSITY OF DELHI

Bachelor of Science (Hons) Instrumentation

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by

Academic Council

Date: No:

Executive Council

Date: No:

Applicable for students registered with Regular Colleges, Non Collegiate Women's Education Board and School of Open Learning

Choice based Credit System (CBCS)
with
Learning Outcomes based Curriculum Framework (LOCF)
for
B.Sc. (Hons)Instrumentation
Undergraduate Programme
(Effective from Academic Year 2019-20)

DEPARTMENT OF ELECTRONIC SCIENCE
FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES
UNIVERSITY OF DELHI SOUTH CAMPUS
NEW DELHI – 110021

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Preamble

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The University of Delhi envisions all its programmes in the best interest of their students and in this endeavour it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Under Graduate programmes.

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability.

Each programme vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice and also skills for employability. In short, each programme prepares students for sustainability and life-long learning.

The new curriculum of B.Sc. (Hons) Instrumentation is designed in such a way that the learners should be able to comprehend and analyze the subject. Students will be able to equip themselves to the basic and advanced theories of Instrumentation to a complete skill set compatible to industry standards. The exhaustive curriculum will prepare them to pursue higher education as well compete in the job market.

The University of Delhi hopes the LOCF approach of the programme B.Sc. (Hons) Instrumentation will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

1.Introduction to Programme

The learning outcomesbased curriculum framework (LOCF) for B.Sc. (Hons) Instrumentation is intended to prepare a curriculum which empowers the graduates to design, construct and maintainthe entire instrumentation system of any industrial undertaking of national and global standards. The framework will help in maintaining international standards to ensure global competitiveness and facilitate student/graduate mobility after completion of B.Sc. (Honours) Instrumentation program. The framework intends to allow for greater flexibility and innovation in curriculum design and syllabus development, teaching learning process, assessment of student learning Levels.

The LOCF for B.Sc. (Honours) Instrumentation is prepared by taking CBCS curricular structure of B.Sc. (H) Instrumentation provided by the UGC as reference. It may be modified without losing the essence of CBCS and LOCF.

Program Duration:

The B.Sc. (Hons) Instrumentaionprogramme will be of three years duration. Each year will be called an academic year and will be divided into two semesters.Thus there will be a total of six semesters. Each semester will consist of sixteen weeks.

Design of Program:

The teaching-learning will involve theory classes (Lectures) of onehour duration, tutorials and practical classes. The curriculum will be delivered through various methods including chalk and talk, powerpoint presentations, audio, video tools, E-learning/E-content, virtual labs, simulations, field trips/Industry visits, seminars (talks by experts), workshops, projects, models , class discussions and other listed suggestive ways. The assessment broadly will comprise of Internal Assessment (Continuous Evaluation) and End Semester Examination. Each theory paper will be of 100 marks with 25% marks for Internal Assessment and 75% for End Semester examination. The internal Assessment will be through MCQ, test, assignment, oral presentation, worksheets, short project and other suggested methods. Each practical paper will be of 50 marks.

Programme Structure:

The programme will consist of six-credit courses, four-credit courses and two credit courses. All six credit courses with practicals will comprise of theory classes (four credits) and practicals (two credits) whereas those without practicals will have theory classes (five credits) and tutorials (one credit). Four credit courses will comprise of theory classes (two credits) and practicals (two credits). Two credit courses will comprise of theory classes only (two credits). For theory or tutorial classes, one credit indicates a one hour lecture per week while for practicals one credit indicates a two-hour session per week. Each practical or tutorial batch will be of 12-15 students.

The programme includes Core Courses (CC) and elective courses. The core courses are all compulsory courses. There are three kinds of elective courses: Discipline-Specific Elective (DSE), Generic Elective (GE) and Skill Enhancement Course (SEC). In addition there are two compulsory Ability Enhancement Courses (AEC). The outline of the Course is as under:

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 Dissertation/Project Work: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study/ solving / analyzing /exploring a real life situation / difficult problem into a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project work. A Dissertation/ Project work would be of 6 credits. A Dissertation/Project Work may be given in lieu of a discipline specific elective paper.

2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. Therefore, the department is free to offer any of its Core Courses as Generic Electives to other discipline/subject.

3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.

3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

To acquire a degree in Instrumentation, a student must study fourteen Core Courses, four Discipline- Specific Electives, four Generic Electives, two Skill Enhancement Courses and two compulsory Ability Enhancement Courses. The Core Courses, Discipline-Specific Electives and Generic Electives are six-credit courses. The Skill Enhancement Courses are four-credit courses while the Ability Enhancement Courses are two credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons) Instrumentation.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Instrumentation. The students will study two Core Courses each in Semesters I and II, three Core Courses each in Semesters III and IV, and two Core Courses each in Semesters V and VI. The Core Courses will be of six credits each (four credits theory and two credits practicals).

The programme offers nine Discipline-Specific Electives (DSEs), of which the student must choose any two in each of the Semesters V and VI. The DSEs will be of six credits each (four credits theory and two credits practicals). A particular option of DSE course shall be offered in Semesters V and VI semesters only if the minimum number of students opting for that course is 15. The DSE course that is project work will also carry six credits. The number of students who will be allowed to opt for project work will vary from college to college depending upon the infrastructural facilities and may vary each year. The college shall announce the number of seats for project work well in advance and may select the students for the same based on merit. Project work will involve investigative work and the student will have to do this in the time after their regular theory and practical classes. The final evaluation of the project work will be through a committee involving internal and external examiners. In this regard guidelines provided by University of Delhi for executing and evaluation of project work will be final. Students will be asked their choice for Project work at the end of IV semester and all formalities of topic and mentor selection will be completed by this time.

Different Generic Elective (GE) courses will be offered to the students of the B.Sc. (Hons) Instrumentationprogramme by other departments of the college and the student will have the option to choose one GE course each in Semesters I, II, III, and IV. The GEs will be of six credits each (four credits theory and two credits practicals or five credits theory and one credit tutorial). The Department of Instrumentation will offer nine GE courses for students of other departments. A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective. Therefore, the Department of Instrumentation is free to offer any of its Core Courses as Generic Electives to other discipline/subject.

The students will undertake two Skill Enhancement (SEC) courses of four credits each in Semesters III and IV which they can choose from the list of SEC courses offered by their college. The SEC courses will be of four credits each (two credits theory and two credits practicals). The Department of Instrumentation is offering six such courses.

The two compulsory Ability Enhancement Courses (AECs): AECC1 (Environmental Sciences) and AECC2 (English communication) will be of four credits each (theory only). The student will take one each in Semesters I and II.

2. Learning Outcome-based Curriculum Framework in B.Sc.(Hons) Instrumentation

The learning outcomes based approach implies that when an academic programme is planned, desirable learning outcomes are identified and considered in formulation of the plans. Course contents, learning activities and assessment types are designed to be consistent with the achievement of desired learning outcomes. The learning outcomes are in terms of knowledge, Professional attitude, work ethics, critical thinking, self managed learning, adaptability, problem solving skills, communication skills, interpersonal skills and group works. At the end of a particular course/program, assessment is carried out to determine whether the desired outcomes are being achieved. This outcome assessment provides feedback to ensure that element in the teaching and learning environment are acting in concert to facilitate the nurturing of the desired outcomes. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn help not only in curriculum planning and development, but also in delivery and review of academic programmes.

The overall objectives of the learning outcomes based curriculum framework are to

- Help formulate graduate attributes, qualification descriptors, program learning outcomes and course learning outcomes that are expected to be demonstrated by the holders of qualification;
- Enable prospective students, parents, employers and other to understand the nature and level of learning outcomes or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.
- Maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility.
- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning level, and periodic review of programme and academic research.

2.1 Nature and Extent of the Programme in B.Sc.(H) Instrumentation

B.Sc. (Hons)Instrumentation is a specialized branch of physical sciences which caters to study of measurement in physical, chemical, biological sciences along with medical and engineering sciences. B.Sc. (Honours) Instrumentation is a professional course which is designed to develop skills which imparts knowledge in science and technology of measurement and control; to prepare skilled manpower that can objectively contribute towards design, development, use and maintenance of various instruments and machine learning environment.

At a time when automation and artificial intelligence are being considered instrumental in defining the onset of the fourth industrial revolution, an outcome-oriented course in Instrumentation has potential to produce trained professionals ready to take up the challenges in research, industrial and commercial organizations. The programmein Instrumentation is designed to develop academic and practical skills. The course includes many specialized papers like Transducers and Sensors, Machine Intelligence, Control Systems, Electronic Instrumentation, Measurement Technology, Analytical Instrumentation, Biomedical Instrumentation and Standardization and Quality Control, with the aim to produce graduates capable of adapting to technological changes.

The present learning outcomes based model curriculum of B.Sc. (Hons) Instrumentation, is designed to provide better learning experience to the graduates. Besides, imparting disciplinary knowledge, curriculum is aimed to equip the graduates with competencies like problem solving, analytical reasoning and leadership which provide them high professional competence.

2.2 Aims of Bachelor Degree Programme in B.Sc. (Hons) Instrumentation

The overall aims of the B.Sc. (Hons) Instrumentation are to:

- Provide students with learning experiences that develop broad knowledge and understanding of key concepts of Instrumentation and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the automation and control industries.
- Develop ability in student's to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems in Instrumentation.
- Develop abilities in students to design and develop innovative solutions for benefits of society, by diligence, leadership, team work and lifelong learning.
- Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

3.Graduates Attributes in B.Sc. (Hons) Instrumentation

Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The Graduate Attributes of B.Sc. (Hons) Instrumentationare listed below:

GA1. Scholarship of Knowledge: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

GA2. Critical Thinking: Analyze complex scientific/technological problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

GA3. Problem Solving: Think laterally and originally, conceptualize and solve scientific/technological problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

GA4. Usage of modern tools: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex scientific/technological activities with an understanding of the limitations.

GA5. Collaborative and Multidisciplinary work: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

GA6. Communication: Communicate with the scientific/technological community, and with society at large, regarding complex scientific/technological activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

GA7. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

GA8. Ethical Practices and Social Responsibility: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

4. Qualification Descriptors for Graduates in B.Sc.(Hons) Instrumentation

A qualification descriptor indicates the generic outcomes and attributes expected for the award of a particular type of qualification. The learning experiences and assessment procedures are expected to be designed to provide every student with the opportunity to achieve the intended programme learning outcomes. The qualification descriptors reflect followings:

1. Disciplinary knowledge and understanding
2. Skills & Ability
3. Global competencies that all students in different academic fields of study should acquire/attain and demonstrate.

4.1 Qualification descriptors for B.Sc. (Honours) Instrumentation Programme: Some of the expected learning outcomes that a student should be able to demonstrate on completion of a B.Sc. (Hons) Instrumentation programme may include the following:

Knowledge & Understanding

- Demonstrate extensive knowledge of the disciplinary foundation in the various areas of Instrumentation, as well as insight into contemporary research and development.
- Demonstrate specialized methodological knowledge in the specialized areas of Instrumentation about professional literature, statistical principles and reviewing scientific work.

Skills & Ability

- Demonstrate ability to apply Instrumentation knowledge & experimental skills critically and systematically for assessment and solution of complex Instrumentation problems and issues related to Analytical systems, Biomedical systems, computers networks, robotics, VLSI Design and fabrication and other specialized areas of Instrumentation.
- Demonstrate ability to model, simulate and evaluate the phenomenon and systems in the advanced areas of Instrumentation.
- Demonstrate ability to apply one’s instrumentation knowledge, experimental skills, scientific methods & advanced design, simulation and validation tools to identify and analyze complex real life problems and frame technological solutions for them.

- Demonstrate ability to design and develop industrial products, processes and Instrumentation systems while taking into account the circumstances and needs of individuals, organizations and society with focus on economical, social and environmental aspects

Competence

- Communicate his or her conclusions, knowledge & arguments effectively and professionally both in writing and by means of presentation to different audiences in both national and international context.
- Ability to work in collaborative manner with others in a team, contributions to the management, planning and implementations.
- Ability to independently propose research/developmental projects, plan its implementation, undertake its development, evaluate its outcomes and report its results in proper manner.
- Ability to identify the personal need for further knowledge relating to the current and emerging areas of study by engaging in lifelong learning in practices.

5. Program learning outcomes for B.Sc. (Honours) Instrumentation

The following program outcomes have been identified for **B.Sc. (Honours) Instrumentation**

PLO1	Ability to apply knowledge of mathematics & science in solving instrumentation related problems
PLO2	Ability to design and conduct instrumentation experiments, as well as to analyze and interpret data
PLO3	Ability to design and manage instrumentation systems or processes that conforms to a given specification within ethical and economic constraints
PLO4	Ability to identify, formulate, solve and analyze the problems in various disciplines of instrumentation.
PLO5	Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility
PLO6	Ability to communicate effectively in term of oral and written communication skills
PLO7	Recognize the need for, and be able to engage in lifelong learning.
PLO8	Ability to use techniques, skills and modern technological/scientific/engineering software/tools for professional practices

Structure of B.Sc. (Hons) Instrumentation

6.1 Credit Distribution for B.Sc. (Hons) Instrumentation

A 148 credits (as per University norms) will be required for a student to be eligible to get degree of B.Sc. (Hons) Instrumentation. The credit distribution is as under:

	Credit Details
	(Theory + Practical) or (Theory + Tutorial)
I. Core Course (14 Papers)	
Core Courses (Theory)	14×4=56
Core Courses (Practical)	14×2=28
II. Elective Course (8 Courses = 4DSE + 4GE)	
A.1. Discipline Specific Elective (DSE) Theory (4 in number)	4 × 4 =16
A.2. Discipline Specific Elective (DSE) Practical (4 in number)	4 × 2 = 8
B.1. Generic Elective/Interdisciplinary (GE) Theory (4 in number)	4 × 4 =16 or4 × 5 = 20
B.2. Generic Elective (GE) Practical/Tutorial*(4 in number)	4 × 2 = 8 or4 × 1 = 4
III. Ability Enhancement Courses	
1. Ability Enhancement Compulsory Courses (AECC) (2 papers of 4 credits each)	
Environmental Science/ English/ MIL Communication	2 × 4 = 8
2. Skill Enhancement Courses (SEC)** (2 papers of 4 credits each)	2 ×4 = 8**
Total	**148**

* Wherever there is a practical there will be no tutorial and vice-versa.
** As per University notification (No. Aca.I/Choice Based Credit System/2016/1173 dated 04.10.2016)

6.2 Semester-wise Distribution of Courses

Semester I					
	Course Type	**Course Name**		**Hours/ Week**	**Credit**
1	Core	Core I:	*Basic Circuit Theory and Network Analysis*	4	4
2		Core II:	*Applied Physics*	4	4
3		Core Lab I:	*Basic Circuit Theory and Network Analysis Lab*	4	2
4		Core Lab II:	*Applied Physics Lab*	4	2
5	GE	GE-1:		4/5	4/5*
6		GE-1:	*Practical/Tutorial*	4/1	2/1*
7	AECC	AECC-I:	*(English/ MIL Communication)/ Environmental Science*	4	4
			Total Credits		**22**

Semester II					
	Course Type	**Course Name**		**Hours/ Week**	**Credit**
1	Core	Core III:	*Analog Devices and Circuits*	4	4
2		Core IV:	*Transducers and Sensors*	4	4
3		Core Lab III:	*Analog Devices and Circuits Lab*	4	2
4		Core Lab IV:	*Transducers and Sensors Lab*	4	2
5	GE	GE-2:		4/5	4/5*
6		GE-2:	*Practical/Tutorial*	4/1	2/1*
7	AECC	AECC-II:	*(English/ MIL Communication)/ Environmental Science*	4	4
			Total Credits		**22**

Semester III					
	Course Type	**Course Name**		**Hours/ Week**	**Credit**
1	Core	Core V:	*Biomedical Instrumentation*	4	4
2		Core VI:	*Digital Electronics and VHDL*	4	4
3		Core VII:	*Engineering Mathematics*	4	4
4		Core Lab V:	*Biomedical Instrumentation Lab*	4	2
5		Core Lab VI:	*Digital Electronics and VHDL Lab*	4	2
6		Core Lab VII:	*Engineering Mathematics Lab*	4	2
7	GE	GE-3:		4/5	4/5*
8		GE-3:	*Practical/Tutorial*	4/1	2/1*
9	SEC	SEC-1:		4	4
			Total Credits		**28**

		Semester IV		
	Course Type	**Course Name**	**Hours/ Week**	**Credit**
1	Core	Core VIII: *Operational Amplifiers and Applications*	4	4
2		Core IX: *Analytical Instrumentation*	4	4
3		Core X: *Electronic Instrumentation*	4	4
4		Core Lab VIII: *Operational Amplifiers and ApplicationsLab*	4	2
5		Core Lab IX: *Analytical Instrumentation Lab*	4	2
6		Core Lab X: *Electronic Instrumentation Lab*	4	2
7	GE	GE-4:	4/5	4/5*
8		GE-4: *Practical/Tutorial*	4/1	2/1*
9	SEC	SEC-2:	4	4
			Total Credits	**28**

		Semester V		
	Course Type	**Course Name**	**Hours/ Week**	**Credit**
1	Core	Core XI: *Measurement Technology*	4	4
2		Core XII: *Microprocessor*	4	4
3		Core Lab XI: *Measurement Technology Lab*	4	2
4		Core Lab XII: *MicroprocessorLab*	4	2
5	DSE	DSE-1:	4	4
6		DSE-2:	4	4
7		DSE-1 Lab: *Practical*	4	2
8		DSE-2 Lab: *Practical*	4	2
			Total Credits	**24**

		Semester VI		
	Course Type	**Course Name**	**Hours/ Week**	**Credit**
1	Core	Core XIII: *Power Electronics*	4	4
2		Core XIV: *Control Systems*	4	4
3		Core Lab XIII: *Power Electronics Lab*	4	2
4		Core Lab XIV: *Control SystemsLab*	4	2
5	DSE	DSE-3:	4	4
6		DSE-4:	4	4
7		DSE-3 Lab: *Practical*	4	2
8		DSE-4 Lab: *Practical*	4	2
			Total Credits	**24**

A. CORE COURSE (CC):

Credit: 06 each (Theory: 04 + Lab: 02)

1. Basic Circuit Theory and Network Analysis (4+4)
2. Applied Physics (4+4)
3. Analog Devices and Circuits (4+4)
4. Transducers and Sensors (4+4)
5. Biomedical Instrumentation (4+4)
6. Digital Electronics and VHDL (4+4)
7. Engineering Mathematics (4+4)
8. Operational Amplifiers and Applications (4+4)
9. Analytical Instrumentation (4+4)
10. Electronic Instrumentation (4+4)
11. Measurement Technology (4+4)
12. Microprocessors (4+4)
13. Power Electronics (4+4)
14. Control Systems (4+4)

B. Discipline Specific Electives (DSE):

(4 papers to be selected) - DSE 1-4
Credit: 06 each (Theory: 04 + Lab: 02)

1. Signals and Systems (4+4)
2. Advanced Analytical Instrumentation (4+4)
3. Communication System (4+4)
4. Advanced Biomedical Instrumentation (4+4)
5. Embedded System and Robotics (4+4)
6. Process Control Dynamics (4+4)
7. Reliability and Quality Control Techniques (4+4)
8. Artificial Intelligence (4+4)
9. Dissertation (4+4)

C. Skill Enhancement Course (SEC) (02 papers) SEC1 to SEC2

Credit: 04 each (Theory: 02 + Lab: 02)

1. Programming in C (2+4)
2. VLSI Design and Verification (2+4)
3. Testing and Calibration (2+4)
4. PLC and SCADA (2+4)
5. Virtual Instrumentation (2+4)
6. Programming using MATLAB (2+4)

D. Generic Elective Papers (GE) for other Departments/Disciplines: (Credit: 06 each)***

1. Sensors and its Applications (4+4)
2. Instrumentation & Control (4+4)
3. Analytical Instrumentation (4+4)
4. Nuclear & Biomedical Instrumentation (4+4)
5. Machine Intelligence (4+4)
6. Standardization and Quality Control (4+4)
7. MATLAB and its Applications (4+4)
8. General Instrumentation (4+4)
9. Applied Mathematics (4+4)

Any of the Core Courses in Category A can be offered as Generic Electives to other discipline/subject.

******* *Finally, a word on the Generic Electives to be chosen by Instrumentation students. They are, of course, free to exercise their choice in a way they deem fit. However, it is recommended that they shall avoid opting for a Generic Elective of another program that has majority overlapping to their core course.*

Important:
The size of the practical group for practical papers is recommended to be 12-15 students.

Note:

1. Universities/Institutions/Departments may wish to add more courses against categories marked B, C and D, depending on the availability of specialists and other required resources.

2. Any major deviation in the category A (core courses) is likely to impact the very philosophy of LOCF in Instrumentation.

3. Departments/Board of Studies/ Universities should have freedom to arrange courses in the order they deem fit with justification.

4. Whenever stakeholders seek to introduce modifications or alterations in the LOCF or CBCS guidelines, they are (a) expected to have adequate and transparent justifications to do so and (b) to notify the UGC regarding the changes and the justifications thereof.

Mapping of Course with program outcomes (PLOs)

	Core Course Name	PLO1: Ability to apply knowledge of mathematics & science in solving instrumentation related problems.	PLO2. Ability to design and conduct instrumentation experiments, as well as to analyze and interpret data.	PLO3. Ability to design and manage instrumentationsystems or processes that conforms to a given specification within ethical and economic constraints.	PLO4Ability to identify, formulate, solve and analyze the problems in various disciplines of instrumentation.	PLO5. Ability to function as a member of a multidisciplinary team with sense of ethics, integrity and	PLO6. Ability to communicate effectively in term of oral and written communication skills	PLO7. Recognize the need for, and be able to engage in lifelong learning.	PLO8. Ability to use techniques, skills and modern technological/scientific/engineering software/tools for professional practices
1	Basic Circuit theory and Networks Analysis	√		√					
2	Basic Circuit theory and Networks Analysis Lab				√	√			√
3	Applied Physics	√		√					
4	Applied Physics Lab				√	√			√
5	Analog Devices and Circuits	√		√					
6	Analog Devices and Circuits Lab				√	√			
7	Transducers and Sensors	√	√				√		
8	Transducers and Sensors Lab				√	√	√		
9	Biomedical Instrumentation	√		√					√
10	Biomedical Instrumentation Lab				√	√			
11	Digital Electronics and VHDL	√	√					√	
12	Digital Electronics and VHDL Lab				√	√		√	
13	Engineering Mathematics	√		√					
14	Engineering Mathematics Lab				√	√			
15	Operational Amplifiers and Applications	√	√					√	
16	Operational Amplifiers and Applications Lab				√	√		√	√
17	Analytical Instrumentation	√	√					√	
18	Analytical Instrumentation Lab				√	√	√	√	
19	Electronic Instrumentation	√		√			√	√	√
20	Electronic Instrumentation Lab				√	√	√	√	
21	Measurement Technology	√	√						
22	Measurement Technology Lab				√	√	√		√
23	Microprocessors	√	√	√			√	√	
24	Microprocessors Lab				√	√	√	√	
25	Power Electronics	√		√					
26	Power Electronics Lab				√	√			
27	Control Systems	√	√	√			√		
28	Control Systems Lab				√	√	√		√
29	Dissertation/Project work	√	√	√	√	√	√	√	√

Details of Core courses

Basic Circuit theory and Network Analysis

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To develop an understanding of the fundamental laws and elements of electric circuits.
- To learn the energy properties of electric elements and techniques to measure current and voltage.
- To develop the ability to apply circuit analysis to AC and DC circuits.
- To understand signals, waveforms and transient & steady state responses of RLC circuits.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the current-voltage characteristics of basic fundamental elements

CO2 Design and analyzethe electronic circuits using various network theorems

CO3 Understand frequency response and behavior of ac circuits

CO4 Understand the concept of two port network and overall response for interconnection of two port networks

Syllabus Contents

Unit- 1 (14 Lectures)

Basic Circuit Concepts: Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction, Characteristics & color coding of resistors, resistors in series and parallel, applications of resistors. Inductors: Fixed and Variable inductors, Self and mutual inductance, Inductance in series and parallel, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor. Capacitors: Working Principles of capacitance, Permittivity, Dielectric Constant, Dielectric strength, types of Capacitor, Construction, Characteristics and coding of capacitors, application of capacitors, capacitors in series and parallel, factors governing the value of capacitors, Energy stored in a capacitor.Testing of resistance, inductance and capacitor using multimeter.

Unit- 2 (12 Lectures)

Concepts of Circuit Analysis: Ohms Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, star-delta conversion & delta-star conversion.

Network Theorem (DC Circuits): Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.

Unit-3 (24 Lectures)

DC Transient Analysis: Time Constant, Response of RC, RL and RLC circuit to dc source(s), Response of source free RC, RL and RLC circuit having initial charge/current.

AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance.Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Mesh Analysis, Node Analysis and Network Theorems for AC Circuits. Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-4 (10 Lectures)

Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Complex Power and Power Triangle, Power Factor.

Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, hybrid (h) parameters and Transmission (ABCD) Parameters.

References

1. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004).
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005).
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004).
4. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill(2005).
5. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2008).

Basic Circuit theory and Network Analysis Lab

(Hardware and Circuit Simulation Software)

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Analyze and familiarize with active and passive components

CO2 Verify the theoretical concepts through laboratory experiments

CO3 Understand the behavior and evaluate frequency response of electronic circuits

Syllabus Contents

1. Familiarization with
   a) Resistance in series, parallel and series – Parallel.
   b) Capacitors & Inductors in series & Parallel.
   c) Multimeter – Checking of components.
   d) Voltage sources in series, parallel and series – Parallel
   e) Voltage and Current dividers
2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's Theorem.
6. Verification of Superposition Theorem.
7. Verification of the Maximum Power Transfer Theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Applied Physics

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To develop an intuitive understanding of thermodynamics by emphasizing the physics
- To provide the students a thorough understanding of the fundamentals of optics
- The aim is to tell the students about the phenomena taking place in the nucleardomain
- To introduce fundamental aspects of fluid flow behaviour.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Gain in depth knowledge about basic concepts of thermodynamics
CO2 Understand the physics behind various phenomenon's in optics
CO3 Express the basic concepts of nuclear physics and radioactive decay
CO4 Understand the dynamics of fluid flow

Syllabus Contents

Unit-1 (13 Lectures)

Thermodynamics: Heat and Temperature, Zeroth law of thermodynamics: thermal equilibrium, thermometry and temperature scales, First law of thermodynamics, Thermodynamic systems and processes, Internal energy and heat capacity, adiabatic processes. Second law of thermodynamics, Reversible and irreversible processes, Carnot Engine, Cycle and theorem.

Unit-2 (22 Lectures)

Interference: Interference of light, Bi prism experiment, displacement of fringes, and interference in thin films wedge shaped film, Newton's rings.

Diffraction - Single, Double & N- Slit, Diffraction grating, Grating spectra, Rayleigh's criterion and resolving power of grating.

Polarization- Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Fresnel's theory of optical activity, Polarimeters.

Laser: Basic principle, Spontaneous and stimulated emission of radiation, Einstein's Coefficients, Laser applications.

Fibre Optics: Principles and applications

Unit-3 (12 Lectures)

Nuclear Physics: Nucleus, constituent of nucleus, Properties of Nucleus size, mass, density, energy, charge, binding energy, nuclear angular momentum, Nuclear force, Radioactivity and decay.

Unit-4 (13 Lectures)

Fluid Mechanics: Fluid properties, Surface Tension, Viscosity, equation, Bernoulli's equation, Navier-Stokes Equations, Differential form of Energy equation. Reynolds number, Incompressible and compressible Flow, Laminar and turbulent flows, Flow through pipes.

References

1. AjoyGhatak –Optics, fourth Edition, McGraw-Hill (2008).
2. M.W. Zemansky and R.H. Dittman- Heat and Thermodynamics, 7th Edition, Mc-Graw Hill (1997).
3. Nuclear physics by Cohen, 1st Edition, McGraw-Hill.
4. Fox and Mc Donald- Introduction to Fluid Mechanics, 5th edition, John Wiley & Sons (2011).
5. AurthurBeiser -Concepts of Modern Physics, 6th Edition, Mc-Graw Hill.
6. Anuradha De. -Optical Fibre& Laser, 2nd Edition, New Age (2009).
7. Resnick, Halliday& Walker -Fundamental of Physics, 10th Edition, Wiley.
8. R.A. Serway& J.W. Jewett -Principles of Physics, 9thEdition,Cengage Learning.
9. H.Callen-Thermodynamics and an Introduction to Thermo statistics, 2nd Edition, Wiley.

Applied Physics Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Gain practical knowledge about various forms of heat transfer

CO2 Learn methods to find out conductivity of good and bad conductors

CO3 Apply the graphical analysis to the experimental data.

CO4 Learn usage of various optical instruments for measurement of wavelength of light and refractive index, dispersive power of material

Syllabus Contents

1. To determine the thermal conductivity of a good conductor by Searl's method.
2. Determination of J, mechanical equivalent of heat by calendar and Barne's method.
3. To determine the temperature coefficient of PRT (Platinum Resistance Thermometer).
4. To determine the dispersive power of prism using spectrometer and mercury source.
5. To determine the refractive index of a prism using spectrometer
6. To determine the wavelength of sodium light by Newton's Ring.
7. To find the wavelength of He-Ne Laser using transmission diffraction grating.
8. To find the thermal conductivity of poor conductors by Lee Disc Method

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Analog Devices and Circuits

Credits: Theory-04 Theory Lectures: 60h

Course Learning Objectives

- To explain operation of semiconductor devices
- To introduce DC analysis and AC models of semiconductor devices.
- To apply concepts for the design of Regulators, Amplifiers& Oscillators.
- To introduce different types of transistors UJT, FET, MOSFET

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the working of diode circuit
CO2 Analyze analog circuits and their applications using active devices
CO3 Understand the designoffeedback circuits and use them in amplifiers and Oscillators
CO4 Explain the operation of FET, MOSFET and UJT

Syllabus Contents

Unit-1 (16 Lectures)

Semiconductor Basics: Introduction to semiconductor materials, intrinsic & extrinsic semiconductors. p-n junction diode: Ideal diode, formation of depletion layer, space charge at a junction, Diode Circuits: clipper circuits, clamping circuits. Half wave rectifier, center tapped and bridge full wave rectifiers, calculation of efficiency and ripple factor. DC power supply: Block diagram of a power supply, Zener diode as voltage regulator, temperature coefficient of Zener diode.

Unit-2 (15 Lectures)

The BJT: Basic transistor action, Transistor current components and amplification. **Transistor configurations:** Common Base (CB), Common Emitter (CE) and Common Collector (CC) configuration, I-V characteristics and hybrid parameters, regions of operation, dc load line, Q point.
Biasing Circuits: Fixed bias, collector to base bias, emitter bias and voltage divider bias circuits.
CE amplifier: dc and ac load line analysis, Hybrid equivalent of CE, frequency response of CE amplifier.

Unit-3 (14 Lectures)

Feedback Amplifiers: Concept of feedback, negative and positive feedback, Negative feedback: advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, derivation of gain, input and output impedances for feedback amplifiers. Positive feedback: Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Crystal oscillator.

Unit-4 (15 Lectures)

Junction Field Effect Transistor (JFET): Construction of JFET, idea of channel formation, pinch-off and saturation voltage, current-voltage output characteristics. Metal Oxide Field Effect Transistor (MOSFET): The ideal MOS diode, accumulation, depletion and inversion, Basic

Construction of MOSFET and working, I-V characteristics, enhancement and depletion modes. Complimentary MOS (CMOS), UJT: construction, working and applications.

References

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).
2. N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGrawHill (2007).
3. J. Millman and C. Halkias, Integrated Electronics, Tata McGraw Hill (2001).
4. David A. Bell, Electronic Devices & Circuits, Oxford University Press, Fifth edition.
5. Mottershed, Electronic Devices, PHI Publication, 1st Edition.
6. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002).
7. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010).
8. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002).
9. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991).
10. P. Arun, Electronics, Narosa Publishing House, 2006.

Analog Devices and Circuits Lab

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the current voltage characteristics of semiconductor devices.
CO2 Extract important information from the graphical plots of device characteristics
CO3 Design and analyze various application oriented circuits based on diodes, BJT and FETs.
CO4 Analyze the frequency response of semiconductor devices for understanding behaviour of electronic circuits at high frequencies.
CO5 Design projects based on device applications

Syllabus Contents

1. To study I-V characteristics of p-n junction and Zener diodes in forward and reverse bias configurations.
2. To study the Half wave rectifier and Full wave rectifier.
3. To study power supply using C filter and Zener diode.
4. To study input and output I-V characteristics of common base and common emitter transistor configurations.
5. To study Fixed Bias and Voltage divider bias configuration for transistor.
6. To design a Single Stage CE amplifier.
7. To study clipping and clamping circuits.
8. To study the Colpitt's Oscillator.
9. To study the Phase Shift Oscillator.
10. To study I-V characteristics of UJT and JFET.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Transducers and Sensors

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To learn about different parameters of a measurement system.
- To understand the basic concept of errors and study different types of errors present in a measurement systems.
- To study different types of transducers – resistive, capacitive and inductive
- To study different type of light, temperature and pressure transducers.

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Understand the basics of concepts of Instrumentation and measurement systems

CO2 Identify and comprehend various sensors used in the real life applications and paraphrase their importance

CO3 Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light

Syllabus Contents

Unit-1 (16 Lectures)

Basic concepts of Instrumentation: Generalized instrumentation systems block diagram representation, scope of instrumentation in Industrial organization.

Measurement systems: Static (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), impedance matching and loading, dynamic characteristics (types, fidelity, speed of response, dynamic error).

Unit-2 (09 Lectures)

Definition of errors:systematic errors, instrumental errors, environmental errors, random errors, loading errors, limiting errors, source of errors in measuring instruments, Uncertainties types, propagation of uncertainties

Unit-3 (19 Lectures)

Transducers: Classification, Active, Passive, Mechanical, Electrical, their comparison. Selection of Transducers, Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits-Null and deflecting, Semi-conductor strain gauge), Capacitive (Capacitive transducers using change in area of plates, change in distance between plates, variation of dielectric constant for displacement measurement) and Inductive (LVDT-Principle and characteristics, Hall effect sensors, magneto-strictive transducers).

Unit-4 (16 Lectures)

Piezoelectric Effect: Element and their properties, Piezo-Electric coefficients, Equivalent circuit and frequency response of P.E. Transducers

Light Transducers: Photo-conductive, Photo-emissive, Photo-voltaic, Semiconductor photodiode(LDR).

Temperature Transducers: Electrical and Non-Electrical**.**
PressureTransducers -Force summing devices, Load cell.

References

1. Doeblin&Manek, Measurement Systems, McGraw Hill, New York, 1992, 5th edition.
2. Nakra&Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd edition.
3. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition.
4. Rangan, Sarma, and Mani, Instrumentation- Devices and Systems, Tata-McGraw Hill, 2nd edition.
5. H.S Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition.
6. DVS Murthy, Measurement & Instrumentation, PHI, 2nd edition.
7. D. Patranabis, Sensors and Transducers, PHI, 2nd edition.

Transducers & Sensors Lab
(Hardware Practical)

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Identify different types of transducers
CO2 Understand the principles of the conversion of measured quantities into electric signal
CO3 Interpret the output and its relation with the input

Syllabus Contents

1. Measurement of pressure, strain and torque using strain gauge/load cells.
2. Measurement of speed using Electromagnetic transducer.
3. Measurement of speed using photoelectric transducers
4. Measurement of angular displacement using Potentiometer.
5. Measurement of displacement using LVDT.
6. Measurement using capacitive transducer.
7. Measurement using inductive transducer.
8. Measurement of Temperature using Temperature Sensors/RTD.
9. Characteristics of Hall effect sensor.
10. Measuring change in resistance using LDR.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Biomedical Instrumentation

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To identify and describe various biomedical signals.
- To describe the origin of biopotentials and explain the role of biopotential electrodes
- To understand the synchronization between physiological systems of the body.
- To understand the basic measurement principlesbehind biomedical instrumentation.
- To realize the working principle of numerous biomedical imaging techniques.
- To analyse the applications of biosensing in different domains of healthcare.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Analyze the origin of various bioelectric signals (ECG, EEG) and the method of recording using different types of electrodes

CO2 Develop the basic knowledge about Cardiovascular, respiratory and nervous system

CO3 Develop an understanding of the measurement principles of medical instrumentationincluding measurement of respiratory function, cardiac variables, blood pressure as well as medical devices

CO4 Comparethe working of various medical imaging techniques including X-ray, computed tomography and ultrasonography

CO5 Design various biomedical instruments with the help of respective transducers

Syllabus Contents

Unit-1 (16 Lectures)

Biopotentials, Bioamplifiers and Bioelectrodes: Introduction to bio-electric potential, bio-amplifier, components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms and transducers to measure various physiological events, types of bio-potential electrodes (Body surface electrodes, Internal electrodes, Micro electrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes

Unit-2 (16 Lectures)

Cardiac vascular system & measurements: ECG: origin, Instrumentation, bipolar system lead system I, II, III, Einthovan's triangle, Augmented lead system, unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Defibrillators: AC, DC. Pacemakers-Internal, External,Oximeters.

Unit-3 (15 Lectures)

Respiratory Measurement Systems: Types of volume, types of measurements, Instrumentation of respiratory system, principle & types of pneumograph, Spirometer, pneumotachometers, nitrogen wash out technique.

Unit-4 (13 Lectures)

Nervous system: Action potential of brain, brain wave, Instrumentation of Electroencephalography (EEG), electrodes used for recording EEG analysis.

Medical Imaging system: An Introduction to Ultrasonography, Thermal imaging system, working, IR detectors, applications. Radiography- conventional X-ray, properties, generation of X-ray, Fluoroscopy.

References

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, 2ndEdition, Prentice Hall (2010).
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education Inc (2010).
3. Khandpur R.S., Handbook of Biomedical Instrumentation, 2ndEdition, Tata McGraw-Hill Publishing (2009).
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2000), 2nd edition, Volume 1.
5. Richard Aston, Principles of Biomedical Instrumentation & Measurement, 1st edition, Merrill Publishing Company (1990).
6. Mandeep Singh, Introduction to Biomedical Instrumentation, 1stEdition, PHI learning private limited (2010).

Biomedical Instrumentation Lab

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Describe the method to record and analyse various bio-electric signals (e.g. ECG, EEG etc)

CO2 Demonstrate measurement of basic medical parameters such as blood pressure, pulse rate etc.

CO3 Calculate basic parameters while measuring pulmonary function, cardiac function etc and compare the obtained values with the standards available.

CO4 Understand the instrumentation behind ultrasonography and implement the basic knowledge to visualize various organs of the body.

CO5 Apply safety standards and select disposal method and procedures for performing diagnostic experimentation.

Syllabus Contents

1. Characterization of bio potential amplifier for ECG signals.
2. Study on ECG simulator.
3. Measurement of heart sound using stethoscope.
4. Study of pulse rate monitor with alarm system.
5. Determination of pulmonary function using spirometer.
6. Measurement of respiration rate using thermister /other electrodes.
7. Study of Respiration Rate monitor/ apnea monitor.
8. Study on ultrasound machine based on medical system
9. Differentiating arteries and veins using ultrasound transducers.
10. Study of a Pacemaker.
11. Measurement of pulse rate using photoelectric transducer & pulse counting for known period.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Digital Electronics and VHDL

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- Familiarization with concepts of Boolean algebra and minimization of various digital logic circuits.
- Develop the basic understanding of flip flops and use them to designsequential circuits.
- Differentiate between various digital logic families.
- Implement logic functions using the programmable logic devices
- Write VHDL program for designing digital systems.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Apply the knowledge of Boolean algebra to solve real time problems and determine how to interconnect logic gates in order to convert the circuit input signals to desired output signals

CO2 Analyze the combinational and sequential circuits using flip flops and show how they can be used for designing various types of digital circuits used for processing and transmission of data

CO3 Compare various digital logic families with respect to their speed, power consumption and cost

CO4 Explain the concept of programmable logic devices and use it to implement logic functions

CO5 Describe and simulate VHDL code for designing digital systems

Syllabus Contents

Unit-1 (12 Lectures)

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code.

Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Truth Tables ofOR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, constructionand symbolic representation of XOR, XNOR, Universal (NOR and NAND) gates.

Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed powerproduct, TTL and CMOS families and their comparison.

Unit-2 (14 Lectures)

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor.

Unit-3 (16 Lectures)

Sequential logic design: Latches and Flip flops , S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave flip flop, Registers, Counters (synchronous and asynchronous and modulo-N), State Table, State Diagrams, counter design using excitation table and equations, Ring counter and Johnson counter.

Unit-4 (18 Lectures)

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA **Introduction to VHDL:** A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, data flow style, behavioral style, structural style, mixed design style, simulating design. Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Expressions, Operands, Operators, types of Expressions.

Gate level modeling: Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

References

1. M. Morris Mano, Digital Logic & Computer Design, Pearson Education Asia (2016)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Limited, 11th Edition, Global Edition (2015)
3. Kumar A. Anand, Fundamentals of Digital Circuits, 3rd Edition (2014), PHI Learning Private Ltd.
4. R.J.Tocci, Neal.SWindmer, Gregory L Moss, Digital Systems, Principles and Applications, 10th Edition, Pearson (2009)
5. J. Bhasker, A VHDL Primer, Pearson, 3rd Edition (2015).
6. Volnei A. Pedroni, Circuit Design and Simulation with VHDL, 2nd Edition (2015), PHI Learning Private Ltd.

Digital Electronics and VHDL Lab

(Hardware and Circuit Simulation Software)

Credits:02 **Lectures: 60h**

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Understand and examine various logic gates ICs

CO2 Design and implement various combinational circuits such as adder, subtractor, and Multiplexer using universal gates

CO3 Design application oriented circuits such as counters, registers etc.

CO4 Analyze and prepare the technical report on the experiments carried out

Syllabus Contents

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.

4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.

Experiments in VHDL

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4 bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 2 bit Magnitude comparator.
10. 3 bit Ripple counter.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Engineering Mathematics

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To introduce the basic concepts required to understand, construct, solve and interpretdifferential equations.
- To teachmethods to solve differential equations of various types.
- To give an ability to apply knowledge of mathematics on engineering problems.
- To teach students to understand the Laplace transform method to solve ordinary differential equations.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Recognize ODEs of varying order and use these to solve engineering problems
CO2 Solve initial value problems and understand the existence and uniqueness of such solutions
CO3 Solve the most common PDEs, recurrent in engineering using standard techniques.
CO4 Demonstrate the utility of Laplace transform in solving the ordinary differential equations
CO5 Familiarize with the concept of Fourier transform & Fourier series

Syllabus Contents

Unit-1 (16 Lectures)

Ordinary Differential Equations: First OrderOrdinary Differential Equations, Separable Ordinary Differential Equations, Linear Ordinary Differential Equations. Linear Independence and Dependence, Linear Differential Equations of Second Order with Constant Coefficients and Variable Coefficients: Homogeneous and non-homogeneous. Method of Variation of Parameters, Electric Circuits, System of Simultaneous Linear Differential Equations with Constant Coefficients.

Unit-2 (14 Lectures)

Partial Differential Equations: Formation of Partial Differential Equation, Partial Differential Equation of First Order: Linear and Non-linear. Method of Separation of Variables. Classification of Partial Differential Equations of Second Order,Modeling a Vibrating string and the Wave Equation.

Unit-3 (16 Lectures)

Laplace Transform: Laplace Transform and its properties, Convolution theorem, Impulse Function and Unit Step function, solutions to ordinary differential equations. Initial and final value theorem. Inverse Laplace transforms and its properties.

Unit-4 (14 Lectures)

Fourier series and Transforms: Period of any function, Fourier Series:even and odd Functions, half range expansions, Forced Oscillations, Fourier Integral, Fourier Transforms: Fourier Sine and Cosine Transforms.

References

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8th Edition.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing CompanyLimited (2007), 6th reprint.
3. Michel D Greenberg; Advanced Engineering Mathematics, Pearson International (2202), 2nd edition.
4. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007), 3rd edition.
5. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004).
6. A.S.Willsky, Oppenheim, Signals and System, Prentice Hall, 2nd edition.
7. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers (1965), 44th edition.

Engineering Mathematics Lab

(Scilab /MATLAB/ any other Mathematical Simulation software)

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand a variety of differential equations and their solutions, with emphasis on applied problems in engineering and physics

CO2 Generate plots and export this for use in reports and presentations

CO3 Develop understanding about implementing different mathematical transformations

Syllabus Contents

1. Solve the linear differential equation of second order with variable coefficients.
2. Solve the linear differential equation of second order with constant coefficients.
3. Plot curves like sin (x), cos(x), tan(x), log(x), exp(x), x^2, x^3, $x+x^2$+exp(x).
4. Computing Fourier Transform of a given signal.
5. Laplace Transform of a given signal.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Operational Amplifiers and Applications

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To provide understanding of DC and AC characteristics of operational amplifiers (op-amp)
- Design various filters and oscillatorse circuits using op-amps
- Study linear and non-linear applications of op-amp
- Design multivibrators and other circuits using 555 timer.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the DC and AC characteristics of operational amplifiers (op-amp) and its effect on output, significance of op-amp parameters, and compensation techniques

CO2 Elucidate and design circuitsto study linear and non-linear applications of op-amps and special application ICs

CO3 Explain the working of signal generators using op-amp

CO4 Explain and compare the working of multivibrators using general purpose op-amp and IC 555

Syllabus Contents

Unit-1 (18 Lectures)

Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output, Single input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741).

Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

(14 Lectures)

Unit-2

Op-Amp Circuits: Open and closed loop configuration, Limitations of open loop, characteristics of ideal op-amp, frequency response of op-amp in open loop and closed loop. Non-Inverting & Inverting amplifiers, Summing & Difference amplifiers, Log & antilog amplifiers, Instrumentation Amplifier, Integrator & Differentiator circuit, Voltage to current converter, Current to voltage converter.

Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.

Unit-3 (16 Lectures)

Signal generators: Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, saw tooth wave generator, and Voltage controlled oscillator(IC 566).

Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Astable and monostable multivibrators.

Phase locked loops (PLL): Block diagram, phase detectors, IC565.

Unit-4 (12 Lectures)

Signal Conditioning circuits: Sample and hold systems, Active filters: Low pass and high pass butterworth filter (first and second order), Band pass filter, Band reject filter, and All pass filter.

Fixed and variable IC regulators: IC 78xx and IC 79xx -concepts only, IC LM317- output voltage equation.

References

1. R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education (2003).
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits,Pearson Education (2001).
3. J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill, (2001).
4. A.P.Malvino, Electronic Principals, 6th Edition, Tata McGraw-Hill, (2003).
5. K.L.Kishore, OP-AMP and Linear Integrated Circuits, Pearson(2011).

Operational Amplifiers and Applications Lab
(Hardware and Circuit Simulation Software)

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the non-ideal behavior of op-amp

CO2 Analyze and prepare the technical reports on the experiments carried out

CO3 Design application oriented circuits using op-amp and 555 timer ICs

CO4 Prepare the technical report on the experiments carried

Syllabus Contents

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a First Order Low-pass filter using op-amp and study its frequency response.
7. Designing of a First Order High-pass filter using op-amp and study its frequency response.
8. Designing of a RC Phase Shift Oscillator using op-amp.
9. Design an astablemultivibrator using IC 555.
10. Design a monostablemultivibrator using IC 555.
11. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 Series.
12. Design a Schmitt trigger circuit using Op-amp and study its hysteresis loop.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Analytical Instrumentation

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To familiarize with detail principle, instrumentation, operation and applications of molecular spectroscopic techniques (UV-VIS and IR)
- To differentiate between principle, instrumentation and operation of Atomic absorption and emission spectroscopy.
- To understand fundamentals of qualitative and quantitative analysis concept.
- To categorize and understand principle behind various separation techniques (planar and columns) and their instrumentation.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand different terms, principle, instrumentation, operation and applications of molecular spectroscopic techniques (UV-VIS and IR)

CO2 Differentiate between principle, instrumentation and operation of Atomic absorption and emission spectroscopy

CO3 Comprehend fundamentals of qualitative and quantitative analysis

CO4 Identify various separation techniques (planar and columns) and their instrumentation

Syllabus Contents

Unit-1 (13 Lectures)

Molecular Spectro-analytical Methods of Analysis: Colorimetry and Spectrophotometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and limitations, types of sources, monochromators and detectors, Instrumentation of single beam and double beam instrument.

Unit-2 (17 Lectures)

Infrared Spectroscopy: Theory, diatomic molecules as a simple harmonic oscillator, instrumentation, sample handling techniques. Fourier Transform Infrared Spectroscopy (FTIR): advantages, instrumentation qualitative and quantitative applications, interpretation of Infrared (IR) spectra.

Atomic Spectroscopy: Principle, comparison of atomic and molecular spectroscopy, atomic transitions, atomic absorption, atomisation process, types of flames- fuel/ oxidant combinations, instrumentation of spectrophotometers; Interferences: spectral, chemical and ionization; applications. Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, analysis using standard addition method, applications.

Unit-3 (14 Lectures)

Separation methods: Theory of chromatography; instrumentation and applications of Paper chromatography, Thin layer chromatography (TLC).

Column chromatography: Principle, process of elution through a column, chromatogram, band broadening, capacity factor, selectivity factor , Column efficiency, number of plates, plate height, column resolution.

Unit-4 (16 Lectures)

Gas Chromatography (GC): carrier gases, different type of injection systems, columns, stationary phases and detectors. Isothermal mode, temperature-programming mode, analysis by internal standard method, applications.

High Performance Liquid Chromatography (HPLC): mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, detectors and their application.

References

1. Skoog&Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th edition, 1970.
2. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 1988.
3. D.C. Harris, Quantitate Chemical Analysis, W.H.Freeman, 7th edition 2010.
4. Christian G.D, Analytical Chemistry, John & Sons, Singapore, 6th edition 2004.
5. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York, 5th edition 1990.
6. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 4th edition 1978.
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill, 14th edition 1992.
8. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication2nd edition 1990.
9. W. Kemp, Organic Spectroscopy, ELBS, 3rd Edition, 1993.
10. Hand book of Instrumental Techniques for Analytical Chemistry, Frank Settle, editor, Prentice Hall, 1997.
11. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rdEdition 2006.
12. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1stEdition, 2011.

Analytical Instrumentation Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Recognize the importance of wavelength/emission spectrum inspectro-analytical instruments

CO2 Examine the properties of sample tested on Colorimeter

CO3 Examine and determine the properties and concentration of a given sample using Colorimeter and UV-VIS spectrophotometer

CO4 Carry out comparative analysis of given sample with standard sample using spectroscopic and chromatographic instruments

CO5 Get an exposure on collection and analysis of data and writing the project reports

CO6 Acquire analytical instrumentation knowledge for implementing small in-house projects

CO7 Describe the testing and calibration method for various analytical Instruments

Syllabus Contents

1. Determination of pKa value for a dye using Colorimeter/double beam spectrophotometer.
2. Spectrometric determination of iron in water sample using double beam spectrophotometer.
3. Determination of concentrations of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Determination of concentration of potassium ions in sample by standard addition method using flame photometer
5. Spectrum interpretation using FT-IR.
6. Analysis of various ions using atomic absorption system.
7. Thin layer chromatographic (TLC) separation of samples from different origin (Biological / Pharmaceutical / Food).
8. Qualitative analysis of samples using Gas chromatography
9. Qualitative analysis of samples using High Performance Liquid Chromatography.
10. To study the effect of organic solvent on membrane permeability of beet root.
11. Paper chromatographic separation of samples from different origin (Biological/pharmaceutical/food).
12. Verification of Beer's Law and determination of concentration of the unknown solution using colorimeter.
13. Determination of concentration of solutes in a mixture using colorimeter.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Electronic Instrumentation

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To study different AC and DC measurement instruments used in laboratory like ohmmeter, voltmeter, ammeter and multimeter.
- To learn about different measuring instruments – Universal counter, Cathode Ray Oscilloscope and Signal Generator.
- To study about different spectrum analyzers and learn about basic concept of wavemeter.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Designing of different AC and DC bridges and their applications

CO2 Construction of different measuring devices-Ammeter, Voltmeter, Ohmmeter and Digital Frequency Meter

CO3 Develop an understanding of construction and working of different measuring instruments- Signal Generator and CRO for appropriate measurement

CO4 Understand the concepts of Spectrum Analyzer and Wavemeter& its types

Syllabus Contents

Unit-1 (18 Lectures)

DC and AC Measurement: DC and AC indicating Instruments: Accuracy and precision - Types of errors, Basic Measurement Instruments-DC Bridges and applications: Wheatstone, Kelvin, AC Bridges: General form of AC bridge balance, comparison bridges, Maxwell, Hay, Schering, Wien, Wagner ground condition.

DC measurement: DC voltmeter, ammeter, ohmmeter, multimeter, AC measurement: voltmeter, Digital type voltmeters, digital multimeter. Digital frequency meter: Elements of frequency meter, universal counter and its different modes, measurement errors and extending the frequency range.

Unit-2 (14 Lectures)

Signal Generators-Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generators, Sweep generator. Probes and Connectors: Test leads, shielded cables, connectors, low capacitance probes, high voltage probes, RF demodulator probes, special probes for IC’s, current probes.

Unit-3 (16 Lectures)

Electronic Displays: Cathode Ray Oscilloscope (CRO) and applications: Block diagram of a General Purpose Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections, CRO probes. Types of CRO’s: dual trace oscilloscope, digital storage oscilloscope, Sampling oscilloscope. Amplitude, Frequency, Phase measurements, Lissajous Figures.

Unit-4 (12 Lectures)

Spectrum Analyser and Wavemeter: Frequency Spectrum, Distortion and wave measurement – Spectrum analyzer, Harmonic distortion analyzer, Intermodulation distortion analyzer, wave analyzer and distortion factor meter, wave meter, Different type of wave meters: Lumped and cavity wavemeters, Q-meter and its applications.

References

1. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill (2006).
2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education (2005).
3. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998).
4. H. Cooper, Modern electronic instrumentation and measurement techniques, Pearson Education (2005).
5. R. A. Witte, Electronic test instruments: Analog and digital measurements, Tata McGraw Hill (2004).
6. S. Wolf and R. F. M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004).

Electronic Instrumentation Lab

(Hardware Practical)

Credits:02 **Lectures: 60**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Practice the construction of testing and measuring set up for electronic systems.

CO2 Deep understanding about different instrumentation devices

CO3 Develop an ability to use measuring instruments and AC and DC bridges for measurements.

CO4 Develop an ability to use digital oscilloscopes and waveform generators in laboratory

Syllabus Contents

1. Study and operation of Multimeters(Analog and Digital), Function Generator, Regulated Power Supplies, CRO.
2. Study the generation of Lissajous figures to find unknown frequency and phase shift.
3. Measurements of Resistance Using Wheatstone/Kelvin Bridge.
4. Measurements of Inductance Using Maxwell's Bridge/ Inductance Comparison Bridge.
5. Measurements of capacitance Using Capacitance Comparison Bridge/ De Sauty's Bridge.
6. Frequency measurement using Wein's Bridge.
7. Study of R, L, C and Q meter.
8. To study bridge based loop tests.
9. Study of Universal Counter.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Measurement Technology

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To provide sound knowledge about various techniques used for the measurement of industrial parameters and processes.
- Discussion of different types of speed and acceleration measuring instruments and their application in various Industrial processes.
- To have adequate knowledge of construction and working of various pressure measuring instruments
- Exposure to construction and working of various flow and level measurement devices used for industrial purposes
- To have sound knowledge about the calibration of various industrial instruments

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Acquire the knowledge of purpose and scope of instrumentation in Industrial processes

CO2 Be competent to handle different types of speed and acceleration measuring instruments and their application in various Industrial processes

CO3 Be conversant in construction and working of various pressure measuring instruments

CO4 Be conversant in construction and working of various flow and level measurement devices used for industrial purposes

CO5 Understand the calibration of various industrial instruments

Syllabus Contents

Unit-1 (18 Lectures)

Pressure measurement: Units of pressure, manometers, different types, elastic type pressure gauges, Bourde type bellows, diaphragms, measurement of vacuum, McLeod gauge, Pirani and Ionisation Gauge, thermal conductivity gauges, Ionization gauge cold cathode and hot cathode types – testing and calibration of pressure gauges, dead weight tester. Vacuum pumps, rotary and diffusion pumps.

Unit-2 (20 Lectures)

Flow Measurement: Introduction, definitions and Units, classification of flow meters, Mechanical type flow-meters, Theory of fixed restriction variable head type flow meters, orifice plate, venturi tube, flow nozzle, Positive displacement flow meters, turbine flow meter, Rotameter, thermal mass flow meter, Principle and constructional details of electromagnetic flow meter, different types of excitations and schemes used, different types of ultrasonic flow meters, laser doppler anemometer systems, vortex shedding flow meter, target flow meter, guidelines for selection of flow meter.

Unit-3 (11 Lectures)

Measurement of Speed and Acceleration: Tachometers, Mechanical, Electric, Contact-less, Frequency, Ignition, Stroboscopic tachometers. Accelerometers, Elementary, Seismic and Practical accelerometers.

Recorders: Types, strip chart, circular, X,Y, oscillographic, magnetic tape.

Printers: Dot matrix, ink jet and laser.

Unit-4 (11 Lectures)

Measurement of Humidity and Moisture: Basic principles, hygrometers, psychrometers, humidity charts , dew point, measurement systems for humidity, Infrared moisture measuring systems, radioactive moisture measuring systems.

References

1. Process Measurement and Analysis, 4th Edition (1995), Liptak B. G., Chilton Book Company, Pennsylvania.
2. Principles of Industrial Instrumentation, 3rd Edition (1997), D.Patranabis, Tata McGraw Hill Publishing Co., New Delhi.
3. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, DhanpatRai& Co.
4. Mechanical and Industrial Measurements, 3rdEdition, Tenth Edition (1996), R.K. Jain, Khanna Publishers.
5. Measurement Systems: Application and Design, 5th Edition (2003), Doeblin E. O, McGraw Hill, Singapore.
6. Instrumentation Measurement and Analysis, 4th Edition (2017), B.C. Nakra, K.K. Chaudhry, McGraw Hill Education Pvt. Ltd.
7. Instrumentation and Control Systems: 1st Edition (2016), K. Padma Raju, Y.J. Reddy, McGraw Hill Education Pvt. Ltd.

Measurement Technology Lab

Credits:02 **Lectures: 60h**

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Understand the working of sophisticated instruments used in industries

CO2 Measure and control industrial oriented parameters based on pressure, conductivity, flow, level and temperature

CO3 Understand the sensing mechanisms to detect the various industrial parameters

CO4 Record and monitor the variations in industrial parameters with time

Syllabus Contents

1. Flow rate measurement using orifice plate flow-meter.
2. Calibration of pressure gauge using dead weight calibrator.
3. To study working of thermocouple.
4. Experiment on control of various functions using RTD.
5. To find out level of water using level transmitters.
6. Measurement of conductivity of test solutions using electrical conductivity meter.
7. To find the flow rate using electromagnetic flow-meter and ultrasonic flow-meter.
8. Study of Ratio controller
9. To study AC/DC meter calibrator.
10. To record the temperature variations using Circular chart recorder.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Microprocessors

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To understand the general architecture of a microcomputer system
- To comprehend the architecture and organization of 8085 and 8086 microprocessor
- To learn the Interfacing of 8-bit microprocessor with memory and peripheral chips involving system design
- To interpret and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming
- To understand difference between RISC and CISC based microprocessors

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Describe the general architecture of a microcomputer system

CO2 Understand the architecture and organization of 8085 and 8086 microprocessor

CO3 Learn the Interfacing of 8-bit microprocessor with memory and peripheral chips involving system design

CO4 Interpret and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming

CO5 Differentiate between RISC and CISC based microprocessors

CO6 Understand the architecture and operation of Programmable Interface Devices and realize the programming & interfacing of it with 8085 microprocessor

Syllabus Contents

Unit-1 (18 Lectures)

8085 Microprocessor: Introduction to Microprocessor 8085, Pin description of 8085, Architecture, registers of 8085, addressing modes. Instruction Type and Instruction Set, Machine Cycle, Instruction Cycle, Timing Diagram, Memory System, Internal and External memory and concept of Virtual Memory, Hardware Interfacing or Types of I/O addressing-Interfacing Memory and Peripheral (I/o Mapped I/O and memory mapped I/O) .

Unit-2 (12 Lectures)

Programming: Assembly Language Programming, Stacks and Subroutine

Interrupts of 8085: Hardware and Software interrupts, Difference between RISC and CISC Processor

Unit-3 (17 Lectures)

Interfacing ICs: Programmable Peripheral Interface: 8155, 8253, 8255

Unit-4 (13 Lectures)

Application of Microprocessor 8085: Interfacing of Stepper Motor.

Introduction to 8086 Microprocessor: Basics of 8086 (16 bit Microprocessor), Architecture of 8086, Concept of parallel processing in 8086.

References

1. Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2nd Edition.

2. P.K Ghosh& P.R Sridhar, 0000 to 8085 microprocessor, John Wiley & Sons, 2nd Edition.
3. Liu Gibson, Microprocessor Systems: The 8086/8088 family Architecture, Programming& Design, PHI, 1999, 2nd Edition.
4. R. Thegarajan and S. Dhanpal, Microprocessor and its Application, New Age International Private Ltd, 1st Edition.
5. K. Udaya Kumar & B.S. Uma Shankar, The 8085 Microprocessor: Architecture, Programming and Interfacing", Pearson Education, 1st Edition, 2008.
6. Barry B. Brey and C R Sarma, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80606, Pearson Education Limited, 8th Edition, 2005.
7. Pentium and Pentium Pro-Processor Architecture, Programming and Interfacing, Pearson Education, (2005).
8. Walter Triebel&Avtar A. Singh, 8088 and 8086 Microprocessors: Programming, Interfacing, Software Hardware and Applications, Pearson Education, 4th edition.
9. D. V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill (2005), revised 2nd edition.
10. Ram Badri, "Advanced Microprocessors and Interfacing", McGraw Hill Education (2001), 1st edition.

Microprocessor Lab

Credits:02 **Lectures: 60h**

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Write assembly programs to run on 8085 microprocessor and systems based on it

CO2 Understand and develop techniques for faster execution of arithmetic and logical operations

CO3 Understand and realize the Interfacing of memory & various I/O devices with 8085 Microprocessor

CO4 Design applications based on microprocessor 8085 using memory chips and peripheral ICs

CO5 Undergo minor projects based on 8085 assembly language programming

Syllabus Contents

1. To write an assembly language program to perform basic mathematical operations (addition, subtraction, multiplication, division).
2. To write an assembly language program to generate first N terms of an A.P. / G.P. series.
3. To write an assembly language program to generate first N terms of Fibonacci series.
4. To write an assembly language program to arrange the given list of number in ascending / descending order.
5. To write an assembly language program to calculate N!.
6. To write an assembly language program to separate prime numbers in a given list of numbers.
7. To write an assembly language program to convert a number from one number system to another.
8. To write an assembly language program to design a clock 36.

9. To write an assembly language program to calculate a mathematical expression (for e.g. 2N/N!).
10. To write an assembly language program to calculate value of sin(x).
11. Interfacing 8085 with chips 8155, 8255 and 8253.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Power Electronics

Credits: 04 **Theory Lectures: 60h**

Course Learning Objectives

- To elucidate the basic operation of various power semiconductor devices.
- To learn about the operation and application of various power supplies.
- To teach about the designing of Chopper, rectifier and Inverter circuit.

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Understand different power devices and study their construction, characteristics and turning on circuits

CO2 Understand the analysis of controlled rectifiers for different loads, inverters, DC choppers and AC voltage controllers

CO3 Learn about different motor drives, various power electronics applications like UPS, SMPS, etc. and some protection circuits

Syllabus Contents

Unit-1 (14 Lectures)

Basic Power Devices and Circuits: SCR, Diacs and Triacs, Two transistor model of SCR, Resistive and RC triggering circuits. Applications of SCR: Basic series inverter circuit, Chopper circuit – Basic concept, step up and step down choppers.

Unit- 2 (16 Lectures)

Types of motors and Motor Drives: Constructional features and characteristics of DC Motors, AC Motors, Induction Motors, Single and three phase Motors, Synchronous Motors, Stepper Motors, and Servo Motors. Motor driving and speed control circuits and their applications, motor starters.

Unit-3 (18 Lectures)

Generators and AC machines: AC and DC generators, comparison between generator and motor action (without constructional comparison).

AC Machines: Types of transformers, Transformer Construction, E.M.F. equation, Transformer Losses, Condition for maximum efficiency, all day efficiency, Auto transformers.

Unit- 4 (12 Lectures)

Supplies: Regulated power supply, Uninterrupted power supply (UPS) and Switched mode power supply (SMPS).

References

1. Power Electronics, 2nd Edition (2006), M. D. Singh, K. B.Khanchandani, Tata McGraw Hill.
2. Electrical Technology, 23rd Edition (2005), B. L. Thareja and A. K. Thareja, S. Chand & Sons.
3. Electronic Principles, 7th Edition (2007), A. Malvino, D. J. Bates, Tata McGraw Hill.
4. Power Electronics, 4th Edition (2002),P. S. Bimbhra, Khanna Publishers.

5. Electrical Machines, 2nd Edition (1997), I. J. Nagrath and D. P. Kothari, Tata McGraw Hill (1997).

Power Electronics Lab

Credits: 02 **Lectures: 60h**

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Understand the behaviour of semiconductor devices when operated as power switches

CO2 Appreciate the role of power electronics for designing energy systems and the applications of power electronics in emerging areas

CO3 Understand the operation of dc and ac motors for different load

CO4 Analyze and prepare the technical report of the experiments carried out

Syllabus Contents

1. Study of I-V characteristics of SCR.
2. Study of I-V characteristics of DIAC.
3. Study of I-V characteristics of TRIAC.
4. Load characteristics of D.C. motor.
5. Speed control of D.C. motor.
6. Study of Load characteristics of Servomotor.
7. Study of speed control and blocked rotor test on single phase Inductor motor.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Control Systems

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To study how to interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
- To help the students understand and practice feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
- To teach about how to solve the steady state and transient analysis of a system for standard inputs
- Introduce students how to compute stability of linear systems using the Routh array test and use this to generate control design constraints
- To teach students the use Evans root locus techniques in control design for real world systems

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Interpret and apply block diagram representations of control systems and design PID controllers based on empirical tuning rules
CO2 Define and explain feedback and feed-forward control architecture and discuss the importance of performance, robustness and stability in control system design
CO3 Solve the steady state and transient analysis of a system for standard inputs
CO4 Compute stability of linear systems using the Routh array test and use this to generate control design constraints
CO5 Use Evans root locus techniques in control design for real world systems
CO6 Compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability

Syllabus Contents

Unit-1 (17 Lectures)

Introduction to Control System: Introduction of open loop and closed loop control systems, mathematical modelling of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function, Armature controlled and field controlled DC servomotors, AC servomotors, block diagram representation & signal flow graph, reduction technique, Mason’s Gain Formula, effect of feedback on control systems.

Unit-2 (13 Lectures)

Time Domain Analysis: Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices.

Concept of Stability: Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

Unit-3 (17 Lectures)

Frequency Domain Analysis: Frequency Domain Analysis: Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using Nyquist criterion, constant M & N circles.

Unit-4 (13 Lectures)

State Space Analysis: Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties.

Controllers and Compensation Techniques: Basic Control Actions: Proportional, Integral and Derivative controls,response with P, PI and PID Controllers,concept of compensation, Lag, Lead and Lag-Lead networks.

References

1. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2018, 6th Edition.
2. K. Ogata, Modern Control Engineering, Prentice Hall of India, 2005, 5th Edition.
3. B. C. Kuo , “Automatic control system”, Prentice Hall of India, 2000, 7th Edition.
4. N.K Jain, Automatic Control System Engineering, DhanpatRai Publication,2005, 2nd Edition.
5. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi, 7th Edition.

Control Systems Lab
(Hardware and Simulation Software)

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Design Lead-Lag compensators based on frequency data for an open-loop linear system.

CO2 Analyze the mathematical model of a system and determine the response of different order systems for standard input

CO3 Demonstrate the time and frequency domain responses of first and second order systems to step, ramp and sinusoidal inputs.

CO4 Understand the performance of a system using P (proportional), I (integral), D (differential) or PID (proportional-integral-differential) controller and frequency response of a system using Lead and Lag networks.

CO5 Analyze the position and speed control of a DC motor.

Syllabus Contents

1. To study characteristics of :
   a. Synchro transmitter receiver
   b. Synchro as an error detector
2. To study position control of DC motor
3. To study speed control of DC motor
4. To find characteristics of AC servo motor
5. To study time response of type 0,1 and 2 systems
6. To study frequency response of first and second order systems
7. To study time response characteristics of a second order system.
8. To study effect of damping factor on performance of second order system
9. To study frequency response of Lead and Lag networks.
10. Study of P, PI and PID controller.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Discipline specific Electives

Signals and Systems

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To give information about signals and systems mathematically and perform mathematical operational on signals.
- To teach the properties and the response of LTI system using convolution.
- To give knowledge about Laplace transform for analyzing continuous-time and discrete-time signals and systems.
- To make them understand the concept of Fourier series and Fourier transform.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the basic concept and types of signals and systems and their properties which is useful to learn digital tele-communication

CO2 Classify systems based on their properties and determine the response of LTI system using convolution

CO3 Understand how to apply the Laplace transform for analyzing continuous-time and discrete-time signals and systems

CO4 Analyze system properties based on impulse response and Fourier analysis

Syllabus Contents

Unit-1 (15 Lectures)

Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and Unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.

(15 Lectures)

Unit-2

Linear Time-Invariant Systems (LTI): Continuous & discrete time LTI systems, Convolution Sum, Convolution integral, Properties of LTI Systems-Commutative, Distributive and Associative, LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response of System, Differential and Difference equation formulation, Block diagram representation of first order systems.

(14 Lectures)

Unit-3

Laplace Transform: Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

(16 Lectures)

Unit-4

Fourier Series Representation of Periodic Signals: Continuous-Time periodic signals, Convergence of the Fourier series, Properties of continuous-Time Fourier series, Discrete-Time periodic signals, Properties of Discrete-Time Fourier series.

Fourier Transform: Aperiodic signals, Periodic signals, Properties of Continuous-time Fourier transform, Convolution and Multiplication Properties and basic Fourier transform Pairs.

References

1. H. P. Hsu, Signals and Systems, Tata McGraw Hill(2007).
2. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, Publications (2008).
3. W. Y. Young, Signals and Systems with MATLAB, Springer (2009).
4. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007).
5. Alan V. Oppenheim, Alan S. Willsky with S. Hamid, Signals and Systems, 2^{nd} edition, Prentice-Hall, Inc. (2007).

Signals and Systems Lab

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the basics of Scilab/MATLAB syntax, functions and programming
CO2 Generate and characterize various continuous and discrete time signals
CO3 Perform the basic operations on the signals
CO4 Design and analyze linear time-invariant (LTI) systems and compute its response
CO5 Analyze the spectral characteristics of signals using Fourier analysis

Syllabus Contents

1. Learning Scilab/MATLAB (Experiments based on available system).
2. Exploration of Signals and Systems using Scilab/MATLAB.
    a. Generation of Signals: continuous time
    b. Generation of Signals: discrete time
    c. Addition, multiplication, folding and reversal of signals.
    d. Convolution of Signals.
    e. Solution of Difference equations.
    f. Introduction to SIMULINK and calculation of output of systems represented by block diagrams.
    g. Fourier series representation of continuous time signals.
    h. Fourier transform of continuous time signals.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Advanced Analytical Instrumentation

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To build up thorough understanding of electromagnetic radiation and its use for analysis
- To familiarize with advanced spectroscopic techniques such as Mass spectrometry, NMR spectroscopy and X-Ray spectroscopy
- To understand the prospective of different advanced analytical methods
- To understand the principle, instrumentation and application of various electro analytical instruments
- To describe the principle and working of various radiation detectors
- To study about various radiochemical analysis along with industrial analyzers
- To disseminate with principle and instrumentation of thermo analytical instruments along with their applications for analyzing products of different origin

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Develop thorough understanding of electromagnetic radiation and its use for analysis

CO2 Get understanding of advanced spectroscopic techniques such as Mass spectrometry, NMR spectroscopy and X-Ray spectroscopy

CO3 Appreciate the potential of different analytical methods for resolving various scientific challenges

CO4 Understand principle, instrumentation and application of electro analytical instruments

CO5 Describe the principle and working of various radiation detectors

CO6 Conduct radiochemical analysis along with industrial analyzers

CO7 Understand principle and instrumentation of thermo analytical instruments along with their applications for analyzing products of different origin

Syllabus Contents

Unit-1 (20 Lectures)

Nuclear Magnetic Resonance (NMR) Spectroscopy : Theory, chemical shift and spin-spin splitting, coupling constant, environmental effects- shielding and deshielding effects due to electronegativity on NMR spectra, instrumentation of NMR , FT-NMR and its advantages, applications.

Mass Spectroscopy: Theory, gaseous ion source, sample inlet system, magnetic sector mass analyzer, electron multiplier detector,Isotopic abundances, metastable ions and applications.

Unit-2 (14 Lectures)

Electro Analytical Methods of Analysis: Potentiometry: Introduction, reference electrode, indicator electrodes, ion-selective electrodes: glass electrode and liquid membrane electrode and their applications, potentiometric titrations.

Unit-3 (14 Lectures)

Radiochemical methods: X-ray spectroscopy-Principle, absorption, emission and diffraction of X-rays, Bragg's Law, Instrumentation: sources, X –ray tube, crystal monochromators, X-ray detectors (Ionization, proportional and GM counter, γ camera), applications.

Unit-4 (12 Lectures)

Thermo-analytical Methods: Thermal detectors. Thermo-gravimetry, Differential Thermal analysis, Differential scanning calorimetry, Principle, Instrumentation, thermobalance, Interpretation of thermograms, Applications, Comparison and advantages of each technique.

References

1. Skoog&Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th Edition, 1970.
2. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers 7th Edition 1988.
3. D.C. Harris, Quantitative Chemical Analysis, W.H. Freeman, 7th Edition 2010.
4. Gary D. Christian, Analytical Chemistry, John & Sons, Singapore, 6th Edition 2004.
5. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York, 5th Edition 1990.
6. Vogel's Textbook of Qualitative Chemical Analysis, ELBS, 4th Edition 1978.
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill, 14th Edition 1992.
8. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication, 2nd Edition 1990.
9. Galen W. Ewing, Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company, 1968.
10. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition, 2006.
11. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition, 2011.

Advanced Analytical Instrumentation Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Operate numerous types of advanced analytical instruments and analyzers

CO2 Describe the functions, strengths and limitations of various advanced analytical instruments

CO3 Apply the integrated knowledge of different analytical instrument in the form of execution of small projects

CO4 Learn to collect the data, analyze the data, interference of data and presenting it in the form of small project which will help them out in doing further research

CO5 Describe the testing and calibration method for various advanced analytical instruments

CO6 Learn the working of advanced sophisticated instruments through demonstrations and field/industrial visit

CO7 Implement various in-house projects

Syllabus Contents

1. Quantitative Analysis of organic compounds using Gas chromatography
2. Quantitative Analysis of organic compounds using HPLC.
3. Study of NMR (Simulation based/Demo).
4. Study of Mass spectrometer (Simulation based/Demo).
5. Study of X ray spectrometer (Simulation based/Demo).
6. Potentiometric titrations: (i) Strong acid with strong base (ii) weak acid with strong base and (iii) dibasic acid with strong base
7. Potentiometric titration of Mohr's salt with potassium dichromate
8. pH metric titrations of (i) strong acid and strong base (ii) weak acid and strong base
9. Group Projects based on analytical techniques.
10. Study of thermoanalytical instruments (Simulation based/Demo).

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Communication Systems

Credits: Theory- 04 **Theory Lectures: 60h**

Course Learning Objectives

- Understand basic elements of a communication system.
- Analyze baseband signals in time and frequency domain.
- Understand various analog and digital modulation/demodulation techniques along with their performances in various transmission environments.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Learn in detail about the various components of communication system like transmitter, modulator, channel and receiver

CO2 Gain in depth knowledge of analog (amplitude, frequency and phase) and digital modulation and demodulation techniques

CO3 Understand different multiplexing techniques for efficient utilization of available bandwidth

Syllabus Contents

Unit-1 (08 Lectures)

Basic communication system: Block diagram, Information source and input transducer, Transmitter medium, Noise, Receiver, Destination, Necessity for modulation, Types of communication systems.

Unit-2 (18 Lectures)

Amplitude Modulation, Frequency and phase modulation: Definition - AM waveforms - Frequency spectrum and bandwidth - Modulation index - DSB-SC, SSB-SC, Vestigial SB - Comparison and application of various AM schemes, Definition-Relationship between FM & PM - Frequency deviation - Spectrum and transmission BW of FM, comparison of AM and FM systems.

Unit-3 (16 Lectures)

Radio Transmitter and Receiver: AM transmitters-High level and low level transmitters - SSB transmitters - FM transmitters - Block diagram.

AM receivers-operation - performance parameters - Communication Transceivers - Block diagram - SSB receiver - FM receivers - Block diagram.

Unit-4 (18 Lectures)

Digital Communication: Pulse Analog Modulation**:** Sampling theorem, Errors in Sampling. Pulse Amplitude Modulation (PAM), Time Division Multiplexing (TDM). Pulse Width Modulation (PWM) and Pulse Position Modulation(PPM). Generation and detection of PAM, PWM, PPM,

PCM- Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding.

References

1. G. Kennedy and B. Davis, Electronic Communication Systems, Tata McGraw Hill (1999).
2. R. P. Singh and S. D. Sapre, Communication Systems: Analog and Digital, Tata McGraw Hill (2007)
3. L. E. Frenzel, Communication Electronics: Principles and Applications, Tata McGraw Hill (2002).
4. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education (2005).
5. T. G. Thomas and S. Chandra Sekhar, Communication Theory, Tata McGraw Hill (2006).
6. L. Temes and M. E. Schultz, Schaum's outline of theory and problems of Electronic Communication (1997).
7. H. Taub and D. Schilling, Principles of Communication Systems, Tata McGraw Hill (1999).
8. W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education (2004).
9. L. E. Frenzel, Communication Electronics, Principles and Applications, Tata McGraw Hill (2002).
10. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education (2005).
11. H. P. Hsu, Analog and Digital Communications, Tata McGraw Hill (2006).
12. S. Haykin, Communication Systems, Wiley India (2006).

Communication Systems Lab

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Design and implement different modulation and demodulation techniques

CO2 Use appropriate design skills to illustrate electronic components & method to implement different communication circuits & systems

CO3 Design and compare various modulation techniques for given range of frequencies

CO4 Analyze the spectral characteristics of PAM, PWM and PPM

Syllabus Contents

1. Study of Amplitude Modulation and Demodulation
2. Study of Frequency Modulation and Demodulation
3. Study of Single Side Band Modulation and Demodulation
4. Study of AM Transmitter and Receiver
5. Study FM Transmitter and Receiver
6. Study of Pulse Amplitude Modulation
7. Study of Pulse Width Modulation
8. Study of Pulse Position Modulation
9. Study of Pulse Code Modulation

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Advanced Biomedical Instrumentation

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To realize the importance of the instruments used in critical care units of the hospital.
- To understand the principle behind the measurement of biochemical signals.
- To understand the concept of instruments used in medical imaging diagnostics and therapeutics.
- To appreciate the efficiency of the surgical and diathermy apparatus in medical incision.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand instruments used in critical care and operating units of hospitals

CO2 Gain knowledge of the instruments used for biochemical analysis in healthcare

CO3 Understand the concepts of various medical imaging techniques and their applications

CO4 Understand instruments used for medical assistance and therapy

Syllabus Contents

Unit-1 (16 Lectures)

Ventilators: Basic principles and types of ventilators.
Anaesthesia Machine: Need of anesthesia, anesthesia delivery system, breathing circuits. **Clinical Laboratory Instruments**: General principle and working of Blood Gases Analyzer, Auto-analyzer, Blood Cell Counters, ELISA reader, Applications of Spectrophotometer and Flame photometer based on Clinical diagnostics.

Unit-2 (16 Lectures)

Medical Imaging System: Ultrasound, properties, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, M Scan, real time ultrasonic imaging, linear array scanners, X-ray computed tomography (CT Scanner) -principle, contrast scale, scanning system, processing Unit, viewing, storage. Magnetic Resonance Imaging: Basic principle, working and construction.

Unit-3 (15 Lectures)

Nuclear Medicine System: radioactive emissions, rectilinear scanner, gamma camera, imaging system, ECT (emission coupled tomography) and its different approaches: positron emission tomography (PET), Single-photon emission computed tomography (SPECT), safety measures.

Unit-4 (13 Lectures)

Surgical Scopy and Diathermy Equipments: Fibre Optics- Endoscopes -light sources, video processors, camera, and fiber optic cable, Principles and applications. Diathermy: Working Principle, Construction and different types (Infrared radiation (IR), ultraviolet (UV), short wave, microwave, ultrasonic and Surgical Diathermy).

References

1. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2010), 2nd edition
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata McGraw-Hill Publishing (2009), 2nd edition
3. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2000), 2nd edition, Volume 1.
4. Richard Aston, Principles of Biomedical Instrumentation & Measurement, Merrill Publishing Company, (1990), 1st edition
5. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition.
6. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2nd Edition.

Advanced Biomedical Instrumentation Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Learn to acquire biomedical measurement and interpret data from various physiological systems.
CO2 Compare the instrumentation behind various imaging modalities available in market.
CO3 Calculate basic parameters associated with various biochemical experiments and could compare the obtained values with the working standards.
CO4 Understand the practical aspects of measurement and instrumentation
CO5 Apply safety standards and select disposal method and procedures for performing diagnostic experimentation.
CO6 Designbuild and test biomedical based projects for various diagnostic applications

Syllabus Contents

1. Study of ultrasound transducers based on medical system.
2. Study of vital organs (such as Heart, Kidney, liver etc) using Ultrasonography.
3. Demonstration of X ray/Computed Tomography/nuclear imaging.
4. Experiment based on clinical instruments such as Blood cell counter/ ELISA reader.
5. Estimation of serum total protein using spectrometer.
6. Estimation of sodium and potassium in blood serum or urine sample.
7. Project based on designing and applications of Biomedical Instrumentation.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Embedded System and Robotics

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To understand what is a microcontroller, microcomputer, embedded system.
- To understand different components of a micro-controller and their interactions.
- Become familiar with programming environment used to develop embedded systems and learn debugging techniques for an embedded system.
- Understand key concepts of embedded systems like IO, timers, interrupts, interaction with peripheral devices.
- To understand the concept of robots, their workspace and various sensors used in the robotics.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the internal architecture of 8051 family microcontrollers and get familiar with programming of 8051 microcontroller

CO2 Gain knowledge of typical interfacing standards and interface 8051 with different peripherals

CO3 Describe the differences between the general computing system and embedded system and understand common aspects of embedded system development

CO4 Analyze in various robot structures and their workspace

Syllabus Contents

Unit-1 (16 Lectures)

Introduction to RISC microcontrollers: Von- Neumann and Harvard architectures, Introduction to 8051 family microcontrollers, 8051 architecture, Register banks and Special Function Registers**,** Block Diagram, Addressing Modes, Instruction Set, Timers, Counters, Stack Operation, Serial communication and interrupts.

(14 Lectures)

Unit-2

8051 Interfacing: 8051 interfacing with Keyboard, display Units (LED, 7-segment display, LCD), ADC, DAC, Stepper motor.

Interfacing and Communication Links Serial Interfacing: SPI / Micro wire Bus, I2C Bus, CAN Bus.

Unit-3 (16 Lectures)

Introduction to Embedded Systems: Overview of Embedded Systems, Features, Requirements and Applications of Embedded Systems, Common architectures for the ES design, Embedded System design issues, Classifications of Embedded System, Introduction to Development and Testing Tools.

Unit-4 (14 Lectures)

Robotics: Overview of Robotics, Law of Robotics, Major Components of Robots, Different Sensors used in Robotics, Types of Robots, Introduction to Computer Vision and Pattern Recognition, Use of Embedded Systems in Robotics.

References

1. Fundamentals of Embedded Software – where C and Assembly Meet by Daniel W. Lewis, Pearson Education (2002).
2. Design with PIC Microcontrollers by John B. Peatman, 8th Edition, Pearson Education (2009).
3. Embedded C Programming and the Microchip PIC by Richard Barnett, Larry O'Cull and Sarah Cox, 1st Edition, Thomson Learning (2003).
4. Microprocessors: From Assembly Language to C using PIC18Fxx2 by Robert B. Reese, 1st Edition, Shroff Publishers and Distributors Pvt Ltd (2003).
5. Robotic Engineering – An Integrated Approach by Richard D Klafter, Thomas A. Chmielewski and Michael Negin, Prentice Hall India (1989).
6. Muhammad Ali Mazidi, Janice GillispieMazidi, The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2nd Edition.

Embedded System and Robotics Lab

(Using 8051 or any other microcontroller)

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Program 8051 microcontroller for different applications along with different peripherals
CO2 Design the software and hardware for an embedded system
CO3 Prepare the technical report of the experiments carried

Syllabus Contents

1. Write a program to multiply two 16 bit unsigned numbers.
2. Write a program to add N 8 bit unsigned integer numbers.
3. Write a program to arrange the unsigned integer numbers in ascending/descending order.
4. Interface a display to the micro controller and display number sequentially in a regular interval.
5. Write a program for LED blinking in a predetermined fashion using 8051 microcontroller.
6. Write a Program to OUT an 8 – bit value on 8051 microcontroller.
7. Write a program for a simple counter, where the count has to be displayed on a 7 – segment LED display.
8. Write a program for interfacing LCD display using 8051 microcontroller.
9. Write a program to convert an analog voltage to digital bits using 8051 microcontroller.
10. Write a program to convert a digital signal to analog signal using 8051 microcontroller.
11. Write a program for temperature sensor interfacing through serial port on 8051 microcontroller kits.
12. Write a program for PWM control of DC motor using 8051 microcontroller.
13. Write a program to drive a stepper motor using 8051 microcontroller.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Process Control Dynamics

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To study about the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants
- To teach studentsabout the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy
- To help students understand and discuss about the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units
- To study additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants

CO2 Know about the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy

CO3 Interpret the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units

CO4 Understand additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

Syllabus Contents

Unit-1 (18 Lectures)

Introduction: Dynamics of Processes, Dead time processes, Inverse response behavior of processes, Dynamic Behavior of first and second order systems.Interacting and non-interacting Systems.Batch& Continuous Process, concept of self-regulation, Controller Principle, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID), Pneumatic, Hydraulic, Electronic controllers. Need for controller tuning, Evaluation criteria, Types of controller tuning.

(17 Lectures)

Unit-2

Controls: Cascade control, Selective control, Ratio Control, Split range control, feed forward control, Feed forward combined with feedback control, Inferential Control, dead time and inverse response compensators, selective control, Adaptive control, Examples from Distillation columns, Chemical Reactors, Heat Exchangers and Boiler, Multivariable Control, Interaction, Tuning of Multivariable systems.

Unit-3 (14 Lectures)

Discrete-State process control: Variables, process specification and event sequence description, Sampling and reconstruction, Transform analysis of sampled-data systems: z transform and its evaluation, inverse z transform, pulse transfer function, stability analysis in z-plane, implementation of digital controller. PLC Block Diagram, Scan cycle, memory organization, addressing, programming. Introduction to distributed control systems (DCS)

Unit-4 (11 Lectures)

Converters and Actuators: I/P, P/I converters, Final control elements, Pneumatic and electric actuators. Types of control valves, Valve positioner and its importance, Inherent and Installed characteristics of control valves.

References

1. Eckman. D.P, Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993, Original Edition.
2. Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition.
3. Bequette B. W., Process Control Modelling, Design and Simulation, PHI Learning, Original Edition.
4. Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition.
5. Kuo B. C. , "Automatic control system", Prentice Hall of India, 2000, 7th Edition.
6. Nagrath I. J. and Gopal M., Control System Engineering, New Age International,2000, 2nd Edition.
7. Stephanopoulis G., Chemical Process Control, Prentice Hall of India, New Delhi, 1990, Original Edition.
8. Liptak B.G., Instrument Engineers Handbook, Process Control, Chilton Book Company, 3rd Edition.
9. Harriott P., Process Control, Tata McGraw Hill, Edition 1972.
10. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company 1980, 3rd Edition.
11. Pollard A., Process Control, Heinemann educational books, London, 1971, Original Edition.
12. Smith C.L. and Corripio A. B., Principles and Practice of Automatic Process Control, John Wiley and Sons, New York, 2nd Edition.
13. Shinskey, Process Control Systems, McGraw Hill, Singapore, 1996, 4th Edition.

Process Control Dynamics Lab

(Hardware and Simulation Software)

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the basic principles & importance of process control in industrial process plants

CO2 Specify the required instrumentation and final elements to ensure that well-tuned control is achieved

CO3 Design, operate and tune process controllers and relay logic for various processes.

CO4 Use appropriate software tools for the modeling of plant dynamics and the design of well tuned control loops

Syllabus Contents

1. Study of PID controller response and it's tuning
2. Study of ON-OFF and Proportional controller responses on temperature loop.
3. Analysis of Flow loop/Level loop/Temperature loop/Pressure loop.
4. Tuning of controllers on a pressure loop.
5. Control valve characteristics with and without positioner.
6. Study of cascade control
7. Study of ratio control/selective control
8. Study of feed forward control
9. Study of pneumatic/ hydraulic controllers
10. Problem solving/Ladder Programming in PLC.
11. Mathematical modeling and simulation of CSTR & STH systems

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Reliability and Quality Control Techniques

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To provide the thorough understanding of concepts of reliability
- To clarifythe basic knowledge of quality concepts and techniques for quality improvement
- To teach, how to use various control charts for improving the product quality
- To provide the clear understanding of different sampling plans and methods

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Acquire the basic knowledge of quality concepts and techniques for quality improvement
CO2 Learn to use various control charts for improving the quality of products
CO3 Describe and compare the different sampling plans and methods
CO4 Understand the concepts of reliability

Syllabus Contents

Unit-1 (15 Lectures)

Quality Concepts: Meaning of Quality, Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques Pareto Diagrams, Cause-Effect Diagrams Quality Circles, Kaizen, six sigma.

Unit-2 (17 Lectures)

Control Charts: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, ARL, sensitizing rules for control charts, Control Charts for X-bar& R (statistical basis, development and use, estimating process capability; interpretation) and control chart for attribute (p, np, c).

Unit-3 (15 Lectures)

Acceptance Sampling: Meaning, objective, and types of research, approaches, Principle of acceptance sampling, Producer's and consumer's risk. AOQL and LTPD, Sampling plans – single, double, O C curve.

Unit-4 (13 Lectures)

Reliability: Different types and modes of failure, causes of failure in electronic components, reliability theory, hazard rate, failure density function, availability, maintainability, mean time to failure and repair system structures: series, parallel, K-type, Fault tree analysis.

References

1. D. C. Montgomery , Introduction to Statistical Quality Control, 6th edition, John Wiley and sons (2009).
2. Reliability Engineering by S.Shreenath, 4th Edition, East West Press (2008).

Reliability and Quality Control Techniques Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Construct control charts for variable and attribute and determine the statistical control of the process

CO2 Design single and double sampling plans

CO3 Plot operating characteristic curve for different sampling plans

CO4 Plot AOQ and ATI curve for different sampling plans

Syllabus Contents

Use latest statistical software package like SPSS to conduct experiments based on:

1. Descriptive statistics
2. Control charts for variable
3. Control charts for attribute
4. OC curve
5. Single sampling and double sampling
6. AOQ curve

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Artificial Intelligence

Credits: Theory-04 **Theory Lectures: 60h**

Course Learning Objectives

- To realize the significance of Artificial Intelligence and expert systems in today's era
- To study neural networks and become able to design neural network based algorithms
- To study fuzzy logic and use it as an alternative tool for modelling.
- To study genetic algorithms and learn about optimizing solutions using genetic algorithms
- Become able to apply the knowledge of artificial control tools to any control application
- To be able to work with imprecise and uncertain solution data for solving problems.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Realize the significance of Artificial Intelligence and expert systems

CO2 Learn the neural network algorithms, modelling using fuzzy logic and optimising solutions using genetic algorithms

CO3 Apply the knowledge of artificial control tools to any control application

CO4 Work with imprecise and uncertain solution data for solving problems

Syllabus Contents

Unit-1 (10 Lectures)

The concept and importance of Artificial Intelligence, human intelligence vs machine intelligence, General concept of knowledge, Acquisition, Knowledge representation and organization, Expert systems: advantages, disadvantages, Expert system architecture, functions of various parts, mechanism and role of inference engine, Role of expert systems in instrumentation and control.

Unit-2 (20 Lectures)

Neural Networks: Biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Artificial neuron models, Types of activation functions, Learning rules, Learning Paradigms-Supervised, Unsupervised and Reinforcement Learning, ANN training algorithms-perceptron, training rules, Delta, Back Propagation Algorithm, parameters in BPN, Hopfield Networks, Recurrent networks, Associative Memories, Applications in identification, optimization, pattern recognition etc.

Unit-3 (20 Lectures)

Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Approximate reasoning, Aggregation, Fuzzy logic modelling and control, fuzzification, inferencing and defuzzification, Linguistic Variables, Arithmetic Operations on Intervals & Numbers. Applications of Fuzzy Logic in process Control and motion control.

Unit-4 (10 Lectures)

Genetic Algorithm: An Overview: Introduction and concept as a process modeling tool, creation of off-springs, encoding, fitness function, reproduction, cross over, insertion, deletion and mutation scaling, Fitness, Implementation of Genetic algorithm, applications.

Hybrid Systems: Introduction to Neuro-fuzzy systems, Fuzzy-Expert system, Fuzzy-GA systems.

References

1. Ross Timothy. J, Fuzzy logic with Engineering Applications, McGraw Hill, New York, 3rd Edition.
2. Hagan M.T , Demuth H.B, Beale M.H, Neural Network Design, PWS Publishing Company, Thomson Learning, 1st Edition.
3. PadhyN.P., Artificial Intelligence and Intelligent Systems, Oxford University Press, 1stEdition.
4. Rajasekaran S., VijayalakshmiPai G. A., Neural Networks, PHI Learning Pvt. Ltd., 2003, 1st Edition.
5. Klir George J , Yuan B, Fuzzy Sets and Fuzzy Logic Theory and Applications, Prentice Hall PTR, 1st Edition.

Artificial Intelligence Lab

Credits:02 **Lectures: 60**

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Course LearningOutcomes

At the end of this course, students will be able to

CO1 Design and train neural networks for pattern recognition problems

CO2 Design and train neural networks for classification and association problems

CO3 Design fuzzy logic based controllers

CO4 Design fuzzy logic based systems for real time applications

Syllabus Contents

1. Implementation of perceptron learning model
2. Pattern recognition using Hopfield network
3. Identification using associative memories
4. Implement fuzzy logic operations on fuzzy sets
5. Implement conversion of given crisp temperature into its equivalent fuzzy variable
6. Implement conversion of error into its equivalent fuzzy variable
7. Design model of fuzzy logic PID controller
8. Design fuzzy logic based temperature control system
9. Design fuzzy logic based washing machine/aircraft landing system

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Dissertation/Project Work

Credits:Theory-06

Course Learning Objectives

The course is designed to facilitate the student to acquire special/advanced knowledge, such as supplement study/support study/ solving / analyzing /exploring a real life situation / difficult problem into a project work. The candidate studies this course on his own with an advisory support by a teacher/faculty member.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Survey and study of published literature on the assigned topic;
CO2 Working out a preliminary Approach to the Problem relating to the assigned topic;
CO3 Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
CO4 Preparing a Written Report on the Study conducted for presentation to the Department;
CO5 Final Seminar, as oral Presentation before a departmental committee.

Syllabus Contents

The object of Internship/Project Work is to enable the student to take up investigative study in the broad field of instrumentation, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor.

Contents:
Unit 1: Identification of research problem
Unit 2: Survey of literature
Unit 3: Formulation of hypothesis, design and methodology
Unit 4: Analysis of data and interpretation of results
Unit 5: Discussion and conclusion
Unit 6: Writing a project report

Continuous evaluation (IA) 50 marks
Experimental work cum project report 75 marks
Presentation and Viva-voce 25 marks

Note:

1. Number of students who will be offered project work will vary from college to college depending upon the available infrastructural facilities and may vary each year.
2. The college shall announce the number of seats for project work well in advance and may select the students for the same based on merit.
3. Project work will involve experimental work and the student will have to do this in the time after their regular theory and practical classes.
4. The final evaluation of the project work will be through a committee involving internal and external examiners.

5. Guidelines provided by University of Delhi for executing and evaluation of project work will be final.
6. Students will be asked their choice for Project work at the end of IV semester and all formalities of topic and mentor selection will be completed by this time.
7. Project work will be offered in lieu of any one Discipline Specific Elective and will be evaluated for 6 credits.

References:

Research Methodology: Methods and techniques by C.R. Kothari and GauravGarg. New Age International, India. 2018.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Skills Enhancement Electives

Programming in C

Credits: Theory-02 **Total Lectures: 30h**

Course Learning Objectives

- To develop codes in C language using basic elements like control statements, arrays and strings
- To understand effective usage of structures, functions, pointers and to implement the memory management concepts for advanced programming
- To learn the basics of searching, sorting and file handling mechanisms which are essential for understanding the concepts in database management

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Develop codes in C language using basic elements like control statements, arrays and strings

CO2 Understand effective usage of structures, functions, pointers and to implement the memory management concepts for advanced programming

CO3 Learn the basics of searching, sorting and file handling mechanisms which are essential for understanding the concepts in database management

Syllabus Contents

Introduction: Algorithm / pseudo code, flowchart, program development steps, structure of C program, identifiers, basic data types and sizes, Constants, variables, Operators, expressions, Input-output statements, if and switch statements, loops- while, do-while and for statements, break, continue, goto and labels.

Functions: Parameter passing, Storage Classes- extern, auto, register, static, Scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, C program examples.

Arrays and pointers: Arrays concept, declaration, accessing elements, storing elements, arrays and functions, two dimensional and multi-dimensional arrays, applications of arrays. Pointers-concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, C program examples.

Derived data types: Structures declaration, initialization, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, type def, bit fields, C program examples. Input and output - concept of a file, streams, standard I/O, formatted I/O, file I/O operations, error handling, C program examples.
Searching - Linear and binary search methods, **Sorting** - Bubble sort, selection sort, insertion sort.

References

1. Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning.
2. Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing.
3. E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing.
4. P. Padmanabham, C & Data structures, B.S. Publications.
5. B.W. Kernighan, Dennis M.Ritchie, The C Programming Language, Pearson Education.
6. J.A. Jones & K. Harrow, C Programming with problem solving, Dreamtech Press.
7. Stephen G. Kochan, Programming in C, III Edition, Pearson Education.
8. K. R. Venugopal, S. R. Prasad, Mastering C, 2nd edition (2017), McGraw-Hill Education.

PRACTICALS

Credits: 02 **Total Lectures: 60h**

Implement programs in C exemplifying:

1. Arithmetic operations
2. If-else construct
3. Switch construct
4. While, do while and for loop
5. Arithmetic operations for n x m matrices
6. Passing by reference and passing by value in functions
7. Inline parameter passing
8. Pointers and pointer arithmetic
9. String operations using pointers and arrays explicitly.
10. Structures

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

VLSI Design and Verification

Credits: Theory-02 **Total Lectures: 30h**

Course Learning Objectives

- To understand the physics of semiconductor, basic theory of metal semiconductor contacts, PN junction and operation of MOS transistors.
- To learn the basic steps of fabrication such as Epitaxy, Diffusion, Oxidation, Lithography and Etching.
- To understand the analog and digital VLSI Design.
- To learn the VHDL hardware programming language.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Describe the techniques and design rules used to design of CMOS logic circuits, switches and memory in VLSI

CO2 Explain high speed VLSI design by decreasing gate length and by using high mobility semiconductors material

CO3 Use of hardware description languages VHDL and Verilog and able to simulate CMOS circuits

Syllabus Contents

MOS Technology and Circuits: MOS Technology and VLSI, Process parameters and considerations for BJT, MOS and CMOS, Electrical properties of MOS circuits and Device modeling, MOS Circuit Design Process, MOS Layers, Stick diagram, Layout diagram, Design rules, Layout Diagrams for NMOS and CMOS Inverter, Propagation delays, Examples of combinational logic design, Sealing of MOS circuits.

Analog VLSI and High speed VLSI Design: Introduction to Analog VLSI, Realization of Switched capacitor filters, nono-CMOS technology, GaAs and high mobility semiconductors based VLSI technology.

Hardware Description Languages: VHDL background and basic concepts, structural specifications of hardware design organization and parameterization.

VHDL/Verilog: Introduction, gate level modeling, modeling and concept of wire, creation, module instantiation, ports and their mapping, data flow modeling, various operators, Data types, modeling delays-specparam, behavioural modeling.

Simulation: Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams, Two Level Logic Synthesis.

References

1. Douglas A. Pucknell and Kamran Eshraghian, Basic VLSI Design Systems and Circuits, Prentice Hall of India Pvt.Ltd.
2. Wayne Wolf, Modern VLSI Design, 2 Edition, Prentice Hall.
3. Amar Mukherjee, Introduction to NMOS and CMOS VLSI System Design, Prentice Hall.
4. Randall L Geiger and PE Allen, VLSI Design Techniques for Analog and Digital Circuits, McGraw Hill International Company.
5. Fabricious.E, Introduction to VLSI Design, McGraw Hill.
6. Navabi.Z, VHDL Analysis and Modeling of Digital Systems, McGraw Hill.
7. Mohammed Ismail and Terri Fiez, Analog VLSI Signal and Information Processing, McGraw Hill.
8. Peter J Ashenden, the Designer's Guide to VHDL, Harcourt Asia Private Limited & Morgan Kauffman.

PRACTICALS

Credits: 02 **Total Lectures: 60h**

1. Implementation of basic logic gates and its testing
2. Implementation of adder (half and full) circuit and its testing
3. Implementation of 4 × 1 Multiplexer and its testing
4. Implementation of 3 × 8 decoder and its testing
5. Implementation of JK and D flip flop and its testing
6. Implementation of BCD counter and its testing
7. Generate RTL design for subtractor (half and full) and 3 × 8 decoder circuit
8. Study and verify the i/p and o/p characteristics of BJT in CE, CB and CC configuration
9. Study and verify the $I_{DS} – V_{GS}$ and I_{DS}-V_{DS} characteristics of n-channel and p-channel MOSFETs
10. Implement and study the characteristics of CMOS NAND and NOR gate
11. Simulation of CMOS inverter for transfer characteristics
12. Generate the layout for CMOS Inverter and Simulate it for verification

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Testing and Calibration

Credits: Theory-02 **Total Lectures: 30h**

Course Learning Objectives

- To describe the units of measure and the various instruments used in various measurement parameters.
- To explain the various components of a calibration system.
- To teach the various standardization techniques in Production Plants.
- To make them understand about the testing and calibration procedures in measurement.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the basic concept of measurements and calibration

CO2 Perform dimensional analysis concepts correctly and present final values with the correct units/symbols

CO3 Analyze various standardization techniques in Production Plants

CO4 Familiarize with various testing and calibration procedures in measurement

Syllabus Contents

Calibration and Standardization Practices Units: Fundamental and Derived Units, Standards: Primary, Secondary and Tertiary standards, Standardizations and Technique: Standardizations of Electrical (voltage, current, frequency, RLC and others), Mechanical (mass, displacement, velocity, acceleration, torque, flow, level, temperature, pressure etc.) and other parameters.

Advanced measurement and Calibration equipment: Inductive voltage dividers, AC and DC comparators, Programmable synthetic signal sources and power supplies, Quad bridge, Automatic AC bridges, Phase sensitive detectors, Lock-in-amplifiers, Digital phase and frequency measurements.

Standardization and calibration modeling: Standardization in Production Plants and manufacturing houses, Reliability studies and inspection, Product Standardization techniques, Calibration: Calibration of measuring instruments, Theory and Principles (absolute and secondary or comparison method), Setup, Modeling.

Various testing and calibration systems: Sensor calibration and testing, Analytical methods in calibrating. Automated test and calibration systems: GPIB based systems, machine computation of errors and uncertainties in measurement.

References

1. Patrick O'Connor, Test Engineering: A Concise Guide to Cost-effective Design, Development and Manufacture (Quality and Reliability Engineering Series), Wiley-Blackwell, 2001.

2. Keith R. Cheatle, 2006, Fundamentals of Test Measurement Instrumentation, Illustrated Ed., ISA.
3. B.G. Liptak 2003, Instrument Engineers Handbook - Process Measurement and Analysis, volume 1, 4th Ed., ISA.
4. Alan S. Morris, 2003, Measurement and Instrumentation Principles, 1st Ed., Butterworth-Heinemann.
5. N. E. Battikha, 2007, The Condensed Handbook of Measurement and Control, 3rd Ed., ISA.

PRACTICALS
Credits: 02 **Total Lectures: 60h**

1. Study of Electrical and Mechanical parameters standards used in testing and calibration.
2. Calibration of DPT (Differential Pressure Transmitter) transducer.
3. Calibration of LVDT transducer for displacement measurement.
4. To study Load Cell calibrator.
5. Calibration of Thermocouple.
6. To Study AC/DC meter calibrator.
7. Calibration of Pressure gauge using Dead weight Tester.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

PLC and SCADA

Credits: Theory-02 **Total Lectures: 30h**

Course Learning Objectives

- To realize the need and importance of automation in process industries
- To understand Programmable Logic Controllers (PLCs) and learn their programming
- To study Distributed Control Systems (DCS) and their applications in industry
- To understand the significance and usage of SCADA in process automation industry

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the need for automation in process industries and learn about PLC

CO2 Learn the programming languages of PLC

CO3 Design distributed Control Systems (DCS) and its applications

CO4 Learn about SCADA, it's usage in process automation industry and associated communication networks

Syllabus Contents

Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems, Types of data available, Data communication components and protocols.

Programmable Logic Controllers (PLC), input/output systems, CPU, memory Unit, Programmer Units, Peripheral devices, Controller programming tools, Programming of PLCs.

Distributed Control Systems (DCS), PLC vs. DCS systems, Local control Units, dedicated card controllers, Unit Operations controllers, DCS multiplexers, DCS system integration.

Supervisory Control and Data acquisition (SCADA) Systems, Types of supervisory systems, Distributed Digital Control Systems (DCS), Direct digital control (DDC), SCADA: Components of SCADA Systems, field data interface devices, communication network and other details, System Architecture: monolithic, distributed, networked, application of SCADA in industry; security and weakness of SCADA Systems.

References

1. S. Gupta, JP Gupta, "PC interface For Data Acquiring & Process Control", 2nd Ed., Instrument Society of America.
2. John W. Web, Ronald A. Reis, "Programmable Logic Controllers" 5th Edition, PHI.
3. Liptak, B. G. (E.d.), "Instrument Engineers Handbook", vol. I to III, Chilton Book Co.
4. Bhatkar, Marshal, "Distributed Computer control & Industrial Automation", Dekker Publication.
5. Frank D. Petruzella, "Programmable Logic Controllers", 3rd Edition, McGraw Hill.

PRACTICALS

Credits: 02 **Total Lectures: 60h**

1. Identify various components, modules and front panel status indicators of a given PLC
2. Design the PLC ladder diagram to test the START STOP logic using two inputs and one output
3. Design the PLC ladder diagrams for all fundamental logic gates
4. Design the PLC ladder program to Verify DeMorgan's Theorems
5. Design the PLC ladder diagrams for various arithmetic operations
6. Design the PLC ladder diagrams for various logical operations
7. Design a PLC ladder program for blinking of LEDs
8. Design the PLC ladder diagram for implementing a digital timer
9. Design the PLC ladder diagram for implementing a digital counter
10. Design the PLC ladder diagram for sequential control of DC motor.
11. Design the PLC ladder diagram for a temperature control system
12. Design the PLC ladder diagram for a flow control system
13. Design the PLC ladder diagram for a level control system
14. Interface personal computers in network using different topologies
15. Identify various level of distributed control system
16. Develop a SCADA mimic diagram and tag database for On-Off control of lamp
17. Develop a SCADA mimic diagram and tag database for Traffic light control system
18. Develop a SCADA mimic diagram and tag database for level control system
19. Develop a SCADA mimic diagram and tag database for water distribution system
20. Develop a SCADA mimic diagram and tag database for elevator system

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Virtual Instrumentation

Credits: Theory-02 **Theory Lectures: 30h**

Course Learning Objectives

- To understand the importance of Virtual Instrumentation and study it's applications
- To learn the basic programming concepts in LabVIEW
- To understand the basics of data acquisition for designing a Virtual Instrument
- To recognize the various building blocks of Virtual instrumentation and use them for PC Based Measurement.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the importance and applications of Virtual Instrumentation

CO2 Learn the basic programming concepts in LabVIEW

CO3 Recognize the components of Virtual instrumentation and use them for PC Based Measurement

Syllabus Contents

Introduction to Virtual Instrumentation: The LabVIEW Programming Environment: Controls/ Indicators, Auto indexing, Debugging, Timing issues (counters).

Simple programming structures and Timing Issues: Basic operations, controls and indicators.Programming Techniques: VIS and sub-VIS, Debugging a VI and Sub-VI's, loops& charts, arrays, clusters, graphs, case & sequence structures.

Formula nodes, local and global variable, string & file input, Graphical programming in data flow**.**

Data Acquisition Basics: ADC, DAC, DIO, Counters & timers

GPIB/IEEE 608 concepts, and embedded system buses - PCI, EISA, CPCI, and USB&VXI,**Developing applications on LabVIEW:** Process control, Waveform generator, Motion control using stepper motor, image acquisition, Temperature data acquisition system, Processing using programming structure.

References

1. John Essick , Hands on Introduction to LabVIEW for Scientists and Engineers, 3rd Edition, 2015.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2nd Edition, 1994.
3. Gary Johnson, LABVIEW Graphical Programming, McGraw Hill, 4th Edition, 2006.
4. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI, 3rd Edition, 2006.
5. Skolkoff, Basic concepts of LABVIEW 4, PHI, 1998.
6. James K, PC interfacing and data acquisition, 2002.
7. Technical Manuals for DAS Modules of Advantech and National Instruments. L.T. Amy, Automation System for Control and Data Acquisition, ISA, 4thEdition, 1992.

PRACTICALS

Credits: 02 **Total Lectures: 60h**

1. Build a VI to convert temperature in degree Celsius to Fahrenheit.
2. Split an input string into two outputs with reference to a separating character. Find the length of the input string and reverse the string
3. Convert a binary number to a decimal number
4. Build a VI to find factorial of a number
5. Create a VI to find the sum of first n natural numbers using a While Loop with a feedback node
6. Create a VI to compare the element of two cluster if value of corresponding element are same switch on LED in output cluster.
7. Build an array of cluster controls in which each cluster consists of a numeric control and a 1D numeric array (with 5 elements). This forms a database of marks of students. The numeric control indicates the roll number and the array indicates the test marks of five subjects. Build logic to modify the mark in a particular subject of a particular student. Input the roll number, subject in which mark is to be changed and the new marks. Display the changed database on a separate array indicator.
8. Create a 1D numeric array which consists of ten elements and rotate it ten times. For each rotation display the equivalent binary number of the first array element in the form of a Boolean array. Also display the reversed Boolean array. Provide delay to view the rotation.
9. Create two 2D numeric arrays and add them. Change the number of rows and number of columns of each array and see the result
10. Create a 1D array and find its reverse.
11. Build a VI to plot a circle in the XY graph using a For Loop
12. Build a VI that generates 1D array of random number and sort the ascending descending array and also find the max. and min. value array element.
13. Build a cluster control which consists of a seven-segment LED display, a switch, a string control and a numeric control. Split the cluster elements using the Unbundle function and alter the values of some of the cluster controls. Bundle them again and display in a cluster indicator
14. Using for loop determine the number of odd numbers between a range of numbers entered by the user.
15. Write a for loop which takes the given values of u from a numeric control labelled coefficient of kinetic friction. calculate f' from theta=0 to 90 degree in 1 degree increment then display the resulting array of f' values on a waveform graph.
16. Create a VI to check whether the cluster elements are in range or not. Specify the upper and lower limits. Display the coerced output and a cluster of LEDs to indicate whether a particular cluster element is in the range or not
17. Write a program to solve $x^2+bx+c=0$.
18. Build a VI to generate two waveform of different amplitude and frequency add the signal to find the resultant and plot it on the separate waveform graph.
19. Build a VI to for four pumps A, B, C, D and a water tank of height 10 meters. Pump a should be switched off if both B and C are simultaneously on, pump B should be switched off if both C

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

Programming using MATLAB

Credits: Theory-02 **Total Lectures: 30h**

Course Learning Objectives

- To familiarize the student with MATLAB software.
- The objective of this lab is to introduce students to the basic operations of MATLAB.
- To enable the student on how to approach for solving Engineering problems using simulation tools.
- To prepare the students to use MATLAB in their project works.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Use of MATLAB for interactive computations
CO2 Generate plots and exports this for use in reports
CO3 Familiar with inbuilt MATLAB functions and will be able to generate user defined functions for various applications
CO4 Understands fundamental of digital image and signal processing

Syllabus Contents

Introduction to MATLAB: Features, MATLAB Windows defining variables, different operations on variables, naming and checking existence, Clear Operations, Introduction to Arrays
Data and Data Flow in MATLAB: Operators in MATLAB, Matrix operations, Reshaping Matrices, Importing & Exporting of Data, Arrays, Data types, File Input-Output, Communication with External Devices.

Editing and Debugging M Files: Writing Script Files and Functions, Error Correction, M-Lint Automatic Code Analyzer, Saving Files.
Programming: Flow Control, Conditional Statements, Error Handling, Work with Multidimensional Array, Cell Array Characters and String.

MATLAB Graphics: Simple Graphics, Graphic Types, Plotting Functions, Creating Plot & Editing Plot (2DGraphics Handles), Introduction of Graphical User Interface (GUI)

Digital Signal Processing: Basic application of DSP, Program for modulation and Demodulation, Program for time scaling and amplitude Scaling, Generation and implementation of various functions on image.
Image Processing: Basic Image processing tools, Basic programs for Histogram processing, image segmentation and image restoration.

References

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, PHI Learning, New Delhi.

2. Fausett, L. V., Applied Numerical Analysis Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
3. Mathews, J.H. and K.D. Fink, Numerical Methods Using MATLAB - Third Edition, Prentice Hall, Upper Saddle River, New Jersey.
4. Linfield, G. & Penny, J., Numerical methods using MATLAB, Ellis- Horwood.
5. Van Loan, C.F., Introduction to Scientific Computing - A Matrix-Vector Approach Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
6. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey.

PRACTICALS

Credits: 02 **Total Lectures: 60h**

1. Define variables and perform various mathematical operations.
2. Create a matrix of any size.
3. Create a multi-dimension array and delete any Row/Column from it and create a new array.
4. Plot and label trigonometric functions using subplot command.
5. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.
6. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
7. Create a function which compare any two strings of equal length and return ‘M’ for matched character and ‘U’ for unmatched Character. Also display the number of characters matched.
8. Generate the (i)AP and (ii) GP series.
9. Write a script to test whether a user defined no. is Prime or not.
10. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by user.
11. Write a script to generate the amplitude and frequency modulated signal.
12. Create a function to change the colors of user defined image.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVES

GENERIC ELECTIVE 1

Sensors and its Applications

Credits: 04 **Total Lectures: 60h**

Course Learning Objectives

- To understand the operation of commonly used sensors and actuators.
- To be able to analyze and select most appropriate sensors or actuators for an application.
- To analyzecharacteristics of sensors and actuators by knowing their basic laws and processes.

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Identify and comprehend various sensors used in the real life applications and paraphrase their importance

CO2 Classify and explain with examples the utilization of sensors for measurement of temperature, strain, motion, position and light in the industry

CO3 Understand the role of sensors and actuators to make sensitive measurements of physical parameters like pressure, flow, acceleration, velocity etc.

Syllabus Contents

Unit-1 (20 Lectures)

Classification of transducers: Active, Passive, Mechanical, Electrical and their comparison. Selection of Transducers, Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, semi-conductor strain gauge) Capacitive, Inductive (LVDT-Principle and characteristics, Piezoelectric, light (photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), load cell.

Unit-2 (14 Lectures)

Flow meters, mechanical type -Theory of variable head type flow meters – orifice plate, venture tube, flow nozzle, Positive displacement flow meters.

Unit-3 (12 Lectures)

Rota meter: thermal mass flow meter, Principle and constructional details of electromagnetic flow meter, different types of ultrasonic flow meters.

Unit 4 (14 Lectures)

Tachometers - Mechanical, Electric, Contact less, Frequency, Stroboscopic tachometers. Elementary accelerometers, Manometers – different types – elastic type pressure gauges – Bourdon type bellows – diaphragms –measurement of vacuum

References

1. A.K Sawhney, A course in mechanical measurements and instrumentation, DhanpatRai& Co, 12th edition, 2001.
2. R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996, 11th edition.
3. A.K. Sawhney , Electrical & Electronic Measurements & Instrumentation, 19th revised edition, 2012.

4. Nakra&Choudhary, Instrumentation measurements and analysis , Tata McGraw Hill, 2nd edition, Revised 2016-2017.

Sensors and its Applications Lab

Credits: 02 **Lectures: 60H**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Explain fundamental physical and technical base of sensors and actuators
CO2 Describe basic laws and phenomena that define behavior of sensors and actuators
CO3 Analyze various approaches, procedures and results related to sensors and actuators
CO4 Conduct experiments and measurements in laboratory and on real components, sensors and actuators
CO5 Interpret the acquired data and measured results

Syllabus Contents

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of displacement using LVDT.
3. Measurement using load cells.
4. Measurement using capacitive transducer.
5. Measurement using inductive transducer.
6. Measurement of temperature using Temperature Sensors/RTD.
7. Characteristics of Hall effect sensor.
8. Measuring change in resistance using LDR
9. Discharge coefficient of orifice plate.
10. Calibration of RTD.
11. E.M. flow meter.
12. Ultrasonic flow meter.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 2

Instrumentation and Control

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To study about how to analyse the stability and response of the closed and open loop systems
- To teach students about how to develop the mathematical model of the physical systems
- To study about how to analyse performance characteristics of system using Frequency response methods
- To study the use of Evans root locus techniques in control design for real world systems
- To study how to compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Analyze the stability and response of the closed and open loop systems
CO2 Develop the mathematical model of the physical systems
CO3 Analyze performance characteristics of system using Frequency response methods
CO4 Use Evans root locus techniques in control design for real world systems
CO5 Compute gain and phase margins from Bode diagrams and Nyquist plots and understand their implications in terms of robust stability
CO6 Handle different types of controller like electronic, pneumatic and hydraulic

Syllabus Contents

Unit-1 (15 Lectures)

Basics of control system, Open loop and closed loop control systems, mathematical modeling of physical systems, transfer function, block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula.Effect of feedback on control systems.

Unit-2 (15 Lectures)

Time – Domain Analysis: Time domain performance criteria, transient response of first and second order system, steady state errors and static error constants.
Concept of Stability: Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

Unit-3 (15 Lectures)

Frequency Domain Analysis: Correlation between time and frequency response, Polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion and relative stability using Nyquist criterion.

Unit-4 (15 Lectures)

Controller Hardware: Electronic pneumatic and hydraulic controller's implementation, single and composite modes of controllers.

Final Control Elements: Control valves types, actuators, Solenoid, I/P P/I converters, stepper motors.

References

1. K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition.
2. B. C. Kuo , "Automatic control system", Prentice Hall of India, 2000, 7th Edition.
3. I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition.
4. Nakra&Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 3rd Edition (2010).
5. Johnson .C.D., Process Control Instrument Technology, Prentice Hall Inc, 8th Edition (2006).

Instrumentation and Control Lab

(Hardware and Simulation Software)

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Control the position and speed of a DC motor

CO2 Design Lead-Lag compensators based on frequency data for an open-loop linear system

CO3 Analyze the mathematical model of a system and determine the response of different order systems for standard input

CO4 Understand the characteristics of Synchro transmitter receiver and Synchro as an error detector

CO5 Be capable of operating and simulating a control system

Syllabus Contents

Some of the experiments mentioned can be simulated on software (MATLAB/MathCAD/LabVIEW/SciLab)

1. To study position control of DC motor
2. To study speed control of DC motor
3. To find characteristics of AC servo motor
4. To study time response of first and second order systems
5. To study frequency response of first and second order systems
6. To study effect of damping factor on performance of second order system
7. To study frequency response of Lead and Lag networks.
8. To study characteristics of
   a. Synchro transmitter receiver
   b. Synchro as an error detector

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 3

Analytical Techniques and Instrumentation

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To understand the principle, instrumentation, characteristics and working mechanisms of common spectroscopic, chromatographic and potentiometric instruments
- To learn about the applications of potentiometry, GC and HPLC in different industries (food, chemical, pharmaceutical, petroleum, etc.)
- To understand the concept of qualitative and quantitative analysis
- To understand the planar and column chromatography for different applications

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Understand the principle, instrumentation, characteristics and working mechanisms of common spectroscopic, chromatographic and potentiometric analytical instruments

CO2 Explore the potential of analytical techniques of potentiometry, GC and HPLC in different industries (food, chemical, pharmaceutical, petroleum,etc.)

CO3 Carry out the qualitative and quantitative analysis of a given sample

CO4 Utilize planar and column chromatography for different applications

Syllabus Contents

Unit-1 (18 Lectures)

Molecular Spectroscopy: Ultraviolet-Visible (UV-Vis) spectroscopy: principle, instrumentation and applications. Infra-Red spectroscopy: principle, instrumentation and applications

Unit-2 (13 Lectures)

Atomic spectroscopy: Theory, instrumentation and application of flame photometry and atomicabsorption spectroscopy.

Unit-3 (17 Lectures)

Planar chromatography: Theory and application of paper and thin layer chromatography, **Column chromatography**: Principle, instrumentation and application of Gas Liquid Chromatography and High Performance Liquid Chromatography.

Unit-4 (12 Lectures)

Potentiometry: Introduction, reference andindicator electrodes, ion selective electrodes: glass electrode and liquid membrane electrode and their applications.

References

1. Skoog, Holler andCrouch, Instrumental Analysis,, Cengage Learning, Indiaedition, 2007.
2. Skoog&Lerry, Instrumental Methodsof Analysis, Saunders College Publications, New York, 4th edition, 1970.
3. H.H.Willard et al., InstumentalMethodsof Analysis, CBS Publishers, 7th edition, 1988

4. Jeffery G.H. et al., Vogel's Text of Quantitative Chemical Analysis, , Longman Scientific and Technical, New York, 4th edition, 1978.
5. R.S Khandpur, Handbook of Analytical Instruments, Tata McGraw-Hill, 3rd Edition 2006.
6. B.K Sharma, Instrumental Methods of Chemical Analysis, Krishna Prakashan Media, 1st Edition 2011.

Analytical Techniques & Instrumentation Lab

Credits:02 **Lectures: 60h**

CourseLearning Outcomes

At the end of this course, students will be able to

CO1 Analyze a sample using different chromatographic techniques (TLC, GC, HPLC)
CO2 Examine the properties of sample tested on Colorimeter
CO3 Apply the principle of UV-VIS spectrometry for verificationof Beer's Lambert law
CO4 Learn to collect the data, analyze the data, interference of data and presenting it in the form of small project which can be helpful for further research
CO5 Apply the integrated knowledge of different analytical instrument in the form of execution of small projects
CO6 Follow the safety procedure and precautions for handling analytical instruments
CO7 Apply the principle of FTIR in industrial application

Syllabus Contents

1. Determination of pKa value for bromophenol blue using double beamspectrophotometer.
2. Spectrometric determination of iron using double beam spectrophotometer.
3. Determination of concentration of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Thin layer chromatographic (TLC) separation of samples from different origin (Biological/pharmaceutical/food)
5. Spectrum analysis using FT-IR.
   a. Qualitative analysis
   b. Quantitative analysis
6. Qualitative and quantitative analysis of various compounds using atomic absorption Spectroscopy.
7. Qualitative and quantitative analysis of organic compounds using Gas chromatography.
8. Qualitative and quantitative analysis of organic compounds using HPLC.
9. To study the effect of organic solvent on membrane permeability of beet root.
10. Paper chromatographic separation of samples from different origin (Biological/pharmaceutical/food).
11. Verification of Beer's Law and determination of concentration of the unknown solution using colorimeter.
12. Determination of concentration of solutes in a mixture using colorimeter.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 4

Nuclear and Biomedical Instrumentation

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To gain the basic technical knowledge of biomedical instrumentation.
- To familiarize with various bioelectric signals and understand their source of generation.
- To understand the working principle and applications of medical imaging instruments and the modalities involved in each technique.
- To apprehend the basic operation of nuclear medicine system.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Learn the technical vocabulary associated with basic instrumentation and design and basic signal analysis

CO2 Develop clear understanding about the various bioelectric signals produced by the body which could be obtained and analyzed using the basic implementation of Instrumentation

CO3 Explain and compare the origin, instrumentation and analysis of biological signals produced by cardiovascular, respiratory and nervous system

CO4 Understand the basic difference between the working principle, instrumentation and application of different medical imaging system such as ultrasound, X-ray and Computed tomography

CO5 Infer the measurement principle and operating conditions of various detectors used in a nuclear medicine system

Syllabus Contents

Unit-1 (08 Lectures)

Introduction to bioelectric potential, bio-amplifier, components of man Instrument system, design factors of biomedical instruments, types of biopotential electrodes.

Unit-2 (20 Lectures)

Cardiac vascular system: Origin of (Electrocardiography) ECG signals, Instruments of ECG, bipolar system lead system I, II, III, Eithoven triangle, Augmented lead system, unipolar chest lead system, types of display.

Respiratory system: Types of volume, types of measurements, Instrumentations of respiratory system, pneumograph, principle & types of pneumograph, Spirometer.

Nervous system: Action potential of brain, brain wave, Instrumentation – Electro encephalography (EEG), analysis

Unit-3 (19 Lectures)

Medical Imaging system: Ultra sound, properties, beam width, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, M Scan.

Radiography: conventional X ray, properties, generation of X-ray, X ray computed tomography (CT scanner) and computer-aided tomography (CAT).

Unit-4 (13 Lectures)

Introduction to nuclear medicine system: Nuclear detectors: Gas filled detectors: Ionization, Proportional, and Geiger Muller (GM) Counter, Scintillation counter – principle, operating condition.

References

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall, 2nd edition.
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education, Inc, 4th edition.
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing, India, 2nd edition.
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, 2nd Edition, Volume 1, IEEE Press.

Nuclear and Biomedical Instrumentation Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the difference between various bioelectric signals (e.g. ECG, EEG and EMG) in terms of frequency and amplitude

CO2 Carry out the measurement of blood pressure and pulse rate independently

CO3 Record the various pulmonary functions and analyze the variations between normal and healthy parameters of an individual

CO4 Appreciate the importance of medical imaging techniques (e.g. Ultrasound) in diagnosis and could perform it independently

CO5 Prepare the technical report on the experiments carried

Syllabus Contents

Characterization of bio potential amplifier for ECG signals.

1. Study on ECG simulator
2. Recording of EEG
3. Measurement of heart sound using electronic stethoscope.
4. Study of pulse rate monitor with alarm system
5. Determination of pulmonary function.
6. Study on ultrasound transducers based on medical system

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 5

Machine Intelligence

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To apply machine intelligence techniques in applications which involve perception, reasoning and learning.
- To acquire knowledge of real world knowledge representation
- To use different machine learning techniques to design AI machine and enveloping applications for real world problems.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Apply machine intelligence techniques in applications which involve perception, reasoning and learning

CO2 Acquire knowledge of real world knowledge representation

CO3 Use different machine learning techniques to design AI machine and enveloping applications for real world problems

Syllabus Contents

Unit-1 (08 Lectures)

Components of AI, human intelligence vs. machine intelligence, Knowledge Acquisition, Representation and organization: Structured Knowledge representation using Semantic Networks, Frames, Expert system architecture, functions of various parts, Mechanism and role of inference engine, Types of Expert system.

Unit-2 (21 Lectures)

Structure and function of a single neuron, artificial neuron models, Types of activation functions, Neural network architectures: Fully connected, layered, acyclic, feed forward, Neural learning: correlation, competitive, Supervised learning: Back propagation algorithm, Unsupervised learning, winner-take all networks, Application areas of neural networks.

Unit-3 (21 Lectures)

Fuzziness vs. probability, Crisp logic vs. fuzzy logic, Fuzzy sets and systems, operations on sets, fuzzy relations, membership functions, fuzzification interface, knowledge/rule base, decision making logic, defuzzification interface, Applications of Fuzzy Logic in process Control and motion control.

Unit-4 (10 Lectures)

Genetic Algorithm: introduction and concept, coding, reproduction, cross-over and mutation Scaling, fitness, applications. Hybrid Systems: Introduction to Neuro-fuzzy systems, Fuzzy-Expert system, Fuzzy-GA systems

References

1. Timothy J. Ross, Fuzzy logic with Engineering Applications , McGraw Hill, New York, 3rd Edition.
2. S. Rajasekaran, G. A. VijayalakshmiPai Neural Networks, Fuzzy Logic And Genetic Algorithm: Synthesis and Applications, PHI Learning Pvt. Ltd., 2003, 1st Edition.
3. Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Neural Network Design,PWS Publishing Company, Thomson Learning, 1st Edition 4. N.P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition.

Machine Intelligence Lab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Implementing perception, reasoning and learning using various machine intelligence algorithms

CO2 Implementing pattern recognition and identification

CO3 Designing and developing real time systems using fuzzy logic

Syllabus Contents

Implement programs using MATLAB Fuzzy logic and Neural Network toolbox exemplifying

1. Implementation of perception learning model.
2. Pattern recognition using Hopfield network.
3. Pattern Identification using associative memories.
4. Implementation of back propagation algorithm.
5. Implement fuzzy logic operations on fuzzy sets.
6. Implement conversion of given crisp variable into its equivalent fuzzy variable.
7. Implement conversion of error of given control system intoits equivalent fuzzy variable.
8. Design model of fuzzy logic PID controller.
9. Design fuzzy logic based temperature control system.
10. Design fuzzy logic based washing machine/aircraft landing system.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 6

Standardization and Quality Control

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To introduce the basic concepts of Total Quality Management.
- To enable the student on how to apply various Statistical Process Control (SPC) techniques to ensurethe quality level of products.
- Tounderstand the significanceofControlCharts and Acceptance sampling in modern quality control systems.
- To make students learnthe national and international quality assurance standards.

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Apply the principles and techniques of Total Quality Management in improving quality practices within an industrial or service organization

CO2 Use statistical process control (SPC) techniques such as pareto charts, control charts and cause-effect diagrams recognized throughout industries to ensure the quality level of products

CO3 Understand the role of Acceptance Sampling (AS) in modern quality control systems

CO4 Develop an understanding of national and international quality assurance standards such as ISO 9000 and 14001

Syllabus Contents

Unit-1 (14 Lectures)

Quality Concepts: Meaning of Quality, Dimensions of Quality, Quality Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques-Quality Circles, Kaizen, Six Sigma.

Unit-2 (16 Lectures)

Quality Control: Graphical and Tabular representation of data, Measures of Central Tendency, Measures of Dispersion, Random Variables, Probability Density Distributions, Chance and assignable causes of variation, Quality Control Tools-Histogram, Pareto Chart, Cause-Effect Diagram, Control Charts. Control Chart for variables (X-bar & R), Control limits, Warning Limits, Process Capability, Sample Size and Sampling Frequency, Sensitizing rules for Control Charts, Rational subgroups, Control Chart for Attributes (p, np, c).

Unit-3 (16 Lectures)

Acceptance Sampling: Advantages and Disadvantages of Sampling, Types of Sampling, Lotformation, Principle of acceptance sampling, OC curve, Producer’s and consumer’s risk, Acceptable Quality Level, Lot Tolerance Percentage Defective, Sampling plans: single, double, Average outgoing Quality, AOQL.

Unit-4 (14 Lectures)

ISO 9001-2000 &14000Series of Standards: History and Evolution of ISO 9000 Series, Importance and overview of ISO 9000- 1998 Series standards, structure of ISO 9000-2000 Series standards, clauses of ISO 9000 series standards and their interpretation and implementation, quality system documentation and audit. Environmental management concepts, and requirement of ISO 14001, benefits of environmental management Systems.

References

1. D. C. Montgomery, Introduction to Statistical Quality Control, John Wiley and sons, 6th edition, 2008.
2. SubburajRamasamy, Total Quality management, Tata McGraw Hill, 2nd Edition, 2012
3. E. L. Grant & R.S. Leavenworth-Statistical Quality Control, 7th Edition, 2000.
4. Kaoru Ishikawa-Guide to Quality Control, Asian Productivity Organization, Series, 1986

Standardization and Quality Control Lab

Credits:02 **Lectures: 60h**

Course LearningOutcomes

At the end of this course, students will be able to

CO1 Learn to apply software tools (e.g. SPSS) to understand different parameters of descriptive statistics

CO2 Compare the different types of bar graph and chart forms

CO3 Analyze various control charts both manually and practically

CO4 Understand the practical aspects of plotting operational characteristic curve

CO5 Prepare technical reports on the process flow domain in any organization

Syllabus Contents

Use latest statistical software package like SPSS to conduct experiments based on :

1. Descriptive statistics
2. Histogram and Pareto Chart
3. Control charts for variables
4. Control charts for attributes
5. OC curve
6. AOQ curve

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 7

MATLAB and its Applications

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To learn to Interact and perform the computations on MATLAB
- To plot the functions using various types of plot command
- To understand the difference between the functions & Scripts in MATLAB
- To familiarize with the fundamentals of digital image and signal processing

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Interact with MATLAB for various computations
CO2 Generate plots and exports this for use in reports
CO3 Familiar with inbuilt MATLAB functions and will be able to create user defined Functions and write scripts for various applications
CO4 Understands fundamental of digital image and signal processing

Syllabus Contents

Unit-1 (10 Lectures)
Introduction to MATLAB: MATLAB features, MATLAB Windows, defining variables, formatting output, types of operators, different operations on variables, checking existence, clear operations, data type, precedence.

Unit-2 (20 Lectures)
Introduction to Arrays: Defining scalars, vectors, matrix, multi-dimensional arrays, Different operations on array, reshaping matrices, importing & exporting of data.
Character and Strings: Defining character and string, accessing character or substring from string, string concatenation and comparing, conversion between strings and number. Defining and working with cell array.
DataPlotting: Graph, plot, types of plot, multiple plots, labelling graph, line colors, style and marker.

Unit-3 (15 Lectures)
Script and Function M File: M-file, writing script files, writing functions, error correction, saving files.
Flow control statement: Conditional or selection, error handling, loop control, program termination, Solution of simultaneous linear equations.

Unit-4 (15 Lectures)
Signal Processing: Generation of continuous time & discrete time signal, time shift, time scaling, amplitude scaling of signal. Generation of amplitude modulated signal, frequency modulated signal.

Image processing: Study of basic tools of Image Processing, Image segmentation, restoration, histogram processing, changing color of image.

References

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, PHI Learning, New Delhi.
2. Mathews, J.H. and K.D. Fink, Numerical Methods Using MATLAB - Third Edition, Prentice Hall, Upper Saddle River, New Jersey.
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, Ellis- Horwood.
4. Van Loan, C.F., Introduction to Scientific Computing - A Matrix-Vector Approach Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
5. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey.

MATLAB and its Applications Lab

Credits: Theory-04 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Interact with MATLAB for understanding various tasks
CO2 Understand and design calculator by exploring and utilizing the power of MATLAB
CO3 Develop program for plagiarism check
CO4 Generate modulated signals and change the color of original image
CO5 Analyze and prepare the reports on the experiment carried out

Syllabus Contents

13. Define variables and perform various mathematical operations.
14. Create a matrix of any size by all possible methods.
15. Create a multi-dimension array and delete any Row/Column from it and create a new array.
16. Plot and label all the trigonometric functions using subplot command.
17. Generate various kinds of continuous and discrete time signals. Plot them with different colour, line style and markers and label the graph.
18. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.
19. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
20. Define a string and count the number of vowels, spaces and consonants in it. Also mention the size and length of the string.
21. Write a script to remove (i) all the alphabets from the alphanumeric string, (ii) all the spaces from a string.
22. Create a function which compare any two strings of equal length and return ‘M’ for matched character and ‘U’ for unmatched Character. Also display the number of characters matched.
23. Generate the (i)AP, (ii) GP and (iii) Fibonacci series.
24. Write a script to test whether a user defined no. is Prime or not.

25. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by user.
26. Write a script to generate the amplitude and frequency modulated signal.
27. Create a function to change the colors of user defined image.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 8

General Instrumentation

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To study basic concepts of Instrumentation and different parameters of an Instrumentation system.
- To study different types of signal generators and display devices like Cathode Ray Oscilloscope.
- To learn about different types of transducers.
- To study about different types of cardiovascular system and measurements.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Have the basic understanding of measurement process

CO2 Understand the construction of different measuring devices-Ammeter, Voltmeter, Ohmmeter and Digital Frequency Meter

CO3 Develop an understanding of construction and working of different measuring instruments- Signal Generator and CRO for appropriate measurement

CO4 Identify the usage of sensors and transducers around us

CO5 Understand the basic concept and applications of cardiovascular systems

.

Syllabus Contents

Unit-1 (14 Lectures)

Basic concepts of Instrumentation: Generalized Instrumentation systems block diagram representation, scope of instrumentation in Industrial organization.

Measurement systems characteristics: Accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, drift, fidelity, response time, error and its types.

Unit-2 (16 Lectures)

Signal Generators-Audio oscillator, Function generators, Pulse generators, RF generator, Random noise generator

Electronic Displays: Cathode Ray Oscilloscope (CRO) and applications: Block diagram of a General Purpose Oscilloscope and its basic operation, electrostatic focusing and deflection, Types of CRO's: dual trace oscilloscope and dual beam CRO.

Unit-3 (14 Lectures)

Transducers: Active and Passive transducers, Mechanical and Electrical transducers, Introduction: to Resistive, Capacitive, Inductive, light (Photo-conductive, Photo-emissive, Photo-voltaic), Temperature transducers.

Unit-4 (16 Lectures)

Cardiovascular system and measurements: ECG: origin, Instrumentation, bipolar system lead system I, II, III, Einthoven's triangle, Augmented lead system, Unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Defibrillators: AC, DC. Pacemakers-Internal and External.

References

1. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill (2006).
2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education (2005).
3. C. S. Rangan, Gs. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998).
4. H. Cooper, Modern electronic instrumentation and measurement techniques, Pearson Education (2005).
5. R. A. Witte, Electronic test instruments: Analog and digital measurements, Tata McGraw Hill (2004).
6. S. Wolf and R. F. M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004).
7. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata McGraw-Hill Publishing (2009), 2nd Edition.
8. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2nd Edition.

General Instrumentation Lab

(Hardware Practical)

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Practice the construction of testing and measuring set up for electronic systems.
CO2 Designing of AC and DC bridges for measurements
CO3 Develop an ability to use digital oscilloscopes and waveform generators in laboratory
CO4 Identify and understand the principles of common sensors and transducers used in daily life
CO5 Brief Knowledge of biomedical instruments

Syllabus Contents

1. Measurement of Temperature using Temperature Sensors/RTD.
2. Measuring change in resistance using LDR
3. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO, DSO.
4. Frequency measurement using Wein Bridge.
5. Study of R, L, C and Q meter.
6. Measurements of L, C, R using bridges.

7. Study of ultrasound transducers based on medical system
8. To analyze and interpret an ECG.
9. To study and learn the blood pressure measurements.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

GENERIC ELECTIVE 9

Applied Mathematics

Credits: Theory-04 **Total Lectures: 60h**

Course Learning Objectives

- To introduce the basic concepts required to identify, formulate, abstract and solve mathematical problems.
- To teach various methods to solve linear algebra and differential equations.
- To make students familiarize with the concept of mathematical transformation such as Fourier and Laplace transform.
- To make students understand a variety of differential equations and their solutions, with emphasis on applied problems in engineering and physics

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Develop an ability to identify, formulate, abstract, and solve mathematical problems including Linear algebra, differential equations and mathematical transformation
CO2 Recognize ODEs of varying order and use these to model engineering problems
CO3 Demonstrate the ability of using Laplace transform in solving the ordinary differential Equations
CO4 Familiarize with the concept of Fourier transform & Fourier series
CO5 Design mathematical models, apply mathematical analysis and problem-solving skills

Syllabus Contents

Unit-1 (14 Lectures)

Linear Algebra: Algebra of matrices, Linear system of equations, Linear Independence, Rank of a Matrix. Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Eigenvalues, Eigenvectors, Symmetric, Skew-Symmetric, and Orthogonal Matrices, Applications of Eigenvalue Problems.

Unit-2 (16 Lectures)

Differential Equations: Ordinary differential Equations, Linear Independence and Dependence, Second Order Differential Equations with Constant Coefficients: Homogeneous, Non-Homogeneous Equations, Differential Equation with Variable Coefficients: Reducible to Equations with Constant Coefficients. Formation of Partial Differential Equation, Partial Differential Equation of First Order, Classification of Partial Differential Equations of Second Order.

Unit-3 (14 Lectures)

Laplace Transform: Laplace Transform, Linearity, s-shifting, Unit Step function, Dirac's Delta Function, t-shifting, Inverse Laplace transforms and their properties, Solutions to ordinary differential equations. Initial and Final value theorem.

Unit-4 (16 Lectures)

Fourier series and Transforms: Periodic Function, Even and Odd Functions, Fourier Series, Fourier Series for Even and Odd Functions, Half range expansions: Fourier Sine and Cosine Series, Fourier Integral Theorem, Fourier Transform, Fourier Sine and Cosine Transforms.

References

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2011), 10th Edition.
2. Ravish R Singh, Mukul Bhatt, Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2016).
3. Michel D Greenberg; Advanced Engineering Mathematics, Pearson International
4. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing CompanyLimited (2010).
5. A.S.Willsky, Oppenheim, Signals and System, Prentice Hall, 2nd edition, 1970.

Applied MathematicsLab

Credits:02 **Lectures: 60h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Apply mathematical concepts and principles to perform computations including algebra, differential equations and mathematical transformation

CO2 Study some different ways to solve the linear differential equations

CO3 Generate different plots and export this for further use

CO4 Understand the implementation of different transformations in mathematics

Syllabus Contents

(**Using SciLab /MATLAB/ any other Mathematical Simulation software**)

1. Matrices: Addition, Scalar Multiplication, Matrix multiplication.
2. Solve the linear differential equation of second order with constant coefficients.
3. Plot the basic trigonometric functions, unit step and impulse function with shifting.
4. Compute the Fourier series Coefficients of the given Periodic Function.
5. Find the Laplace Transform of the given signal.
6. Find the Fourier transform of the given signal.

Indicative Course Teaching-Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.

7.3 Course Teaching-Learning Process

As a program of study, B.Sc. (Hons) Instrumentation is designed to encourage the acquisition of knowledge of Instrumentation, understanding and professional skills required for the industrial/professional jobs. Development of practical/experimental skills should constitute an important aspect of the teaching-learning process. Methods which actively involve students are more effective than lectures for encouraging them to take intense approaches which are likely to result in developing understanding and encouraging critical thinking. Students learn more effectively when lectures include activities which engage their thoughts and motivation.

The faculty should promote learning on a proportionate scale of 20:30:50 principle, where lectures (listening/hearing) constitute 20 percent of the delivery; visuals (seeing/power point presentation/video/demonstrations) 30 percent of the learning methods; and experience (doing/participating/discussion) 50 percent. This ratio is subject to change as per institutional needs. In order to achieve its objective of focused process based learning and holistic development, the Institution/University may use a variety of knowledge delivery methods. The following general approaches are suggested for more outcome oriented and participative learning.

Lectures: Lectures should be designed to provide the learners with interesting and fresh perspectives on the subject matter. Lectures should be interactive in a way that students work with their teachers to get new insights in the subject area, on which they can build their own bridges to higher learning. In order to make every lecture outcome oriented, faculty may specify the lecture outcomes in the beginning and at the end, the main points covered during the lecture should be summarized.

Case Studies: Real case studies, wherever possible, should be encouraged in order to challenge students to find creative solutions to complex problems faced by instrumentation industry, community, society and various aspects of knowledge domain concerned. Student may be asked to communicate findings of the study in the form of a report and seminar.

SWAYAM Portal: The platform provides the best teaching learning e-resources to all. Students can enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology on SWAYAM portal. The courses hosted on SWAYAM are in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts.

Lab Sessions: In traditional laboratory a student follow a given procedure to obtain pre-determined outcome. This allows student to manipulate equipment, learn standard techniques, collect data, interpret data and write report. *It has to be recognized that for students to obtain the necessary laboratory skills, to use lab facilities effectively, requires a significant commitment of time for both the instructor and the student.*

In order to enhance the lab experience of the students following should be implemented

<u>Simulations:</u> Simulations can be used as a pre-lab experience to give students some idea of what they will encounter in an actual experiment. Student should be given opportunity to work on

simulation tools like MATLAB, Scilab, MULTISIM/ PSPICE, LabVIEWetcto support their laboratory work.

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Optional Experiments: Students must be given wide range of options in selecting the experiments. After completion of mandatory experiments, they should be required to select few out of the multiple optional laboratory experiments relating to their field of interest. Thus experiments designed for a particular course should be more than the minimum required experiments.

Problem solving: Instead of following an established procedure given in laboratory manual, student will be given a scientific problem and will be able to design his/her own way of solving the problem. Student involvement in the laboratories increases if the experiments are designed and executed by the students themselves.

Mini Projects: Mini-projects provide opportunities for the students to develop project management skills while working in a team. They may be assigned circuit/system design related problems for solving.

Virtual Remote Laboratory: Virtual and remote laboratories are e-learning resources that enhance the accessibility of experimental setups providing a distance teaching framework which meets the student's hands-on learning needs. The use of virtual remote laboratory should be encouraged as it enhances student's life-long learning capabilities along with routine subject/experimental skills.

Lab Report: The Lab report should clearly reflect the student's experience during the lab sessions. Primarily student should be able to establish the science behind the experiment. That is, laboratory procedure is expected to yield certain results and to a certain extent, the quality of the experiment depends on whether or not those results are obtained. One should be able to clearly relate the theory with the laboratory findings. The lab report should systematically introduction, results and conclusion of experiment be made with emphasis on followings

Introduction section must define the problem statement, establish scientific concept, and provide logical reasoning.
Results must begin with effective statements of overall findings and results must be presented visually, clearly and accurately.
Conclusion section must convincingly describe what has been learned in the lab, whether expected outcomes are met or not. It should provide sound judgment based on the evidences. Clear evidence to judgment must be provided in the findings and how evidence contributed toward judgment.

Project-based learning: Students learn to work on their individual skills regarding critical thinking and problem solving, creativity and innovation, collaboration/teamwork and leadership, communications, learning self-reliance and project management. Project-based learning can be used in single sequences (a combination of lecture and project-based learning) or as the predominant teaching method in a module. Accordingly, the assessment has to consider both the result and the working process. Adequate examination requirements for individual marking are practical tests of the result/product, presentations with discussions and seminar papers of the working process and the result/product.

Summer training/internship: Industrial training in professional program is very important to give an insight on how the industry operates, and to provide the necessary industrial career exposure. Students are expected to complete reports and presentations as a normal professional would do. The benefits of such training can be twofold; firstly, industrial training contributes positively to the development of generic employability skills; and secondly, placements provide a 'head start' for graduates at the outset of their careers.

After the period of training, it is expected that students should achieve the course outcomes below:

- Recognize the duties, responsibilities and ethics of profession.
- Ability to communicate effectively in the work environment.
- Understand general and specific work procedures in instrumentation industry.
- Gain exposure and practical experience in the relevant field.
- Ability to prepare technical reports for the training.
- Ability to apply knowledge learned to solve problems in the industry.

Industrial/Field Visitsare important to help bridge the gap between education and hands-on experience. They are a vital requirement as students will be able to appreciate state of the art technology in place.They will help students acquire knowledge, hands-on experience, technology at work and understand societal requirements and challenges. It will help is raising curiosity in them and finding answers to their queries.

Invited talks and Hands-on Workshops shall be organized on regular basis as it will help students interact with various subject experts from outside the institute domain. It will help them apprise about the latest technological as well as research developments, industrial needs and market requirements. It will assist them in developing self-confidence through the art of self doing.

7.4 Assessment Methods

Instrumentation is a professional academic program, so there is need to focus more on activity based evaluation rather than purely written examination. A variety of assessment methods that are appropriate within the disciplinary area of Instrumentation must be used. The assessment of learners' achievement in B.Sc. (Hons) Instrumentationwillbe aligned with the following:

- Course outcomes
- Program Outcomes

Allowing for the diversity in learning and pedagogical methods adopted by different universities and institutions, Universities are expected to ensure that the assessment techniques are able to provide clear information about the attainment level of course outcomes and program outcomes for each and every student.

Assessment priorities: Institutions will be required to prioritize formative assessments (in-semester activities including tests done at the department or instructor level) rather than giving heavy and final weightage to summative assessments (end-semester). Progress of learners towards achieving learning outcomes may be assessed making creative use of the following, either independently or in combination:

- Time-constrained examinations (say 1-hour or 2-hour tests);
- Closed-book and open-book tests (if applicable);

- Problem based assignments;
- Quizzes
- Real life projects;
- Lab reports
- Individual/Team project reports;
- Oral presentations, including seminar presentation;
- Viva voce,
- Interviews;
- Computerized adaptive testing for MCQ;
- Peer and self-assessment etc.
- Any other pedagogic approaches as may be relevant keeping in view the learners' level, credit load and class size.

Weightage Distribution: In view of need for more activity centric evaluation, more marks should be assigned for in-semester i.e. internal evaluation. The distribution of marks in in-semester and end-semester examination should preferably be in the ratio of 25:75.

End Semester Examination: The final theory exam should contain preferably 40% marks assigned for problem solving questions. The problem solving questions should comprise numerical problems, circuit analysis and design type questions.

The various teaching, learning and evaluation strategies for various skills/outcomes are summarized in the next table.

Innovation and Flexibility: Within each category, institutions are expected to encourage instructors to bring in innovative and flexible methods to guarantee the fullest realization of Learning Outcomes outlined in the document. All such instructional and assessment requirements must be clearly communicated to all stakeholders at the time of course registration. Any subsequent change or minor modification necessary for fuller realization of learning outcomes must be arranged with due notice and institutional arrangement at the relevant level.

Freedom and Accountability: Freedom and accountability of the stakeholder are key attributes that determine the success of the Learning Outcomes framework. The excellence of institutions will be increasingly determined by Learning Outcomes rather than programme or course objectives. Hence it is necessary to innovate continually in learning and assessment in order to ensure meaningful and socially relevant learning (with transparent Learning Outcomes indices) rather than rote learning.

8 Keywords

Instrumentation, Biomedical Instrumentation, Analytical techniques, Industry 4.0 Standards, Microprocessors, Microcontrollers, Statistical tools, VLSI, Artificial Intelligence, MATLAB, LabVIEW, Virtual Instrumentation, Control Systems, Process control, Automation, PLC, SCADA, Embedded Systems, Digital and Analog Electronics.

Table 1: Suggestive Learning and Evaluation Strategies for B.Sc. (Hons) Instrumentation

Skills	Program Learning Outcomes	Graduate Attributes	Teaching-Learning Methods	Assessment Methods
Remembering & Understanding	PLO1:Ability to apply knowledge of mathematics and science for solving Instrumentation related problems	Scholarship of Knowledge	• Lectures, Self Readings, • Demonstration, • Discussion	• Written Exams • Seminars • Quizzes, Assignments
Applying & Analyzing	PLO2: Ability to perform instrumentation experiments, as well as to analyze and interpret data.	Critical Thinking & Analytical Reasoning	• Demonstrate methods or procedures • Labs Sessions, • Open Ended Experiments,	• Lab Reports • Practical Exam • Practical Exam
Applying & Analyzing	PLO3: Ability to design and manage instrumentation systems or processes that conforms to a given specification within ethical and economic constraints.	Critical Thinking & Problem Solving	• Demonstrate application of rules, laws, or theories • Demonstrate problem-solving (Numerical problems)	• Written Exam • Viva-voce
Applying & Analyzing	PLO4: Ability to identify, formulate, solve and analyze the problems in various sub disciplines of instrumentation.	Critical Thinking, Analytical Reasoning, Problem Solving	• Case Studies, Simulations, • Open Ended Experiments, • Projects • Collecting relevant information	• Project Reports • Practical Exam • Viva-voce • Written Exam • Rubrics
Team Player	PLO5: Ability to work effectively and responsibly as a team member.	Cooperation /Team Work	• Project/labwork/development based projects. • Collecting relevant information	Rubrics for project evaluations
Good communication	PLO6: Ability to communicate effectively in term of oral and written communication ski lls	Communication Skills	• Lab Reports • Case Studies Reports • Project Dissertations • Seminar/Presentations	• Project/lab Report • Presentations • Viva-voce • Rubrics
Life-long learning	PLO7: Recognize the need for, and be able to engage in lifelong learning.	Life-long Learning:	• Project work • Literature survey, Self Study • Project implementation, Visits	• Project Reports • Presentations • Rubrics
Apply	PLO8: Use Modern Tools/Techniques	Use of Modern Tools	• Lab work • Projects • Visits/Training	• Lab reports • Practical Exams • Rubrics