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UNIVERSITY OF DELHI

Bachelor of Science (Hons) Electronic Science

(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) Electronic Science
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) Electronic Science offer the undergraduates a complete package to have an in-depth understanding of basic to advance electronics. They can equip themselves to the fundamentals of electronics to a complete skill set compatible to industry 4.0 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) Electronic Science 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 outcomes based curriculum framework (LOCF) for B.Sc. (Hons) Electronic Science is intended to prepare a curriculum which enables the graduates to respond to the current needs of the industry and equip them with skills relevant for national and global standards. The framework will assist in maintaining international standards to ensure global competitiveness and facilitate student/graduate mobility after completion of B.Sc. (Hons) Electronic Science programme. 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. (Hons) Electronic Science is prepared on the contours and curricular structure of CBCS provided by the UGC, and may be modified without sacrificing the spirit of CBCS and LOCF.

Programme Duration:

The B.Sc. (Hons) Electronic Science programme 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 Programme:

The teaching-learning will involve theory classes (Lectures) of one hour 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, lab sessions, virtual labs, simulations, optional experiments, 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, quizzes, 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 and four-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 with practicals will comprise of theory classes (two credits) and practicals (two credits). Four credit courses without practicals will comprise of theory classes only (four 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 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.

Note: 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 Honours degree in Electronic Science, 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 and Ability

Enhancement Courses are four credit-courses. A student has to earn a minimum of 148 credits to get a degree in B.Sc. (Hons) Electronic Science.

There will be fourteen Core Courses which are to be compulsorily studied to complete the requirements for an Honours degree in B.Sc. Electronic Science. 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 fourteen 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 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 done 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) Electronic Science programme 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 Electronic Science will offer thirteen GE courses for students of other departments. A core course offered in a discipline/subject may be treated as a Generic Elective by other discipline/subject and vice versa. Therefore, the department of Electronic Science 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 Electronic Science is offering eleven 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) Electronic Science

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:

- 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 others 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. (Hons) Electronic Science

B.Sc. (Hons) Electronic Science is a professional program which needs to develop a specialized skill set among the graduates to cater the need of industries. In recent years, Electronic Science has made unprecedented growth in terms of new technologies, new ideas and principles. The research organizations and industries that work in this frontier area are in need of highly skilled and scientifically oriented manpower. This manpower can be available only with flexible, adaptive and progressive training programs and a cohesive interaction among the research organizations, academicians and industries. The key areas of study within subject area of Electronic Science comprise: Semiconductor Devices, analog and digital circuit design, Microprocessors & Microcontroller systems, Communication techniques, IoT and computation techniques for Electronics, computer coding/programming in high level languages etc.

B.Sc. (Hons) Electronic Science covers topics that overlap with areas outlined above and with applied fields such as embedded system, advanced computer and data communication, robotics, control systems, VLSI Design and Fabrication, Nanoelectronics, Artificial Intelligence, Internet of Things etc.

The present learning outcomes based model curriculum of B.Sc. (Hons) Electronic Science, 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) Electronic Science

The overall aims of the B.Sc. (Hons) Electronic Science are:

- Provide students with learning experiences that develop broad knowledge and understanding of key concepts of electronic science and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the field of electronics.
- Develop ability in student's to apply knowledge and skills they have acquired to the solution of specific theoretical and applied problems in electronics.
- 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) Electronic Science

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) Electronic Science are 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) Electronic Science

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. (Hons) Electronic Science programme: Some of the expected learning outcomes that a student should be able to demonstrate on completion of a B.Sc. (Hons) Electronic Science programme may include the following:

Knowledge & Understanding

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

Skills & Ability

- Demonstrate ability to apply electronics knowledge & experimental skills critically and systematically for assessment and solution of complex electronics problems and issues related to communication systems, embedded systems, computers networks, robotics, VLSI Design and fabrication and other specialized areas of electronics.
- Demonstrate ability to model, simulate and evaluate the phenomenon and systems in the advanced areas of electronics.

- Demonstrate ability to apply one's electronics 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 electronics 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. (Hons) Electronic Science

The following program outcomes have been identified for **B.Sc. (Hons) Electronic Science**

PLO1	Ability to apply knowledge of mathematics & science in solving electronics related problems
PLO2	Ability to design and conduct electronics experiments, as well as to analyze and interpret data
PLO3	Ability to design and manage electronic 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 electronics
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) Electronic Science

6.1 Credit Distribution for B.Sc. (Hons) Electronic Science

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

		Credits Details	
		(Theory + Practical) or (Theory +Tutorial)	
I. Core Course (14 Papers)			
Core Courses (Theory)		14X4=56	
Core Course (Practical)		14X2=28	
II. Elective Course (8 Courses = 4 DSE + 4 GE)			
A.1. Discipline Specific Elective (DSE) (Theory) (4 in number)		4x4 =16	
A.2. Discipline Specific Elective (Practical) (4 in number)		4x2=8	
B.1. Generic Elective/Interdisciplinary (GE) (4 in number)		4X4=16 or	4X5=20
B.2. Generic Elective(Practical/ Tutorial*) (4 in number)		4x2 =8 or	4 X1=4
III. Ability Enhancement Courses			
1. **Ability Enhancement Compulsory Courses (AECC)** (2 Papers of 4 credit each)			
Environmental Science/ English/MIL Communication		2 X 4=8	
2. **Skill Enhancement Courses (SEC) **** (2 Papers of 4 credit each)		2 X 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: *Mathematics Foundation for Electronics*	4	4
3		Core Lab I: *Basic Circuit Theory and Network Analysis Lab*	4	2
4		Core Lab II: *Mathematics Foundation for Electronics 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 communications/Environmental Science*	4	4
		Total Credits		**22**

Semester II				
	Course Type	**Course Name**	**Hours/week**	**Credit**
1	Core	Core III: *Semiconductor Devices*	4	4
2		Core IV: *Applied Physics*	4	4
3		Core Lab1II: *Semiconductor Devices Lab*	4	2
4		Core Lab IV: *Applied Physics 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 communications/Environmental Science*	4	4
		Total Credits		**22**

Semester III				
	Course Type	**Course Name**	**Hours/week**	**Credit**
1	Core	Core V: *Electronic Circuits*	4	4
2		Core VI: *Digital Electronics and Verilog/VHDL*	4	4
3		Core VII : *C Programming and Data Structures*	4	4
4		Core Lab V: *Electronic Circuits Lab*	4	2
5		Core Lab VI: *Digital Electronics and Verilog/VHDL Lab*	4	2
6		Core Lab VII: *C Programming and Data Structures Lab*	4	2
7	GE	GE-3	4/5	4/5*
8		GE-3: *Practical/Tutorial**	4/1	2/1*
	SEC	SEC-1:	2	2
9		SEC-1: *Practical*	4	2
		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: *Signals and Systems*	4	4
3		Core X : *Electronic Instrumentation*	4	4
4		Core Lab VIII: *Operational Amplifiers and Applications Lab*	4	2
5		Core Lab IX: *Signals and Systems 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*
	SEC	SEC-2:	2	2
9		SEC-2: *Practical*	4	2
		Total Credits		**28**

Semester V				
	Course Type	**Course Name**	**Hours/week**	**Credit**
1	Core	Core XI: *Microprocessors and Microcontrollers*	4	4
2		Core XII: *Electromagnetics*	4	4
3		Core Lab XI: *Microprocessors and Microcontrollers Lab*	4	2
4		Core Lab XII: *Electromagnetics Lab*	4	2
5	DSE	DSE-1:	4	4
6		DSE-2:	4	4
7		DSE-1: *Practical*	4	2
8		DSE-2: *Practical*	4	2
		Total Credits		**24**

Semester VI				
	Course Type	**Course Name**	**Hours/week**	**Credit**
1	Core	Core XI: *Communication Electronics*	4	4
2		Core XII: *Photonics*	4	4
3		Core Lab XI: *Communication Electronics Lab*	4	2
4		Core Lab XII: *Photonics Lab*	4	2
5	DSE	DSE-3:	4	4
6		DSE-4:	4	4
7		DSE-3: *Practical*	4	2
8		DSE-4: *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. Mathematics Foundation for Electronics (4+4)
3. Semiconductor Devices (4+4)
4. Applied Physics (4+4)
5. Electronic Circuits (4+4)
6. Digital Electronics and Verilog/VHDL (4+4)
7. C Programming and Data Structures (4+4)
8. Operational Amplifiers and Applications (4+4)
9. Signals and Systems (4+4)
10. Electronic Instrumentation (4+4)
11. Microprocessors and Microcontrollers (4+4)
12. Electromagnetics (4+4)
13. Communication Electronics (4+4)
14. Photonics (4+4)

B. Discipline Specific Electives (DSE):

(4 papers to be selected) - DSE 1-4

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

Group 1 (V Semester) (DSE 1, 2)

1. Power Electronics (4+4)
2. Numerical Analysis (4+4)
3. Digital Signal Processing (4+4)
4. Basic VLSI Design (4+4)
5. Computer Networks (4+4)
6. Semiconductor Fabrication and Characterization (4+4)
7. Biomedical Instrumentation (4+4)

Group 2 (VI Semester) (DSE-3, 4)

1. Electrical Machines (4+4)
2. Modern Communication Systems (4+4)
3. Control Systems (4+4)
4. Transmission Lines, Antenna and Wave Propagation (4+4)
5. Nanoelectronics (4+4)
6. Embedded Systems (4+4)
7. Dissertation/ Project work

C. Skill Enhancement Course (SEC) (02 papers) - SEC1 to SEC2
Credit: 04 each (Theory: 02 + Lab: 02)

1 Design and Fabrication of Printed Circuit Boards (2+4)
2 Robotics (2+4)
3 Mobile Applications Development (2+4)
4 Internet and Java Programming (2+4)
5 Programming with LabVIEW (2+4)
6 Artificial Intelligence (2+4)
7 Internet of Things (2+4)
8 Data Sciences (2+4)
9 Cyber Security (2+4)
10 3D Printing and Design (2+4)
11 Virtual Reality (2+4)

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

1. Electronic Circuits and PCB Designing (4+4)
2. Digital System Design (4+4)
3. Instrumentation (4+4)
4. Practical Electronics (4+4)
5. Communication Systems (4+4)
6. Microprocessor and Microcontroller Systems (4+4)
7. Consumer Electronics (4+4)
8. Computational Mathematics (5+1)
9. Applied Mathematics-I (5+1)
10. Applied Mathematics-II (5+1)
11. Artificial Intelligence (4+4)
12. Internet of Things (4+4)
13. Data Science (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 Electronic Science 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:
1. The size of the practical/tutorial group for practical/tutorial based 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 Electronic Science.

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. Apply subject knowledge & scientific/technical skills.	PLO2. Design and conduct electronics experiments, as well as to analyze and interpret data	PLO3. Design and manage electronic systems	PLO4. Identify, formulate, solve and analyse the problems in Electronics.	PLO5. Function as a member of a multidisciplinary team	PLO6. Communicate effectively	PLO7. Lifelong learning and Professional Development	PLO8. Use techniques, skills and modern technological/scientific/engineering
1	Basic Circuit Theory and Network Analysis	√		√	√				
2	Basic Circuit Theory and Network Analysis Lab		√	√		√	√		
3	Mathematics Foundation for Electronics	√		√	√				
4	Mathematics Foundation for Electronics Lab		√			√	√		√
5	Semiconductor Devices	√		√					
6	Semiconductor Devices Lab		√	√		√	√		
7	Applied Physics	√			√	√			
8	Applied Physics Lab		√			√	√		
9	Electronic Circuits	√		√	√				
10	Electronic Circuits Lab		√			√	√		√
11	Digital Electronics and Verilog/VHDL	√		√	√				
12	Digital Electronics and Verilog/VHDL Lab		√			√	√		√
13	C Programming and Data Structures	√	√						√
14	C Programming and Data Structures Lab		√			√	√		√
15	Operational Amplifiers and Applications	√		√	√				
16	Operational Amplifiers and Applications Lab		√			√	√		
17	Signals and Systems	√		√	√				
18	Signals and Systems Lab		√			√	√		
19	Electromagnetics	√							
20	Electromagnetics Lab					√			
21	Microprocessors and Microcontrollers			√	√				
22	Microprocessors and Microcontrollers Lab		√			√	√		
23	Communication Electronics	√			√				
24	Communication Electronics lab		√			√	√		
25	Electronic Instrumentation	√		√	√				
26	Electronic Instrumentation Lab		√			√	√		
27	Photonics	√		√	√				
28	Photonics 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 study the basic circuit concepts in a systematic manner suitable for analysis and design.
- To study and analyze the transient and steady-state response of circuits.
- To analyze electric circuits using network theorems and two-port parameters.

Course Learning Outcomes

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

CO1 Study basic circuit concepts in a systematic manner suitable for analysis and design.

CO2 Understand transient analysis.

CO3 Determine AC steady state response.

CO4 Analyze the electric circuit using network theorems.

CO5 Understand the two–port network parameters.

Syllabus Contents

Unit-1 (8 Lectures)

Basic Circuit Concepts: Voltage and Current Sources, V- I characteristics of ideal voltage and ideal current sources, various types of controlled sources, passive circuit components, V-I characteristics and ratings of different types of R, L, C elements.

Unit- 2 (16 Lectures)

Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.

DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits With Sources, DC Response of Series RLC Circuits.

Unit-3 (18 Lectures)

AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC 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 (18 Lectures)

Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem. AC circuit analysis using Network theorems.

Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters, h 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 Verify the network theorems and operation of typical electrical circuits.
CO2 Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.
CO3 Prepare the technical report on the experiments carried.

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 combination
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.

Mathematics Foundation for Electronics

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

Course Learning Objectives

The purpose of this course is to provide students with the skills and knowledge to perform calculations for solution of problems related to various topics they would study in their programme, particularly the use of ordinary differential equations. The course aims to prepare students with the mathematical tools they would require while solving transient circuits in power electronics and problem solving in Electromagnetic Theory.

Course Learning Outcomes

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

CO1 Use mathematics as a tool for solving/modeling systems in electronics

CO2 Solve non-homogeneous linear differential equations of any order using a variety of methods, solve differential equations using power series and special functions

CO3 Understand methods to diagonalize square matrices and find eigenvalues and corresponding eigenvectors for a square matrix, and check for its diagonalizability

CO4 Familiarize with the concept of sequences, series and recognize convergent, divergent, bounded, Cauchy and monotone sequences.

CO5 Perform operations with various forms of complex numbers to solve equations

Syllabus Contents

Unit-1 (16 Lectures)

Ordinary Differential Equations: First Order Ordinary Differential Equations, Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations. Second Order homogeneous and non-homogeneous Differential Equations.

Series solution of differential equations and special functions: Power series method, Legendre Polynomials, Frobenius Method, Bessel's equations and Bessel's functions of first and second kind. Error functions and gamma function.

Unit-2 (14 Lectures)

Matrices: Introduction to Matrices, System of Linear Algebraic Equations, Gaussian Elimination Method, Gauss-Seidel Method, LU decomposition, Solution of Linear System by LU decomposition. Eigen Values and Eigen Vectors, Linear Transformation, Properties of Eigen Values and Eigen Vectors, Cayley-Hamilton Theorem, Diagonalization, Powers of a Matrix. Real and Complex Matrices, Symmetric, Skew Symmetric, Orthogonal Quadratic Form, Hermitian, Skew Hermitian, Unitary Matrices.

Unit-3 (14 Lectures)

Sequences and series: Sequences, Limit of a sequence, Convergence, Divergence and Oscillation of a sequence, Infinite series, Necessary condition for Convergence, Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series, Leibnitz's Theorem, Absolute Convergence and Conditional Convergence, Power Series.

Unit-4 (16 Lectures)

Complex Variables and Functions: Complex Variable, Complex Function, Continuity, Differentiability, Analyticity. Cauchy-Riemann (C- R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Function, Trigonometric Functions, Hyperbolic Functions. Line Integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivative of Analytic Functions. Sequences, Series and Power Series, Taylor's Series, Laurent Series, Zeroes and Poles. Residue integration method, Residue integration of real Integrals.

References

1. E. Kreyszig, advanced engineering mathematics, Wiley India (2008)
2. Murray Spiegel, Seymour Lipschutz, John Schiller, Outline of Complex Variables, Schaum Outline Series, Tata McGraw Hill (2007)
3. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007).
4. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
5. 5. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited

Mathematics Foundation for Electronics 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 Perform operations with various forms of complex numbers to solve equations

CO2 Use mathematics as a tool for solving/modeling systems in electronics

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Solution of First Order Differential Equations
2. Solution of Second Order homogeneous Differential Equations
3. Solution of Second Order non-homogeneous Differential Equations
4. To test convergence of a given series.
5. To test divergence of a given series.
6. Solution of linear system of equations using Gauss Elimination method.
7. Solution of linear system of equations using Gauss – Seidel method.
8. Solution of linear system of equations using L-U decomposition 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.

Semiconductor Devices

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

Course Learning Objectives

- To understand the basic crystal structure and different types of semiconductor materials and physics of semiconductor devices
- To be able to plot the current voltage characteristics of Diode, Transistors and MOSFETs
- The student should be able to explain and calculate small signal parameters of semiconductor devices.
- The student should be able to understand the behavior, characteristics and applications of power devices such as SCR, UJT,MESFET, DIAC, TRIAC, IGBT

Course Learning Outcomes

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

CO1 Describe the behavior of semiconductor materials

CO2 Reproduce the I-V characteristics of diode/BJT/MOSFET devices

CO3 Apply standard device models to explain/calculate critical internal parameters of semiconductor devices

CO4 Explain the behavior and characteristics of power devices such as SCR/UJT etc.

Syllabus Contents

Unit 1 (14 Lectures)

Semiconductor Basics: Introduction to Semiconductor Materials, Crystal Structure, Planes and Miller Indices, Energy Band in Solids, Concept of Effective Mass, Density of States, Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Derivation of Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Temperature Dependence of Carrier Concentrations. Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation And Recombination Processes, Continuity Equation.

Unit 2 (14 Lectures)

P-N Junction Diode: Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism. Tunnel diode, varactor diode, solar cell: circuit symbol, characteristics, applications

Unit 3 (14 Lectures)

Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Base Transport Factor, Current Gain, Energy Band Diagram of Transistor in Thermal Equilibrium, Quantitative Analysis of Static Characteristics (Minority Carrier Distribution and Terminal Currents), Base-Width Modulation, Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions: Ohmic and Rectifying Contacts.

Unit 4 (18 Lectures)

Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Complimentary MOS (CMOS).

Power Devices: UJT: Basic construction and working, Equivalent circuit, intrinsic Standoff Ratio, Characteristics and relaxation oscillator-expression.

SCR: Construction, Working and Characteristics, Triac, Diac, IGBT, MESFET, Circuit symbols, Basic constructional features, Operation and Applications.

References

1. S. M. Sze, Semiconductor Devices: Physics and Technology, 2ndEdition, Wiley India edition (2002).
2. Ben G Streetman and S. Banerjee, Solid State Electronic Devices, Pearson Education (2006)
3. Dennis Le Croissette, Transistors, Pearson Education (1989)
4. Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons (2001)
5. Kanaan Kano, Semiconductor Devices, Pearson Education (2004)

Semiconductor Devices 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 Examine the characteristics of basic semiconductor devices.

CO2 Perform experiments for studying the behavior of semiconductor devices for circuit design applications.

CO3 Calculate various device parameters' values from their IV characteristics.

CO4 Interpret the experimental data for better understanding the device behavior.

Syllabus Contents

1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i, r_o, β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o, α.
4. Study of the I-V Characteristics of the Common Collector Configuration of BJT and obtain voltage gain, r_i, r_o.
5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell
10. Study of Hall Effect.

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

The objective of the course is to make the students understand the inadequacies of Classical Physics and know basic postulates of Quantum Mechanics. in order to be able to apply the wave equation. The course also discusses mechanical, thermal, electric and magnetic properties of material relevant in today's scenario.

Course Learning Outcomes

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

CO1 Explain the limitation of classical physics and basic concepts of quantum physics,

CO2 Describe the mechanical, thermal and magnetic properties of materials.

CO3 Understand the various thermal effects life Seebeck and Peltier effect and their usefulness in solving the real life problems

Syllabus Contents

Unit-1 (19 Lectures)

Quantum Physics: Inadequacies of Classical physics. Compton's effect, Photo-electric Effect, Wave-particle duality, de Broglie waves. Basic postulates and formalism of quantum mechanics: probabilistic interpretation of waves, conditions for physical acceptability of wave functions. Schrodinger wave equation for a free particle and in a force field (1 dimension), Boundary and continuity conditions. Operators in Quantum Mechanics, Conservation of probability, Time-dependent form, Linearity and superposition, Operators, Time independent one dimensional Schrodinger wave equation, Stationary states, Eigen-values and Eigen functions.

Particle in a one-dimensional box, Extension to a three dimensional box, Potential barrier problems, phenomenon of tunneling. Kronig Penney Model and development of band structure. Spherically symmetric potentials, the Hydrogen-like atom problem.

Unit-2 (11 Lectures)

Mechanical Properties of Materials: Elastic and Plastic Deformations, Hooke's Law, Elastic Moduli, Brittle and Ductile Materials, Tensile Strength, Theoretical and Critical Shear Stress of Crystals. Strengthening Mechanisms, Hardness, Creep, Fatigue, Fracture.

Unit-3 (15 Lectures)

Thermal Properties: Brief Introduction to Laws of Thermodynamics, Concept of Entropy, Concept of Phonons, Heat Capacity, Debye's Law, Lattice Specific Heat, Electronic Specific Heat, Specific Heat Capacity for Si and GaAs, Thermal Conductivity, Thermoelectricity, Seebeck Effect, Thomson Effect, Peltier Effect.

Unit-4 (15 Lectures)

Electric and Magnetic Properties: Conductivity of metals, Ohm's Law, relaxation time, collision time and mean free path, electron scattering and resistivity of metals, heat developed in current carrying conductor, Superconductivity.

Classification of Magnetic Materials, Origin of Magnetic moment, Origin of dia, para, ferro and antiferromagnetism and their comparison, Ferrimagnetic materials, Saturation Magnetisation and Curie temperature, Magnetic domains, Concepts of Giant Magnetic Resistance (GMR), Magnetic recording.

References

1. S. Vijaya and G. Rangarajan, Material Science, Tata Mcgraw Hill (2003)
2. W. E. Callister, Material Science and Engineering: An Introduction, Wiley India (2006)
3. A. Beiser, Concepts of Modern Physics , McGraw-Hill Book Company (1987)
4. A. Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, Macmillan India (2004)

Applied Physics Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Perfrom lab experiments for studying mechanical, thermal and magnetic parameters of materials

CO2 Calculate and determine mechanical parameters such as young modulus, rigidity etc.

CO3 Collect data and Present it in the form of lab report

Syllabus Contents

1. To determine Young's modulus of a wire by optical lever method.
2. To determine the modulus of rigidity of a wire by Maxwell's needle.
3. To determine the elastic constants of a wire by Searle's method.
4. To measure the resistivity of a Ge crystal with temperature by four –probe method from room temperature to 200 ^{0}C.
5. To determine the value of Boltzmann Constant by studying forward characteristics of diode.
6. To determine the value of Planck's constant by using LEDs of at least 4 different wavelengths.
7. To determine e/m of electron by Bar Magnet or by Magnetic Focusing.
8. To determine the Coefficient of Thermal Conductivity of Cu by Searle‟ s Apparatus
9. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions using a null method. And also calibrate the Thermocouple in a specified temperature range.
10. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube 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.

Electronics Circuits

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

Course Learning Objectives

- Understand diode and it's applications in clipping and clamping circuits, Rectifiers and design regulated power supply using Zener diodes.
- Understand frequency response of BJT and MOSFET amplifiers.
- Understand the concept of feedback and design feedback amplifiers and oscillators.
- Understand different power amplifiers and single tuned amplifiers.

Course Learning Outcomes

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

CO1 Illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.

CO2 Describe the frequency response of MOSFET and BJT amplifiers.

CO3 Explain the concepts of feedback and construct feedback amplifiers and oscillators.

CO4 Summarizes the performance parameters of amplifiers with and without feedback

Syllabus Contents

Unit-1 (14 Lectures)

Diode Circuits: Ideal diode, piecewise linear equivalent circuit, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms. Zener diode regulator circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit- 2 (15 Lectures)

Bipolar Junction Transistor: Review of CE, CB Characteristics and regions of operation. Hybrid parameters. Transistor biasing, DC load line, operating point, thermal runaway, stability and stability factor, Fixed bias without and with RE, collector to base bias, voltage divider bias and emitter bias (+VCC and –VEE bias), circuit diagrams and their working. Transistor as a switch, circuit and working**,** Darlington pair and its applications. BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration, Quantitative study of the frequency response of a CE amplifier, Effect on gain and bandwidth for Cascaded CE amplifiers (RC coupled).

Unit- 3 (13 Lectures)

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

Unit- 4 (18 Lectures)

MOSFET Circuits: Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Small Signal Parameters, Common Source amplifier circuit analysis, CMOS inverter ~~circuits~~.

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers, Class A, Class B, Class C and their comparisons. Operation of a Class A single ended power amplifier. Operation of Transformer coupled Class A power amplifier, overall efficiency. Circuit operation of complementary symmetry Class B push pull power amplifier, crossover distortion, heat sinks.

Single tuned amplifiers: Circuit diagram, Working and Frequency Response for each, Limitations of single tuned amplifier, Applications of tuned amplifiers in communication circuits.

References

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
2. Electronic devices, David A Bell, Reston Publishing Company
3. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
4. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)
5. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
6. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010)
7. J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw

Electronics Circuits 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 Study various stages of a zener diode based regulated power supply.
CO2 Understand various biasing concepts, BJT and FET based amplifiers.
CO3 Understand the concept of various BJT based power amplifiers and Oscillators.
CO4 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Study of the half wave rectifier and Full wave rectifier.
2. Study of power supply using C filter and Zener diode.
3. Designing and testing of 5V/9 V DC regulated power supply and find its load-regulation
4. Study of clipping and clamping circuits.
5. Study of Fixed Bias, Voltage divider and Collector-to-Base bias Feedback configuration for transistors.
6. Designing of a Single Stage CE amplifier.
7. Study of Class A, B and C Power Amplifier.
8. Study of the Colpitt's Oscillator.
9. Study of the Hartley's Oscillator.
10. Study of the Phase Shift Oscillator
11. Study of the frequency response of Common Source FET amplifier.

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 Verilog/VHDL

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

Course Learning Ojectives

- To represent information in various number systems
- To convert data from one number system to another and do various arithmetic operations
- To analyze logic systems and able to implement optimized combinational circuit using Karnaugh Map.
- To analyze and implement sequential circuits using state machines
- Use VLSI design methodologies to understand and design simple digital systems
- Understand the HDL design flow and write programs in VHDL/Verilog

Course Learning Outcomes

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

CO1 Understand and represent numbers in powers of base and converting one from the other, carry out arithmetic operations

CO2 Understand basic logic gates, concepts of Boolean algebra and techniques to reduce/simplify Boolean expressions

CO3 Analyze and design combinational as well as sequential circuits

CO4 Explain the concepts related to PLD's

CO5 Use VLSI design methodologies to understand and design simple digital systems & Understand the HDL design flow and capability of writing programs in VHDL/Verilog

CO6 Familiar with Simulation and Synthesis Tools, Test Benches used in Digital system design

Syllabus Contents

Unit-1 (11 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 of OR, AND, NOT, Basic postulates and fundamental theorems of Boolean algebra, Truth tables, construction and 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 power product, TTL and CMOS families and their comparison.

Unit-2 (13 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 (18 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.

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA

Unit-4 (18 Lectures)

Introduction to Verilog: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools. Verilog Modules, Delays, data flow 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

Data flow Modeling: Data flow Modeling: Continuous assignment, net declaration assignments, delays, net delays.

Gate level modeling - Introduction, built in Primitive Gates, multiple input gates.

OR

Introduction to VHDL: Design flow, Simulation and Synthesis tools, Translation of VHDL code into a circuit. Code Structure: library, entity, architecture, package. Data object, class constant, variable, signal, file. Modes in, out, inout, buffer. Data types, operators. Concurrent code: Difference between concurrent and sequential code, concurrent code using operators, When statement, Select statement.

References

1. M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
5. A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
6. Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

Digital Electronics and Verilog/VHDL 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 Apply VLSI design methodologies to understand and design simple digital systems.

CO2 Familiarize with Simulation and Synthesis Tools, Test Benches used in Digital system design

CO3 Write programs in VHDL/Verilog

CO4 Prepare the technical report on the experiments carried.

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 Verilog/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. Tristate buffer.
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. Arithmetic unit.

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.

C Programming and Data Structures

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

Course Learning Objectives

To understand

- The basic Structure of the C-language, declaration and usage of variables
- operators, conditional, branching, iterative statements and recursion
- arrays, string and functions (modular programming)
- Pointers to access arrays, strings and functions.
- input/output statement and library functions (math and string related
- functions)
- user defined data types -structures
- The concept of Object-oriented programming and its characteristic features.
- The basic data structures and their implementations
- Various searching and sorting techniques.

Course Learning Outcomes

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

CO1 Develop algorithms for arithmetic and logical problems and write programs in C language

CO2 Implement conditional branching, iteration and recursion.

CO3 Use concept of modular programming by writing functions and using them to form a complete program.

CO4 Understand the concept of arrays, pointers and structures and use them to develop algorithms and programs for implementing stacks, queues, link list, searching and sorting.

Syllabus Contents

Unit-1 (12 Lectures)

C Programming Language: Introduction, Importance of C, Character set, Tokens, keywords, identifier, constants, basic data types, variables: declaration & assigning values. Structure of C program, Arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, bit wise operators, expressions and evaluation of expressions, type cast operator, implicit conversions, precedence of operators. Arrays-concepts, declaration, accessing elements, storing elements, two-dimensional and multi-dimensional arrays. Input output statement and library functions (math and string related functions).

Unit-2 (19 Lectures)

Decision making, branching & looping: Decision making, branching and looping: if, if-else, else-if, switch statement, break, for loop, while loop and do loop. Functions: Defining functions, function arguments and passing, returning values from functions.

Structures: defining and declaring a structure variables, accessing structure members, initializing a structure, copying and comparing structure variables, array of structures, arrays within structures, structures within structures, structures and functions. Pointers.

Introduction to C++: Object oriented programming, characteristics of an object-oriented language.

Unit-3 (15 Lectures)

Data Structures: Definition of stack, array implementation of stack, conversion of infix expression to prefix, postfix expressions, evaluation of postfix expression. Definition of Queue, Circular queues, Array implementation of queues. Linked List and its implementation, Link list implementation of stack and queue, Circular and doubly linked list.

Unit-4 (14 Lectures)

Searching and sorting: Insertion sort, selection sort, bubble sort, merge sort, linear Search, binary search.

Trees : Introduction to trees, Binary search tree, Insertion and searching in a BST, preorder, postorder and inorder traversal (recursive)

References

1. Yashavant Kanetkar, Let Us C , BPB Publications
2. Programming in ANSI C, Balagurusamy, 2nd edition, TMH.
3. Byron S Gottfried, Programming with C , Schaum Series
4. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall
5. Yashavant Kanetkar, Pointers in C, BPB Publications
6. S. Sahni and E. Horowitz, “Data Structures”, Galgotia Publications
7. Tanenbaum: “Data Structures using C”, Pearson/PHI.
8. Ellis Horowitz and Sartaz Sahani “Fundamentals of Computer Algorithms”, Computer Science Press.

C Programming and Data Structures Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Develop algorithms and write programs in C language for arithmetic and logical operations.

CO2 Write programs in C language to implement the concept of conditional branching, iteration, recursion, arrays and pointers.

CO3 Write Programs in C language to implement data structures.

CO4 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Generate the Fibonacci series up to the given limit N and also print the number of elements in the series.
2. Find minimum and maximum of N numbers.
3. Find the GCD of two integer numbers.
4. Calculate factorial of a given number.
5. Find all the roots of a quadratic equation Ax2 + Bx + C = 0 for non – zero coefficients A, B and C. Else report error.
6. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.
7. Generate and print prime numbers up to an integer N.
8. Sort given N numbers in ascending order.

9. Find the sum & difference of two matrices of order MxN and PxQ.
10. Find the product of two matrices of order MxN and PxQ.
11. Find the transpose of given MxN matrix.
12. Find the sum of principle and secondary diagonal elements of the given MxN matrix.
13. Calculate the subject wise and student wise totals and store them as a part of the structure.
14. Maintain an account of a customer using classes.
15. Implement linear and circular linked lists using single and double pointers.
16. Create a stack and perform Pop, Push, Traverse operations on the stack using Linear Linked list
17. Create circular linked list having information about a college and perform Insertion at front, Deletion at end.
18. Create a Linear Queue using Linked List and implement different operations such as Insert, Delete, and Display the queue elements.
19. Implement polynomial addition and subtraction using linked lists.
20. Implement sparse matrices using arrays and linked lists.
21. Create a Binary Tree to perform Tree traversals (Preorder, Postorder, Inorder) using the concept of recursion.
22. Implement binary search tree using linked lists. Compare its time complexity over that of linear search.
23. Implement Insertion sort, Merge sort, Bubble sort, Selection sort.

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 develop understanding of Analog Devices starting with ideal Op Amp model and assessing the practical device limitations covering the direct and cascading approach and learning importance of the Data Sheets.
- Design not only linear applications but also design of non-linear application without feedback(voltage comparators), with positive feedback(Schmitt Trigger), and the negative feedback but using non- linear elements such as diodes and switches(sample and hold circuits)
- Study of Signal Generators including also Timers, Multivibrators using IC 555, and V-F conversion with IC 566, and also a Study of various fixed and variable IC Regulators 78XX and 79XX and ICLM317
- Understanding of non-linear circuits such as log/ anti-log amplifiers and also study of Phase Locked Loop(PLL),a topic that covers many important concepts of this paper.

Course Learning Outcomes

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

CO1 Understand basic building blocks of an op-amp and its parameters for various applications design.

CO2 Elucidate and design the linear and non-linear applications of an op-amp.

CO3 Understand the working of multivibrators using IC 555 timer and V-F inter-conversion using special application ICs 565 and 566.

CO4 Study various fixed and variable IC regulators.

Syllabus Contents

Unit-1 (18 Lectures)

Basic Operational Amplifier: Concept of differential amplifiers (Dual 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.

Unit-2 (18 Lectures)

Op-Amp Circuits: Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator,

Differentiator, Voltage to current converter, Current to voltage converter.

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

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

Unit-3 (12 Lectures)

Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators. Phase locked loops (PLL): Block diagram, phase detectors, IC565.

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

Unit-4 (12 Lectures)

Signal Conditioning circuits: Sample and hold systems, Active filters: First order low pass and high pass butterworth filter, Second order filters, Band pass filter, Band reject filter, All pass filter, Log and antilog amplifiers.

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 Application 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 Understand the non-ideal behaviour by parameter measurement of Op-amp.

CO2 Design application oriented circuits using Op-amp ICs.

CO3 Generate square wave using different modes of 555 timer IC.

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 opamp.
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.
7. Designing of a First Order High-pass filter using op-amp.
8. Designing of a RC Phase Shift Oscillator using op-amp.
9. Study of IC 555 as an astable multivibrator.
10. Study of IC 555 as monostable multivibrator.
11. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 series.

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.

Signals & Systems

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

Course Learning Objectives

- Understand mathematical description and representation of continuous and discrete time signals and systems.
- Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
- Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s- domain.

Course Learning Outcomes

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

CO1 Represent various types of continuous-time and discrete-time signals

CO2 Understand concept of convolution, LTI systems and classify them based on their properties and determine the response of LTI system

CO3 Determine the impulse response, step response and frequency response of LTI systems

CO4 Analyze system properties based on impulse response and Fourier analysis.

CO5 Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis

CO6 Understand Laplace transform and its properties and apply the Laplace transform to obtain impulse and step response of simple circuits.

Syllabus Contents

Unit-1 (17 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.

Unit-2 (13 Lectures)

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

Unit-3 (18 Lectures)

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. Frequency-Selective filters, Simple RC highpass and lowpass filters

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

Unit-4 (12 Lectures)

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

References

1. V. Oppenheim, A. S. Wilsky and S. H. Nawab, Signals and Systems, Pearson Education (2007)
2. S. Haykin and B. V. Veen, Signal and Systems, John Wiley & Sons (2004)
3. C. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)
4. H. P. Hsu, Signals and Systems, Tata McGraw Hill (2007)
5. S. T. Karris, Signal and Systems: with MATLAB Computing and Simulink Modelling, Orchard Publications (2008)
6. W. Y. Young, Signals and Systems with MATLAB, Springer (2009)
7. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007)

Signals & Systems Lab
(Scilab/MATLAB/ Other Mathematical Simulation software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Learn the practical implementation issues stemming from the lecture material.

CO2 Learn the use of simulation tools and design skills.

CO3 Learn to work in groups and to develop Scilab/MATLAB/other mathematical simulation software simulations of various signals and systems.

CO4 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Generation of Signals: continuous time
2. Generation of Signals: discrete time
3. Time shifting and time scaling of signals.
4. Convolution of Signals
5. Solution of Difference equations.
6. Fourier series representation of continuous time signals.
7. Fourier transform of continuous time signals.
8. Laplace transform of continuous time signals.
9. Introduction to Xcos/similar function and calculation of output of systems represented by block diagrams

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

The objective of this subject is to provide insight into electronic instruments being used in the industries and labs. It details the basic working and use of different instruments used for measuring various physical quantities. Also, it details the identification, classification, construction, working principle and applications of various transducers used for displacement, temperature, pressure and intensity measurement.

Course Learning Outcomes

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

CO1 Describe the working principle of different measuring instruments.

CO2 Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.

CO3 Correlate the significance of different measuring instruments, recorders and oscilloscopes.

Syllabus Contents

Unit-1 (15 Lectures)

Qualities of Measurement: Specifications of instruments, their static and dynamic characteristics, Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis. Statistical analysis of data and curve fitting.

Basic Measurement Instruments: PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, **o**hm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating types), digital multimeters, digital frequency meter system (different modes and universal counter).

Connectors and Probes: low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.

Unit-2 (15 Lectures)

Measurement of Resistance and Impedance: Low Resistance: Kelvin's double bridge method, Medium Resistance by Voltmeter Ammeter method, Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Maxwell's bridge, Hay's bridge, and Anderson's bridge, Measurement of Capacitance, Schering's bridge, DeSauty's bridge, Measurement of frequency, Wien's bridge.

A-D and D-A Conversion: 4 bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all).

Unit-3 (16 Lectures)

Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronization, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Powerscope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time).

Signal Generators: Audio oscillator, Pulse Generator, Function generators.

Unit-4 (14 Lectures)

Transducers and sensors: Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area Type – Variable Air Gap type – Variable Permittivity type), Inductive (LVDT) and piezoelectric transducers. Measurement of displacement, velocity and acceleration (translational and rotational). Measurement of pressure (manometers, diaphragm, bellows), Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

References

1. H. S. Kalsi, Electronic Instrumentaion, TMH(2006)
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice- Hall (2005).
3. Instrumentation Measurement and analysis: Nakra B C, Chaudry K, TMH
4. E.O.Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
5. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education (2005)
6. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall (2013).
7. Oliver and Cage, “Electronic Measurements and Instrumentation”, TMH (2009).
8. Alan S. Morris, “Measurement and Instrumentation Principles”, Elsevier (Buterworth Heinmann- 2008).
9. A. K Sawhney, Electrical and Electronics Measurements and Instrumentation, DhanpatRai and Sons (2007).
10. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).

Electronic Instrumentation Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Perform experiments on the measuring instruments.

CO2 Perform measurements of various electrical/electronic parameters using appropriate instruments available in the laboratory.

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Design of multi range ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measurement of Capacitance by de’Sautys.
4. Measure of low resistance by Kelvin’s double bridge.
5. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement

of Strain using half and full bridge.)

6. To determine the Characteristics of LVDT.
7. To determine the Characteristics of Thermistors and RTD.
8. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
9. To study the Characteristics of LDR, Photodiode, and Phototransistor:
    (i) Variable Illumination.
    (ii) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor

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.

Microprocessor and Microcontrollers

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

Course Learning Objectives

- To understand basic architecture of 8085 microprocessor
- To understand the instruction set and write programs in assembly language
- To interface 8085 microprocessor with common peripheral devices
- To understand the differences in architecture and applications between Microprocessors and Microcontrollers
- To understand basic architecture , instruction set and simple interfacing of PIC16F887 microcontroller

Course Learning Outcomes

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

CO1 Understand the basic blocks of microcomputers i.e. CPU, Memory, I/O and architecture of microprocessor's and Microcontroller's

CO2 Apply knowledge and demonstrate proficiency of designing hardware interfaces for memory and I/O as well as write assembly language programs for target microprocessor and microcontroller.

CO3 Derive specifications of a system based on the requirements of the application and select the appropriate Microprocessor or Microcontroller

Syllabus Contents

Unit-1 (18 Lectures)

Introduction to Microprocessor: Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used)

Microprocessor 8085: Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.

8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.

Unit-2 (14 Lectures)

Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay.

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts

Comparison of 8085 Microprocessor with 8086 Microprocessor (Internal Architecture, Data Addressing Mode)

Unit-3 (18 Lectures)

Peripheral Devices: 8255-Programmable Peripheral Interface, 8253- Programmable interval Timer, 8259- Priority Interrupt Controller.

Microcontrollers: Introduction, different types of microcontrollers, embedded microcontrollers, processor architectures. Harvard vs. Princeton, CISC vs. RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals.

Unit-4 (14 Lectures)
Introduction to PIC16F887 Microcontroller: Core features, Architecture, pin diagram, memory organization- Program and data memory organization, I/O Ports, addressing modes, instruction set.

Interfacing to PIC16F887: LED, Switches, Solid State Relay, Seven Segment Display, DC Motor,
Interfacing program examples using C language/ Assembly Language.
References

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar – Wiley Eastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram—Danpat Rai Publications.
3. Microchip PIC16F87X datasheet
4. PIC Microcontrollers, Milan Verle, , mikro Elektronika, 1st edition (2008)
5. Muhammad Ali Mazidi, "Microprocessors and Microcontrollers", Pearson, 2006
6. B. Brey, The Intel Microprocessors- Architecture, Programming and Interfacing, Pearson Education (2003)

Microprocessor and Microcontrollers Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Be proficient in use of IDE's for designing, testing and debugging microprocessor and microcontroller based system

CO2 Interface various I/O devices and design and evaluate systems that will provide solutions to real-world problem

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

8085 Assembly language programs:
1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multibyte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16 bit number by 8 bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to find minimum and maximum among N numbers
9. Program to find the square root of an integer.
10. Program to find GCD of two numbers.
11. Program to sort numbers in ascending/descending order.
12. Program to verify the truth table of logic gates.
13. Interfacing using 8255

14. Interfacing using 8253
15. Interfacing using 8259

PIC Microcontroller Programming

Note: Programs to be written using C programming language/ assembly language.

1. Any five programs from 8085 Assembly language programs list Sl. Nos 1-12
2. LED blinking with a delay of 1 second.
3. Solid State Relay Interface/Seven Segment display interfacing.
4. DC motor Interfacing.

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.

Electromagnetics

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

Course Learning Objectives

The syllabus of the paper is very carefully framed with the objective to well verse the students of the programme about

- Basic laws of electromagnetics required for any student who wants to pursue his career in research
- To understand the concept and working of electric devices, including hard disk drives, speakers, motors, and generators and many other devices.
- To develop medical instruments like MRI etc. which require a thorough knowledge of Electromagnetics
- This paper is the backbone in the development of new integrated devices.

Course Learning Outcomes

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

CO1 Getting familiar with vector algebra, coordinate system and coordinate conversion
CO2 Plotting of fields (Electrostatic and Magnetostatics) and solution of Laplace's equation.
CO3 Physical interpretation of Maxwell's equation and problem solving in different media.
CO4 Understanding of propagation of an electromagnetic wave.

Syllabus Contents

Unit-1 (16 Lectures)

Vector Analysis: Scalars and Vectors, Vector Algebra, Rectangular (Cartesian) Coordinate System, Vector Components and Unit Vector, Vector Field, Products, Cylindrical Coordinates, Spherical Coordinates, Differential Length, Area and Volume, Line Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector, the Laplacian.

Electrostatic Fields: Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation. Electric Potential, Potential due to a Charge and Charge distribution, Electric dipole. Electric Fields in Conductors, Current and Current Density, Continuity of Current, Metallic Conductor Properties and Boundary Conditions, Method of Images. Dielectric materials, Polarization, Dielectric Constant, Isotropic and Anisotropic dielectrics, Boundary conditions, Capacitance and Capacitors. Electrostatic Energy and Forces.

Unit-2 (14 Lectures)

Poisson's Equation and Laplace's Equation: Derivation of Poisson's and Laplace's equation, Uniqueness Theorem, Examples of Solution of Laplace's Equation: Cartesian, Cylindrical and Spherical Coordinates.

Magnetostatics: Biot Savert's law and Applications, Magnetic dipole, Ampere's Circuital Law, Curl and Stoke's Theorem, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Scalar and Vector Magnetic Potentials. Magnetization in Materials and Permeability, Anisotropic materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits. Inductances and Inductors, Magnetic Energy, Forces and Torques.

Unit-3 (13 Lectures)

Time-Varying Fields and Maxwell's Equations: Faraday's Law of Electromagnetic Induction, Stationary Circuit in Time-Varying Magnetic Field, Transformer and Motional EMF, Displacement Current, Maxwell's Equations in differential and integral form and Constitutive Relations. Potential Functions, Lorentz gauge and the Wave Equation for Potentials, Concept of Retarded Potentials. Electromagnetic Boundary Conditions. Time-Harmonic Electromagnetic Fields and use of Phasors

Unit-4 (17 Lectures)

Electromagnetic Wave Propagation: Time-Harmonic Electromagnetic Fields and use of Phasors, the Electromagnetic Spectrum, Wave Equation in a source free isotropic homogeneous media, Uniform Plane Waves in Lossless and Lossy unbounded homogeneous media, Wave Polarization, Phase and Group velocity, Flow of Electromagnetic Power and Poynting Vector. Uniform Plane wave incident on a Plane conductor boundary, concept of reflection and standing wave.

Guided Electromagnetic Wave Propagation: Waves along Uniform Guiding Structures, TEM, TE and TM waves, Electromagnetic Wave Propagation in Parallel Plate and Rectangular Metallic Waveguides.

References

1. Murray. R. Spiegel, Vector Analysis, Schaum series, Tata McGraw Hill (2006)
2. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
3. W. H. Hayt and J. A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
4. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
5. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
6. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
7. Introduction to Electrodynamics, D.J. Griffiths, Pearson Education (2012)
8. Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)

Electromagnetics Lab
(using Scilab/MATLAB/ any other similar freeware)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Design capacitors & inductors and analyze their characteristics. Also, they become efficient in solving simple boundary value problems, using Poisson's equation.

CO2 Interpret a Smith chart and also become familiar with describing & recognizing fundamental properties of waveguide modes.

CO3 Calculate the cutoff frequency and propagation constant for parallel plate, rectangular, and dielectric slab waveguides. Also, they can calculate the resonant frequency of simple cavity resonators.

CO4 Analyze problems involving TEM-waves.

Syllabus Contents

1. Understanding and Plotting Vectors.
2. Transformation of vectors into various coordinate systems.
3. 2D and 3D Graphical plotting with change of view and rotation.
4. Representation of the Gradient of a scalar field, Divergence and Curl of Vector Fields.
5. Plots of Electric field and Electric Potential due to charge distributions.
6. Plots of Magnetic Flux Density due to current carrying wire.
7. Programs and Contour Plots to illustrate Method of Images
8. Solutions of Poisson and Laplace Equations – contour plots of charge and potential distributions
9. Introduction to Computational Electromagnetics: Simple Boundary Value Problems by Finite Difference/Finite Element Methods.

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 Electronics

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

Course Learning Objectives

- To introduce basic concepts of various modulation techniques used in communication systems and analyze their comparative performance.
- To understand the effect of noise on communication receivers.

Course Learning Outcomes

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

CO1 Understand the basic concept of a communication system and need for modulation

CO2 Evaluate modulated signals in time and frequency domain for various continuous modulation techniques

CO3 Describe working of transmitters and receivers and effect of noise on a communication system

CO4 Understand baseband Pulse Modulation

Syllabus Contents

Unit-1 (20 Lectures)

Introduction: Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals.

Amplitude modulation: Basics of Amplitude Modulation, generation of AM (balanced modulator, collector modulator), Amplitude Demodulation (diode detector), Double side band suppressed carrier, DSBSC generation (balanced modulator), Single side band suppressed carrier, SSBSC generation (filter method, phase cancellation method, Weaver's method), Introduction to other forms of AM (Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation).

Unit-2 (14 Lectures)

Angle modulation: Frequency and Phase modulation, modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM (direct and indirect methods), FM detector (PLL). Comparison between AM, FM and PM.

Unit -3 (10 Lectures)

Transmitters: Low-level and high-level modulation, AM transmitter, FM transmitter.
Receivers: Receiver parameters: sensitivity, selectivity and fidelity, AM receiver, FM receiver.
Concept of Noise: External noise, internal noise, signal to noise ratio, noise factor, noise temperature, Friis formula

Unit -4 (16 Lectures)

Pulse Analog Modulation: Sampling theorem, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM). Generation and detection of PAM, PWM, PPM signals.
Pulse Code Modulation: Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization, Quantization Noise, Companding, Coding, Digital Formats. Decoding,

Regeneration, Transmission noise and Bit Error Rate. Differential Pulse Code Modulation, Delta Modulation, Quantization noise, Adaptive Delta Modulation.

References

1. Electronic communication systems- Kennedy, 3rd edition, McGraw international publications
2. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
3. Communication Systems, S. Haykin, Wiley India (2006)
4. Advanced electronic communications systems – Tomasi, 6th edition, PHI.
5. Communication Systems: Analog and Digital-R. P. Singh and S. D. Sapre, Tata McGraw Hill (2007)
6. Principles of Communication Systems-H. Taub and D. Schiiling, Tata McGraw Hill(2008)

Communication Electronics 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 Understand basic elements of a communication system.
CO2 Analyze the baseband signals in time domain and in frequency domain.
CO3 Build understanding of various analog and digital modulation and demodulation techniques.
CO4 Prepare the technical report on the experiments carried.

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
10. Study of Delta Modulation
11. Study of Adaptive Delta 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.

Photonics

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

Course Learning Objectives

- To understand light as an electromagnetic wave and various phenomenon like interference, diffraction and polarization.
- Interaction between a photon and electron and its relevance to laser and various other optoelectronic devices.
- Understand the propagation of wave in optical fibre.

Course Learning Outcomes

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

CO1 Describe the optics and simple optical systems.

CO2 Understand the concept of light as a wave and the relevance of this to optical effects such as interference and diffraction and hence to lasers and optical fibers.

CO3 Use mathematical methods to predict optical effects with e.g. light-matter interaction, interference, fiber optics, geometrical optics

Syllabus Contents

Unit-1 (22 Lectures)

Light as an Electromagnetic Wave: Plane waves in homogeneous media, concept of spherical waves. Reflection and transmission at an interface, total internal reflection, Brewster's Law. Interaction of electromagnetic waves with dielectrics: origin of refractive index, dispersion.

Interference : Superposition of waves of same frequency, Concept of coherence, Interference by division of wavefront, Young's double slit, Division of Amplitude, thin film interference, anti-reflecting films, Newton's rings; Michelson interferometer. Holography.

Diffraction: Huygen Fresnel Principle, Diffraction Integral, Fresnel and Fraunhoffer approximations. Fraunhoffer Diffraction by a single slit, rectangular aperture, double slit, Resolving power of microscopes and telescopes; Diffraction grating: Resolving power and Dispersive power

Unit-2 (13 Lectures)

Polarization: Linear, circular and elliptical polarization, polarizer-analyzer and Malus' law; Double refraction by crystals, Interference of polarized light, Wave propagation in uniaxial media. Half wave and quarter wave plates. Faraday rotation and electro-optic effect.

Unit-3 (13 Lectures)

Light Emitting Diodes: Construction, materials and operation.

Lasers: Interaction of radiation and matter, Einstein coefficients, Condition for amplification, laser cavity, threshold for laser oscillation, line shape function. Examples of common lasers.
The semiconductor injection laser diode.

Photodetectors: Bolometer, Photomultiplier tube, Charge Coupled Device. Photo transistors and Photodiodes (p-i-n, avalanche), quantum efficiency and responsivity.

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.

Unit-4 (12 Lectures)

Guided Waves and the Optical Fiber: TE and TM modes in symmetric slab waveguides, effective index, field distributions, Dispersion relation and Group Velocity. Step index optical fiber, total internal reflection, concept of linearly polarized waves in the step index circular dielectric waveguides, single mode and multimode fibers, attenuation and dispersion in optical fiber.

References

1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)
2. E. Hecht, Optics, Pearson Education Ltd. (2002)
3. J. Wilson and J. F. B. Hawkes, Optoelectronics: An Introduction, Prentice Hall India (1996)
4. S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Pearson Education (2009)
5. Ghatak A.K. and Thyagarajan K., "Introduction to fiber optics," Cambridge Univ. Press. (1998)

Photonics Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Perform experiments based on the phenomenon of light/photons.

CO2 Measure the parameters such as wavelength, resolving power, numerical aperture etc. using the appropriate photonic/optical technique.

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. To verify the law of Malus for plane polarized light.
2. To determine wavelength of sodium light using Michelson's Interferometer.
3. To determine wavelength of sodium light using Newton's Rings.
4. To determine the resolving power and Dispersive power of Diffraction Grating.
5. Diffraction experiments using a laser.
6. Study of Faraday rotation.
7. Study of Electro-optic Effect.
8. To determine the specific rotation of scan sugar using polarimeter.
9. To determine characteristics of LEDs and Photo- detector.
10. To measure the numerical aperture of an optical fiber.

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

Power Electronics

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

Course Learning Objectives

The course deals with use of electronics for control and conversion of electrical power. The concept of high power devices, their construction and their applications is discussed. The concept of converters and inverters is important to evolve their applications for Dc to Ac and Ac to Ac conversion. Its importance carries good relevance with regard to the high demand of battery operated vehicles. Electric motors are discussed in detail.

Course Learning Outcomes

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

CO1 Explain the basic principles of switch mode power conversion, models of different types of power electronic converters including dc-dc converters, PWM rectifiers and inverters

CO2 Choose appropriate power converter topologies and design the power stage and feedback controllers for various applications They use power electronic simulation packages for analyzing and designing power converters

CO3 Describe the operation of electric machines, such as motors and their electronic controls.

CO4 Analyze the performance of electric machine

Syllabus Contents

Unit-1 (12 Lectures)

Power Devices: Need for semiconductor power devices, Power diodes, Enhancement of reverse blocking capacity, Introduction to family of thyristors.

Silicon Controlled Rectifier (SCR): structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Factors affecting the characteristics/ratings of SCR, Gate-triggering circuits, Control circuits design and Protection circuits, Snubber circuit.

Unit-2 (14 Lectures)

Diac and Triac: Basic structure, working and I-V characteristic of, application of a Diac as a triggering device for a Triac.

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA) etc.

Application of SCR: SCR as a static switch, phase controlled rectification, single phase half wave, full wave and bridge rectifiers with inductive & non-inductive loads; AC voltage control using SCR and Triac as a switch.

Power MOSFETs: operation modes, switching characteristics, power BJT, second breakdown, saturation and quasi-saturation state.

Unit-3 (17 Lectures)

Power Inverters: Need for commutating circuits and their various types, d.c. link invertors, Parallel capacitor commutated invertors with and without reactive feedback and its analysis, Series Invertor, limitations and its improved versions, bridge invertors.

Choppers: basic chopper circuit, types of choppers (Type A-D), step-down chopper, step-up chopper, operation of d.c. chopper circuits using self commutation (A & B-type commutating circuit), cathode pulse turn-off chopper(using class D commutation), load sensitive cathode pulse turn-off chopper (Jones Chopper), Morgan's chopper

Unit-4 (17 Lectures)

Electromechanical Machines: DC Motors, Basic understanding of field and armature, Principle of operation, EMF equation, Back EMF, Factors controlling motor speed, Thyristor based speed control of dc motors, AC motor (Induction Motor only), Rotor and stator, torque & speed of induction motor, Thyristor control of ac motors(block diagrams only)

References

1. Power Electronics, P.C. Sen, TMH
2. Power Electronics & Controls, S.K. Dutta
3. Power Electronics, M.D. Singh & K.B. Khanchandani, TMH
4. Power Electronics Circuits, Devices and Applications, 3rd Edition, M.H. Rashid, Pearson Education

Power Electronics Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Reproduce the characteristics of power semicondcutor devices like SCR, DIAC, TRIAC etc.

CO2 Calculate the various device parameters from their characteristics.

CO3 Design power control circuits using semicondcutor power devices.

CO4 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Study of I-V characteristics of DIAC
2. Study of I-V characteristics of a TRIAC
3. Study of I-V characteristics of a SCR
4. SCR as a half wave and full wave rectifiers with R and RL loads
5. DC motor control using SCR.
6. DC motor control using TRIAC.
7. AC voltage controller using TRIAC with UJT triggering.
8. Study of parallel and bridge inverter.
9. Design of snubber circuit
10. I-V Characteristic of MOSFET and IGBT (Both)
11. Study of chopper circuits

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.

Numerical Analysis

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

Course Learning Objectives

- To apply mathematical techniques for real world and engineering problems.
- To fit data to appropriate curves and identify the best fit for the stated problem.
- Solve problems via numerical approach and optimization.

Course Learning Outcomes

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

CO1 Understand the common numerical methods and how they are used to obtain approximate solutions to mathematical problems.

CO2 Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

CO3 Analyze and evaluate the accuracy of common numerical methods.

Syllabus Contents

Unit-1 (16 Lectures)

Numerical Methods: Floating point, Round-off error, Error propagation, Stability, Programming errors.

Solution of Transcendental and Polynomial Equations f(x)=0: Bisection method, Secant and Regula Falsi Methods, Newton Raphson method, Rate of convergence, General Iteration Methods, Newton's Method for Systems, Method for Complex Roots, Roots of Polynomial Equations.

Unit-2 (14 Lectures)

Interpolation and Polynomial Approximations: Taylor Series and Calculation of Functions, Langrange Interpolation, Newton Divided Difference Interpolation (forward and backward difference formulae), Truncation errors.

Curve Fitting: Least square fitting, Curve fitting, Interpolation by Spline functions.

Unit-3 (16 Lectures)

Numerical Integration: Trapezoidal Rule, Error bounds and estimate for the Trapezoidal rule, Simpson's Rule, Error of Simpson's rule.

Numerical Differentiation: Finite difference method and applications to electrostatic boundary value problems.

Numerical methods for first order differential equations: Euler-Cauchy Method, Heun's Method, Classical Runge Kutta method of fourth order. Methods for system and higher order equations.

Unit-4 (14 Lectures)

Numerical Methods in Linear Algebra: Linear systems Ax=B, Gauss Elimination, Partial Pivoting, LU factorization, Doolittle's, Crout's and Cholesky's method. Matrix Inversion, Gauss-Jordon, Iterative Methods: Gauss-Seidel Iteration, Jacobian Iteration.

Matrix Eigenvalue: Power Method.

References

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (1999).
2. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall India, Third Edition.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall India (2008).
4. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods: Problems and Solutions, New Age International (2007).
5. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C and C++, Khanna Publishers (2012).

Numerical Analysis Lab
(C language**/** Scilab/MATLAB/Other Mathematical Simulation software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Implement numerical methods in C language**/** Scilab/MATLAB/Other Mathematical Simulation software.

CO2 Write efficient, well-documented code in the above mathematical simulation softwares and present numerical results in an informative way.

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Program to implement Bisection Method
2. Program to implement Secant Method
3. Program to implement Regula falsi method
4. Program to implement Newton Raphson Method
5. Program to implement Trapezoidal rule
6. Program to implement Simpson's rule
7. Program to implement Runge Kutta Method
8. Program to implement Euler-Cauchy Method
9. Program to implement Gauss-Jordon Method
10. Program to implement Gauss-Seidel Iteration
11. Program to implement Newton's Forward Interpolation
12. Program to obtain a second degree polynomial from a given data set.

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 Signal Processing

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

Course Learning Objectives

The course objective is to introduce the techniques of modern digital signal processing that are fundamental to a wide variety of application areas. Special emphasis is placed on the basic concepts related to discrete time signals and systems, analysis of signals in time as well as frequency domain using Fourier and Z transform, and design and architecture techniques for digital filters.

Course Learning Outcomes

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

CO1 Understand the basic concepts related to discrete time signals, systems, Z transform and Fourier transform

CO2 Apply knowledge and demonstrate proficiency of analyzing signals in time as well as frequency domain using Fourier and Z transforms

CO3 Design and analyze IIR/FIR filters with given specifications

CO4 Apply transform methods for representing signals and systems in time and frequency domain

Syllabus Contents

Unit-1 (15 Lectures)

Discrete Time systems: Discrete sequences, linear coefficient difference equation, Representation of DTS, LSI Systems. Stability and causality, frequency domain representations and Fourier transform of DT sequences.

Unit-2 (15 Lectures)

Z-Transform: Definition and properties, Inverse Z Transform and stability. Parsevals Theorem and applications.

System Function: signal flow graph, its use in representation and analysis of Discrete Time Systems. Techniques of representations. Matrix generation and solution for DTS evaluations.

Unit-3 (15 Lectures)

Discrete Fourier Transform: DFT assumptions and Inverse DFT. Matrix relations, relationship with FT and its inverse, circular convolution, DFT theorems, DCT. Computation of DFT. FFT Algorithms and processing gain, Discrimination, interpolation and extrapolation. Gibbs phenomena. FFT of real functions interleaving and resolution improvement. Word length effects.

Unit-4 (15 Lectures)

Digital Filters: Analog filter review. System function for IIR and FIR filters, network representation. Canonical and decomposition networks. IIR filter realization methods and their limitations. FIR filter realization techniques. Discrete correlation and convolution; Properties and limitations.

References
1. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
2. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.

Digital Signal Processing Lab
(Scilab/MATLAB/Other Mathematical Simulation software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Draw signal flowgraphs of discrete time systems and analyze and derive properties of LTI systems

CO2 Apply transform methods for representing signals and systems in time and frequency domain

CO3 Simulate, synthesize and process signals using software tools

CO4 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Generation of unit sample sequence, unit step, ramp function, discrete time sequence, real sinusoidal sequence.
2. Generate and plot sequences over an interval.
3. Given x[n], write program to find X[z].
4. Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform
5. Design of a Butterworth analog filter for low pass and high pass.
6. Design of digital filters.

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.

Basic VLSI Design

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

Course Learning Objectives

The paper discusses basic principle of MOS Transistor operation, SPICE model, MOS transistor and Inverter layout, CMOS layout. Inverter design, CMOS inverter, inverter characteristics and specifications. Static and Sequential MOS Logic design, pass transistor logic, static & dynamic latches, flip flops, static & dynamic registers, CMOS Schmitt trigger, Monostable & Astable circuits. MOS memory design, RAM & ROM cells, Logic families performance, clock interconnections and distribution performance parameters.

Course Learning Outcomes

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

CO1 Understand the concept of models of MOS devices and their implementation in designing of CMOS inverter.

CO2 Measure the performance parameters like threshold voltage, noise margins, time delays etc.

CO3 Familiarize with the techniques and components involved in combinational MOS circuit designs

CO4 Describe the various types of semiconductor memories and issues involved in them

Syllabus Contents

Unit-1 (15 Lectures)

Metal Oxide Semiconductor (MOS): Introduction to basic principle of MOS transistor, large signal MOS models (long channel) for digital design. MOS SPICE model, MOS device layout: Transistor layout, Inverter layout, CMOS digital circuit layout.

Unit-2 (15 Lectures)

MOS Inverter: Inverter principle, Depletion and enhancement load inverters, the basic CMOS inverter, transfer characteristics, logic threshold, Noise margins, Dynamic behavior, Propagation Delay and Power Consumption.

Unit -3 (15 Lectures)

Combinational MOS Logic Design: Static MOS design, Pass Transistor logic, complex logic circuits. Sequential MOS Logic Design - Static latches, Flip flops & Registers, Dynamic Latches & Registers, CMOS Schmitt trigger, Monostable sequential Circuits, Astable Circuits.

Unit -4 (15 Lectures)

Memory Design: ROM & RAM cells design. Dynamic MOS design- Dynamic logic families and performances. Interconnect & Clock Distribution- Interconnect delays, Cross Talks, Clock Distribution.

References

1. Kang & Leblebigi "CMOS Digital IC Circuit Analysis & Design"- McGraw Hill, 2003.
2. Rabey, "Digital Integrated Circuits Design", Pearson Education, Second Edition, 2003.
3. Weste and Eshraghian, "Principles of CMOS VLSI design" Addison-Wesley, 2002.
4. Basic VLSI design: Douglas A Pucknell, Kamran Eshraghian, PHI, 3rd edition

Basic VLSI Design Lab

(PSpice/Similar Simulation software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Reproduce the characteristics of digital circuits like inverter and other logic gates based on CMOS technology

CO2 Design the digital circuit components like latches, multiplexers etc.

CO3 Perform experiments and the circuit design and collect and analyze the data

CO4 Write a technical report on the experiment performed.

Syllabus Contents

1. To plot the (i) output characteristics & (ii) transfer characteristics of an n-channel and p-channel MOSFET.
2. To design and plot the static (VTC) and dynamic characteristics of a digital CMOS inverter.
3. To design and plot the output characteristics of a 3-inverter ring oscillator.
4. To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
5. To design and plot the characteristics of a 4x1 digital multiplexer using pass-transistor logic.
6. To design and plot the characteristics of a positive and negative latch based on multiplexers.
7. To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers.

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.

Computer Networks

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

Course Learning Objectives

The objective of the paper is to provide students with a theoretical overview of the concepts and fundamentals of data communication and computer networks, various techniques in layered network architecture and models, network topologies, network configuration, management and protocols.

Course Learning Outcomes

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

CO1 Understand the fundamentals of computer networks and issues involved.

CO2 Understand the set of rules and procedures that mediates the exchange of information between communicating devices.

Syllabus Contents

Unit- I (15 Lectures)

Data Communications : Components, protocols and standards, Network and Protocol Architecture, Reference Model ISO-OSI, TCP/IP-Overview, topology, transmission mode, digital signals, digital to digital encoding, digital data transmission, DTE-DCE interface, interface standards, modems, cable modem, transmission media- guided and unguided, transmission impairment, Performance, wavelength and Shannon capacity. Review of Error Detection and Correction codes.

Switching: Circuit switching (space-division, time division and space-time division), packet switching (virtual circuit and Datagram approach), message switching.

Unit-2 (15 Lectures)

Data Link Layer: Design issues, Data Link Control and Protocols: Flow and Error Control, Stop-and-wait ARQ. Sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to –Point Access: PPP Point –to- Point Protocol, PPP Stack

Medium Access Sub layer: Channel allocation problem, Controlled Access, Channelization, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

Unit-3 (15 Lectures)

Network Layer: Design issues, Routing algorithms, Congestion control algorithms, Host to Host Delivery: Internetworking, addressing and routing, IP addressing (class full & Classless), Subnet, Network Layer Protocols: ARP, IPV4, ICMP, IPV6, ICMPV6.

Unit-4 (15 Lectures)

Transport Layer: Process to Process Delivery: UDP; TCP, congestion control and Quality of service.

Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP), file transfer (FTP), HTTP and WWW.

References

1. S. Tannenbum, D. Wetherall, “Computer Networks”, Prentice Hall, Pearson, 5Th Ed
2. Behrouz A. Forouzan, “Data Communications and Networking”, Tata McGraw-Hill, 4th Ed

Computer Networks Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Understand the fundamentals of computer networks and issues involved.

CO2 Use the set of rules and procedures that mediates the exchange of information between communicating devices.

CO3 Write programming using open source tools

CO4 Prepare lab report on the experiments performed

Syllabus Contents

1. Introduction to Computer Network laboratory Introduction to Discrete Event Simulation Discrete Event Simulation Tools - ns2/ns3, Omnet++
2. Using Free Open Source Software tools for network simulation of telnet and ftp between N sources - N sinks (N = 1, 2, 3). Evaluate the effect of increasing data rate on congestion.
3. Using Free Open Source Software tools for network simulation to study the effect of queuing disciplines on network performance - Random Early Detection/Weighted RED / Adaptive RED.
4. Using Free Open Source Software tools for network simulation for http, ftp and DBMS access in networks
5. Using Free Open Source Software tools for network simulation to study effect of VLAN on network performance - multiple VLANs and single router.
6. Using Free Open Source Software tools for network simulation to study effect of VLAN on network performance - multiple VLANs with separate multiple routers.
7. Using Free Open Source Software tools for network simulation to study the performance of wireless networks

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.

Semiconductor Fabrication and Characterization

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

Course Learning Objectives

- The course gives a first-hand account of how the Semiconducting Devices are fabricated
- It deals with various fabrication processes that go into the making of a single device in detail
- Various optical, electrical and structural characterization techniques are discussed in detail.
- It gives an overall insight into the process requirements for the device made, their integration and control at the micro / nano level.

Course Learning Outcomes

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

CO1 Summarize the developments in the field of microelectronics technologies

CO2 Explain the semiconductor material characterization techniques like SEM, TEM, UV-Vis.

CO3 Describe the lithography, etching and various film deposition processes.

CO4 Explain the process sequence for BJT, CMOS and BiCMOS fabrication Processes.

Syllabus Contents

Unit-1 (19 Lectures)

Introduction of Semiconductor Process Technology (Line width – 10 nm technology), Semiconductor materials, single crystal, polycrystalline and amorphous, Crystal growth techniques: Si from the Czochralski technique, starting material, Distribution of dopants, Effective Segregation Coefficient. Silicon Float Zone Process, GaAs from Brigdman techniques. Wafer preparation.

Epitaxy Deposition: Epitaxial growth by vapor phase epitaxy (VPE) and molecular beam epitaxy (MBE).

Characterization: Various characterization methods for structural, electrical and optical properties. Basic idea of X-ray diffractometer, Scanning electron microscope, Transmission electron microscope and UV-VIS-NIR spectrophotometer.

Unit-2 (15 Lectures)

Oxidation: Thermal Oxidation Process: Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities, Impurity Redistribution during Oxidation, Masking property of Silicon Oxide, Oxide Quality, Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow.

Diffusion: Basic Diffusion Process: Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation and its comparison with diffusion.

Unit-3 (15 Lectures)

Lithographic Processes: Clean room, Optical lithography, exposure tools, masks, Photoresist, Pattern Transfer, Resolution Enhancement Technique. Electron Beam Lithography, X-ray Lithography and Ion Beam Lithography. Comparison between various lithographic techniques.

Etching: Wet Chemical Etching-basic process and few examples of etchants for semiconductors, insulators and conductors; Dry etching using plasma etching technique.; **Metallization:** Uses of Physical Vapor Deposition and Chemical Vapor Deposition technique for Aluminum and Copper Metallization.

Unit-4 (11 Lectures)

Process Integration: Passive components- Integrated Circuit Resistor, Integrated Circuit Inductor, Integrated Circuit Capacitor. Bipolar Technology: Basic fabrication process, Isolation techniques. MOSFET Technology: Basic fabrication process of NMOS, PMOS and CMOS technology.

References

1. Gary S.May and S.M.Sze , Fundamentals of Semiconductor Fabrication, John Wiley& Sons(2004)
2. Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press (1986).

Semiconductor Fabrication and Characterization Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Operate the advanced computer simulations tools as well as visit research laboratories for better understanding of semiconductor fabrications processes.

CO2 Perform the simulation of semiconductor device fabrication processes like oxidation and diffusion.

CO3 Perform experiments to calculate the electronic parameters like resistivity, mobility, carrier concentration and band gap etc in semiconductors.

CO4 Operate the deposition system for fabrications of thin films.

Syllabus Contents

1. To measure the resistivity of semiconductor crystal with temperature by four –probe method.
2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. Oxidation process Simulation
4. Diffusion Process Simulation
5. To design a pattern using photolithographic process and its simulation
6. Process integration simulation
7. Fabrication of thin film using Spin Coating/Thermal Coating System.
8. Determination of Optical Bandgap through transmission spectra.
9. Visit to Research Lab/institutions to see the live demonstrations of the processes.

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

- The students get familiarize with various types of Biomedical Signals and their physiological aspects.
- The students analyze the various types of Biomedical instruments and their working and practical implementation in medical.
- Learn about Modern Imaging systems like CT scan and MRI techniques and various other cardiac instruments.
- Use of Microprocessor in medical Instruments and microcontrollers in critical care units.
- Learn about the emerging fields like MEMS Biosensors , EEG , ECG , EMG etc.
- Students will learn about the science of Biomedical and connect it with real life problems.

Course Learning Outcomes

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

CO1 Understand the basic knowledge of physiology.
CO2 Explore the occurrence of potential and operation of cardiovascular measurements.
CO3 Understand the basic knowledge on respiratory and pulmonary measurements.
CO4 Describe the methods used for monitoring the patients.

Syllabus Contents

Unit-1 (17 Lectures)

Biomedical signals & Physiological transducers: Source of biomedical signal, Origin of bioelectric signals, recording electrodes, Electrodes for ECG, EMG & EEG .Physiological transducers: Pressure, Temperature, photoelectric & ultrasound Transducers. Measurement in Respiratory system**:** Physiology of respiratory system, Measurement of breathing mechanics Spiro meter, Respiratory therapy equipments Inhalators ventilators & Respirators, Humidifiers, Nebulizers Aspirators, Biomedical recorders: ECG, EEG & EMG. MEMS based biosensors

Unit -2 (16 Lectures)

Patient Monitoring systems & Audiometers: Cardiac monitor, Bedside patient monitor, measurement of heart rate, blood pressure, temperature, respiration rate, Arrhythmia monitor, Methods of monitoring fatal heart rate, Monitoring labor activity. Audiometers: Audiometers, Blood cell counters, Oximeter, Blood flow meter, cardiac output measurement, Blood gas analyzers.

Unit-3 (16 Lectures)

Modern Imaging systems: Introduction, Basic principle & Block diagram of x-ray machine, x-ray Computed Tomography (CT), Magnetic resonance imaging system (NMR), ultrasonic imaging system. Eco-Cardiograph, Eco Encephalography, Ophthalmic scans, MRI. Therapeutic Equipments: Cardiac pacemakers, cardiac defibrillators, Hemodialysis machine, surgical diathermy machine.

Unit -4 (11 Lectures)

Patients safety & Computer Applications in Biomedical field: Precaution, safety codes for

electro medical equipment, Electric safety analyzer, Testing of biomedical equipment, Use of microprocessors in medical instruments, Microcontrollers, PC based medical instruments, Computerized Critical care units, Planning & designing a computerized critical care unit.
Physiotherapy: Software Diathermy, microwave diathermy, Ultrasound therapy unit. Electrotherapy Equipments, Ventilators.

References

1. Joseph J. Carr & John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson.
2. Shakti Chatterjee, "Textbook of Biomedical Instrumentation System", Cengage Learning
3. Khandpur R. S. - Handbook of Biomedical Instrumentation, TMH
4. Bertil Jacobson & John G. Webster - Medicine and Clinical Engineering, PHI
5. Prof. S.K.VenkataRam-Bio-Medical Electronics and Instrumentation, Galgotia Publications

Biomedical Instrumentation Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Familiarize with functioning of biomedical instrumentation
CO2 Perform experiments on the biomedical instruments and collect & analyze the data
CO3 Prepare the technical report on the experiments carried

Syllabus Contents

1. Characterization of bio potential amplifier for ECG signals.
2. Study on ECG simulator
3. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
4. Study of pulse rate monitor with alarm system
5. Determination pulmonary function using spirometer (using mechanical system).
6. Measurement of respiration rate using thermister/other electrodes.
7. Study of Respiration Rate monitor/ apnea monitor
8. Study on ultrasound transducers based on medical system
9. Study of a Pacemaker.
10. 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.

Electrical Machines

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

Course Learning Objectives

The paper deals with High Voltage Electrical and Electronic systems. Its deals with working, construction and principle of DC and AC machines. The paper covers the concept of control of speed, generation of Torque, various losses, efficiency etc. of the electromechanical machines such as motors and generators in the real world. The understanding of mathematical relations between the various parameters gives in depth knowledge of dependence of characteristics of these machines to optimize the output response under a given condition.

Course Learning Outcomes

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

CO1 Familiarize with the basics of DC Machines, Generators and Motors

CO2 Explain the concept of polyphase circuits and their applications in polyphase induction motors.

CO3 Describe the synchronous motors and their comparison with induction motors

Syllabus Contents

Unit-1 (20 Lectures)

DC Machines: Basic constructional features and physical principles involved in electrical machines, armature winding (ac and dc), lap and wave connections, different types of pitches

D.C. Generators: Construction and principles of operation, brief idea about armature reaction and commutation, E.M.F. Equation, Methods of excitation, and Characteristics of Self excited and separately (Shunt, Compound and Series) excited generators, Losses and efficiency, applications.

D.C. Motors: Comparison of generator and motor action & interchangeability, principle of operation, significance of back EMF, maximum power, Torque and speed relation, Characteristics of series, shunt and Compound excited motors & applications, losses & efficiency, necessity of motor starters, Three point starter, Speed control of DC motors, electronic speed control of DC motors, electric braking

Unit-2 (12 Lectures)

Transformers: Types of transformers, Transformer Construction, EMF equation, No load operation, operation under load, Phasor diagram, equivalent circuit of transformer, Transformer Losses, Voltage regulation, condition for maximum efficiency, All day efficiency, Short circuit and open circuit tests, Auto transformers.

Polyphase Circuits: Polyphase circuits, three phase transformers, delta-delta and delta –Y connection

Unit-3 (16 Lectures)

Poly Phase Induction Motors: General constructional features, Types of rotors, Rotating magnetic field (Ferrari's Principle), Induction motor as a generalized transformer, equivalent circuit, Production of torque, Slip, Torque equation, Torque-slip characteristics, Speed control of Induction motor. Comparison with DC motor

Single Phase Motors: Single phase induction motors, Construction, principle of operation based on starting methods, Split phase motors, capacitor start motors, capacitor start & run motors, Reluctance Motor, Stepper Motor, Single phase a.c. series motors, Universal motor.

Unit-4 (12 Lectures)

Synchronous Machines: Brief construction details of three phase synchronous generators, E.M.F. equation, Principle of operation of synchronous motor, methods of starting, factors for failure to start, applications, comparison of synchronous and induction motor

References

1. B.L. Thareja, A.K. Thareja, A Textbook of Electrical Technology-Vol-II, S.Chand
2. J.B. Gupta, Electrical Technology (Electrical Machines), Katsons
3. I. J. Nagrath and D. P. Kothari, Electrical Machines, Tata McGraw Hill
4. G. Mc. Pherson, An introduction to Electrical Machines & Transformers, John Wiley & Sons
5. H. Cotton, Advanced Electrical Technology, CBS Publishers and Distributors, New Delhi
6. S. Ghose, Electrical Machines, Pearson Education
7. N. K. De and P. K. De, Electric Drives, Prentice Hall of India

Electrical Machines Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Understand the working of DC series/shunt motors

CO2 Perform experiments and the circuit design and collect and analyze the data

CO3 Study working of SCR/phase transformer

CO4 Write a technical report on the experiment performed.

Syllabus Contents

1. Study of characteristics of DC Series motor.
2. Study of characteristics of DC Shunt motor.
3. Study of characteristics of single phase induction motor.
4. Study of characteristics of three phase induction motor.
5. Study of control of DC motor using SCR.
6. Study of Open Circuit Test on single phase transformer.
7. Study of Short Circuit Test on single phase transformer.

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.

Modern Communication Systems

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

Course Learning Objectives

This course will help students to get familiarize with core fundamental communication concepts relevant in field of Digital, Mobile, Satellite and optical fiber. It will also help to gain good understanding of application of communications in day to day real world.

Course Learning Outcomes

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

CO1 Summarize different types of modern communication systems.
CO2 Understand the basics of a digital communication system.
CO3 Explain the basics of an optical communication system.
CO4 Understand the working of a cellular communication system.
CO5 Understand the working of satellite communication

Syllabus Contents

Unit-1 (20 Lectures)

Multiplexing: TDM and FDM

Digital Modulation Technique: Block diagram of digital transmission and reception, Information capacity, Bit Rate, Baud Rate and M-ary coding. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). Binary Line Coding Technique, Multi level coding, QAM (Modulation and Demodulation)

Unit-2 (10 Lectures)

Optical Communication: Introduction of Optical Fiber, Types of Fiber, Guidance in Optical Fiber, Attenuation and Dispersion in Fiber, Optical Sources and Detectors, Block Diagram of optical communication system, optical power budgeting

Unit-3 (15 Lectures)

Cellular Communication: Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Unit-4 (15 Lectures)

Satellite communication: Introduction, need, satellite orbits, advantages and disadvantages of geostationary satellites. Satellite visibility, satellite system – space segment, block diagrams of satellite sub systems, up link, down link, cross link, transponders (C- Band), effect of solar eclipse, path loss, ground station, simplified block diagram of earth station. Satellite access, TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA, Satellite antenna (parabolic dish antenna), GPS-services like SPS & PPS.

Local area networks (LAN): Primary characteristics of Ethernet-mobile IP, OSI model, wireless LAN requirements-concept of Bluetooth, Wi-Fi and WiMAX.

References

1. W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education, 3rd Edition
2. Martin S. Roden, Analog & Digital Communication Systems, Prentice Hall, Englewood Cliffs, 3rd Edition
3. Modern digital and analog Communication systems- B. P. Lathi, 4rd Edition 2009 Oxford University press.
4. ThiagarajanVishwanathan, Telecommunication Switching Systems and Networks, Prentice Hall of India.
5. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2nd Edition, Pearson Education Asia.

Modern Communication Systems Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Understand the functioning of various digital communication techniques

CO2 Calculate the performance parameters involved in electronic communication systems

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Modulation of LED and detection through Photo detector.
2. Calculation of the transmission losses in an optical communication system.
3. Study of 16 QAM modulation and Detection with generation of Constellation
1. Diagram
4. Study of Amplitude Shift Keying
5. Study of Frequency Shift Keying
6. Study of Phase Shift Keying
7. Study of architecture of Mobile phone.
8. Study of Satellite Communication System.
9. Study of Optical Fiber Communication 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.

Control Systems

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

Course Learning Objectives

The course is aimed at providing knowledge in the following major topics of control systems:

- Mathematical modelling and analysis of open-loop and closed-loop control systems.
- Time-domain and Frequency-domain analysis of control systems.
- Methods for accessing absolute and relative stability of control systems.
- State-space analysis

Course Learning Outcomes

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

CO1 Understand the concepts of closed loop control systems.
CO2 Analyse the stability of closed loop systems.
CO3 Apply the control techniques to any electrical systems.
CO4 Compute and assess system stability.

Syllabus Contents

Unit-1 (16 Lectures)

Introduction to Control Systems: Open loop and Closed loop control systems, Mathematical modeling 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 (14 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 (14 Lectures)

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 (16 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: 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, 2000
2. K. Ogata, Modern Control Engineering, PHI 2002
3. B. C. Kuo , "Automatic control system", Prentice Hall of India, 2000

Control Systems Lab

(Hardware and Scilab/MATLAB/Other Mathematical Simulation software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Perform experiments involving concepts of control systems

CO2 Design experiments for controlling devices like AC/DC motors etc.

CO3 Study the behaviour of First and Second Order systems.

CO4 Comparison of various types of control mechanisms.

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.

Transmission Lines, Antenna and Wave Propagation

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

Course Learning Objectives

The course discusses the fundamentals of propogation of electromagnetic waves. The basics of transmission lines along with its parameters is included. Wave propogation along with modes in waveguides is discussed along with their applications. Antenna parameters along with their types is also discussed.

Course Learning Outcomes

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

CO1 Describe the principals of electromagnetic wave propagation and various effects involved in it

CO2 Explain the phenomenon of transmission line, its types and finding out performance parameters of transmission lines like losses SWR.

CO3 Calculate input impedance and reflection coefficient of an arbitrarily terminated transmission-line and can use Smith chart to convert these quantities.

CO4 Concept of retarded potential to explain radiation, half wave dipole and characteristics of antenna, radar equation.

Syllabus Contents

Unit-1 (15 Lectures)

Electromagnetic Wave Propagation: Propagation in Good Conductors, Skin Effect, Reflection of uniform Plane Waves at normal incidence, Plane Wave reflection at Oblique Incidence, Wave propagation in dispersive media, concept of phase velocity and group velocity.

Unit-2 (17 Lectures)

Transmission Lines: Typical Transmission lines- Co-axial, Two Wire, Microstrip, Coplanar and Slot Lines, Transmission Line Parameters, Transmission Line Equations, Wave propagation in Transmission lines, lowloss, lossless line, Distortionless line, Input Impedence, Standing Wave Ratio, Power. and lossy lines, Shorted Line, Open-Circuited Line, Matched Line, Smith Chart, Transmission Line Applications.

Unit-3 (13 Lectures)

Waveguides and Waveguide Devices: Wave propagation in waveguides, Parallel plate waveguides, TEM, TM and TE modes, Rectangular waveguides, circular waveguides, Power transmission and attenuation, Rectangular cavity resonators, directional couplers, isolator, circulator.

Unit-4 (15 Lectures)

Radiation of electromagnetic waves: Concept of retarded potentials, Antenna Parameters: Radiation Mechanism, Current Distribution on a Thin Wire Antenna, Radiation Pattern, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance Antenna Radiation Efficiency, Effective Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation

Types of Antenna: Hertzian dipole, Half wave dipole, Quarter-wave dipole, Yagi-Uda, microstrip, Parabolic antenna, Helical antenna, Antenna array.

References

1. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press (2001)
2. Karl E. Longren, Sava V. Savov, Randy J. Jost., Fundamentals of Electromagnetics with MATLAB,PHI
3. W. H. Hayt and J.A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
4. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
5. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
6. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
7. G. S. N. Raju, Antennas and Propagation, Pearson Education (2001)

Transmission Lines, Antenna and Wave Propagation Lab
(Scilab/MATLAB/Other Mathematical Simulation Software)

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Understanding the propagation of plan electromagnetic wave in different types of media

CO2 Study of various types of transmission line, power flow and power loss along the length.

CO3 Study of various types of waveguide power flow and power attenuation along the length.

CO4 Study of Antenna types, characteristics and radar Transmission equation.

Syllabus Contents

1. Program to determine the phasor of forward propagating field
2. Program to determine the instantaneous field of a plane wave
3. Program to find the Phase constant, Phase velocity, Electric Field Intensity and Intrinsic ratio
4. Program to find skin depth, loss tangent and phase velocity
5. Program to determine the total voltage as a function of time and position in a loss less transmission line
6. Program to find the characteristic impedance, the phase constant an the phase velocity
7. Program to find the output power and attenuation coefficient
8. Program to find the power dissipated in the lossless transmission line
9. Program to find the total loss in lossy lines
10. Program to find the load impedance of a slotted line
11. Program to find the input impedance for a line terminated with pure capacitive impedance
12. Program to determine the operating range of frequency for TE10 mode of air filled rectangular waveguide
13. Program to determine Directivity, Bandwidth, Beamwidth of an antenna
14. Program to determine diameter of parabolic reflector
15. Program to find out minimum distance between primary and secondary antenna

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.

Nanoelectronics

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

Course Learning Objectives

The syllabus includes the basic concepts and principles to categories and understand nanomaterial. Various nanomaterial synthesis/growth methods and characterizations techniques are discussed to explore the field in detail. The effect of dimensional confinement of charge carries on the electrical, optical and structural properties are discussed. Interesting experiments which shape this filed are introduced. The important applications areas of nanomaterials are introduced.

Course Learning Outcomes

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

CO1 Describe the principles of nanoelectronics and the processes involved in making nano components and material.

CO2 Explain the advantages of the nanomaterials and appropriate use in solving practical problems.

CO3 Explain the various aspects of nano-technology and the processes involved in making nano components and material.

CO4 Differentiate between various nanomaterials synthesis processes.

Syllabus Contents

Unit-1 (15 Lectures)

Introduction: Definition of Nano-Science and Nano Technology, Applications of Nano-Technology.

Introduction to Physics of Solid State: Size dependence of properties, bonding in atoms and giant molecular solids, Electronic conduction, Systems confined to one, two or three dimension and their effect on property

Quantum Theory for Nano Science: Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step: Reflection and tunneling (Quantum leak). Penetration of Barrier, Electron trapped in 2D plane (Nano sheet), Quantum confinement effect in nanomaterials.

Quantum Wells, Wires and Dots: Preparation of Quantum Nanostructure; Size and Dimensionality effect, Fermi gas; Potential wells; Partial confinement; Excitons; Single electron Tunneling, Infrared detectors; Quantum dot laser Superconductivity.

Unit-2 (17 Lectures)

Growth Techniques of Nanomaterials: Synthetic aspects: bottom up and top down approaches, Lithograpahic and Nonlithograpahic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique (p-$CuAlO_2$ deposition). Thermal evaporation technique, E-beam evaporation, Chemical Vapour deposition(CVD), Synthesis of carbon nano-fibres and multi-walled carbon nanotubes, Pulsed Laser Deposition, Molecular beam Epitaxy, Sol-Gel Technique (No chemistry required), Synthesis of nanowires/rods, Electro deposition, Chemical bath deposition, Ion beam deposition system, Vapor-Liquid –Solid (VLS) method of nanowire

Unit-3 (18 Lectures)

Methods of Measuring Properties and Characterization techniques: Microscopy: Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) including energy dispersive X-ray (EDX) analysis, low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED)

Spectroscopy: Infra-red and Raman Spectroscopy, X-ray Spectroscopy, Magnetic resonance, Optical and Vibrational Spectroscopy, Characterization and application like biopolymer tagging and light emitting semiconductor quantum dots

Unit-4 (10 Lectures)

Carbon nanotubes, nano cuboids, graphene, carbon quantum dots: Fabrication, structure, electrical, mechanical, and vibrational properties and applications. Use of nano particles for biological application, drug delivery and bio-imaging, Impact of nanotechnology on the environment.

References

1. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
2. Nanomaterials: synthesis, properties and applications, Institute of Physics, 1998.
3. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
4. Electron Microscopy and analysis, 2nd ed. Taylor and Francis, 2000.
5. Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Publishers.
6. Quantum dot heterostructures, Wiley, 1999.
7. Modern magnetic materials: principles and applications, John Wiley & Sons, 2000.
8. Nano: The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
9. Nanobiotechnology, concepts, applications and perspectives, Wiley-VCH, 2004.

Nanoelectronics Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Choose appropriate technique for the synthesis of nanomaterials based on its type and application

CO2 Calculate the material parameters of nanomaterials using suitable characterization techniques.

CO3 Visit to Research laboratories/USIC and use advanced tools/techniques for synthesis and characterization of nanomaterials.

CO4 Prepare a technical reports of the experiments carried out.

Syllabus Contents

1. Synthesis of at least two different sizes of Nickel Oxide/ Copper Oxide/ Zinc Oxide Nano Particles Using Sol- Gel Method
2. Polymer synthesis by suspension method / emulsion method
3. B-H loop of nanomaterials.
4. Magnetoresistance of thin films and nanocomposite, I-V characteristics and transient response.
5. Particle size determination by X-ray diffraction (XRD) and XRD analysis of the given XRD spectra
6. Determination of the particle size of the given materials using He-Ne LASER.
7. Selective area electron diffraction: Software based structural analysis based on TEM based experimental data from published literature. (Note: Later experiment may be performed in the lab based on availability of TEM facility).
8. Surface area and pore volume measurements of nanoparticles (a standard sample and a new sample (if available)).
9. Spectroscopic characterization of metallic, semiconducting and insulating nanoparticles.
10. Visit to Research Lab/institutions to see the live demonstrations of synthesis and characterization of the processes.

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 Systems

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

Course Learning Objectives

The course is designed to make student familiar with principles, features, classification, architectures and design issues involved in embedded system. The selection criteria for choosing microcontroller based on system requirement in embedded systems is also discussed. A balance between hardware and software exposure is maintained. Syllabus covers both assembly and C programming. Latest protocols like SPI and TWI are also included.

Course Learning Outcomes

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

CO1 Explain the concepts related to embedded systems and architecture of microcontrollers
CO2 Familiarize with serial bus standards.
CO3 Design systems for common applications like general I/O, counters, PWM motor control, data acquisition etc.
CO4 Demonstrate knowledge of the development tools for a microcontroller, and write assembly language code according to specifications

Syllabus Contents

Unit – 1 (10 Lectures)

Introduction to Embedded Systems: Overview of Embedded Systems, Features, Requirements and Applications, Recent Trends in the Embedded System Design, Common architectures for the Embedded System Design, Embedded Software design issues.

Introduction to microcontrollers, Overview of Harvard architecture and Von Neumann architecture, RISC and CISC microcontrollers

Unit –2 (17 Lectures**)**

AVR RISC Microcontrollers like ATMega32: Introduction to AVR RISC Microcontrollers, Architecture overview, status register, general purpose register file, memories, Instruction set, Data Transfer Instructions, Arithmetic and Logic Instructions, Branch Instructions, Bit and Bit-test Instructions, MCU Control Instructions. Simple programs in Assembly Language/C Language

Unit – 3 (17 Lectures)

Interrupts and Timer: Introduction to System Clock, Reset sources, Introduction to interrupts, External interrupts, IO Ports, 8-bit and 16-bit Timers, introduction to different modes, Input Capture and Compare Match.

Unit – 4 (16 Lectures)

Perpherals: Analog Comparator, Analog-to-Digital Converter, Serial Peripheral Interface (SPI), The Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART), Two Wire Interface (TWI) / I2C bus

References

1. AVR Microcontroller and Embedded Systems: Using Assembly and C by Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, PHI
2. Embedded system Design - Frank Vahid and Tony Givargis, John Wiley, 2002

3. Programming and Customizing the AVR Microcontroller by D V Gadre, McGraw- Hill
4. Atmel AVR Microcontroller Primer: Programming and Interfacing by Steven F. Barrett, Daniel J. Pack, Morgan & Claypool Publishers
5. An Embedded Software Primer by David E Simon, Addison Wesley
6. AVR Microcontroller Datasheet, Atmel Corporation, www.atmel.com

Embedded Systems Lab

Credits:02 **Lectures 60h**

Course Learning Outcomes

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

CO1 Use various peripherals on the microcontroller to implement systems, interrupts driven I/O and modes of timer/ counter

CO2 Design systems for common applications like general I/O, counters, PWM motor control, data acquisition etc.

CO3 Prepare the technical report on the experiments carried.

Syllabus Contents

1. Flash LED at an observable rate.
2. Hello LED – Flash LED at a rate such that the LED appears always on. Estimate the onset of the rate when the LED appears to stay on
3. Controlling ON/OFF of an LED using switch.
4. Use LFSR based random number generator to generate a random number and display it.
5. Toggle the LED every second using Timer interrupt.
6. Use the potentiometer to change the red LED intensity from 0 to maximum in 256 steps.
7. Use the switch to select the LED (from RGB led) and then the potentiometer to set the intensity of that LED and thus create your own color from amongst 16million colors.
8. Read the ADC value of the voltage divider involving the LDR. Print the value on the serial monitor.
9. Use the LDR and estimate a threshold for the LDR value and use that to turn the RGB LED on, to simulate an ‘automatic porch light’.
10. Use the thermistor to estimate the temperature and print the raw value on the serial monitor.
11. Connect the display Board and print ‘Hello World’ on it. Scroll display from left to right.
12. Use the on-board EEPROM to store the temperature min and max values together with a time stamp.
13. Speed control of DC motor.
14. Speed control of stepper 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.

Dissertation/Project work

Credits: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 objective of Dissertation/Project Work is to enable the student to take up investigative study in the broad field of Electronics, 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 investigative 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

1. Research Methodology: Methods and techniques by C.R. Kothari and Gaurav Garg. 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

Mobile Application Programming

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

Course Learning Objectives

In this course, student will be developing foundational programming skills to support graphical element presentation and data manipulation from basic functions through to advanced processing. You will continue to build your skill set to use and apply core graphics, touch handling and gestures, animations and transitions, alerts and actions as well as advanced algorithms, threading and more. By the end of this course you will be able to develop a more advanced, fully functioning app. Currently this course is taught using Android Studio.

Course Learning Outcomes

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

CO1 Explain the concepts on: Elements of user interface, Model-View-Controller architecture, Data persistence and storage, Multithreading, Mobile web vs. mobile app, Services, broadcasts and notifications, Sensor management and location-based services.

CO2 Describe different mobile application models/architectures and patterns.

CO3 Describe the components and structure of a mobile development framework (Google's Android Studio)

CO4 Apply a mobile development framework in the development of a mobile application

Syllabus Contents

Introduction: What is mobile Application Programming, Different Platforms, Architecture and working of Android, iOS and Windows phone 8operating system, Comparison of Android, iOS and Windows phone 8.

Android Development Environment: What is Android, Advantages and Future of Android, Tools and about Android SDK, Installing Java, Eclipse, and Android, Android Software Development Kit for Eclipse, Android Development Tool: Android Tools for Eclipse, AVDs: Smartphone Emulators, Image Editing,

Android Software Development Platform: Understanding Java SE and the Dalvik Virtual Machine, Directory Structure of an Android Project, Common Default Resources Folders, The Values Folder, Leveraging Android XML, Screen Sizes, Launching Your Application: The AndroidManifest.xml File, Creating Your First Android Application.

Android Framework Overview: The Foundation of OOP, The APK File, Android Application Components, Android Activities: Defining the User Interface, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications, Content Providers: Data Management, Android Intent Objects: Messaging for Components, Android Manifest XML: Declaring Your Components.

Views and Layouts, Buttons, Menus, and Dialogs, Graphics Resources in Android: Introducing the Drawables, Implementing Images, Core Drawable Subclasses, Using Bitmap, PNG, JPEG and GIF Images in Android, Creating Animation in Android

Handling User Interface(UI) Events: An Overview of UI Events in Android, Listening for and Handling Events , Handling UI Events via the View Class, Event Callback Methods, Handling Click Events, Touchscreen Events, Keyboard Events, Context Menus, Controlling the Focus.

Content Providers: An Overview of Android Content Providers, Defining a Content Provider, Working with a Database.

Intents and Intent Filters: Intent, Implicit Intents and Explicit Intents, Intents with Activities,

Intents with Broadcast Receivers
Advanced Android: New Features in Android 4.4**.**
iOS Development Environment: Overview of iOS, iOS Layers, Introduction to iOS application development.
Windows phone Environment: Overview of windows phone and its platform, Building windows phone application.

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

1. Develop an application that uses GUI components, Font and Colors.
2. Develop an application that uses Layout Managers and event listeners.
3. Develop a native calculator application.
4. Write an application that draws basic graphical primitives on the screen.
5. Develop an application that makes use of database.
6. Develop an application that makes use of RSS Feed.
7. Implement an application that implements Multi threading.
8. Develop a native application that uses GPS location information.
9. Implement an application that writes data to the SD card.
10. Implement an application that creates an alert upon receiving a message.
11. Write a mobile application that creates alarm clock.
12. Develop an application for working with Menus and Screen Navigation.
13. Develop an application for working with Notifications

List of Projects:-

1. Counter App
2. Calculator App
3. Music player App
4. Audio recorder App
5. Voice to text Converter
6. Tic-tac-toe Game
7. Snake game

References

1. Beginning Android 4, Onur Cinar , Apress Publication
2. Professional Android 4 Application Development, Reto Meier, Wrox
3. Beginning iOS 6 Development: Exploring the iOS SDK, David Mark, Apress
4. Beginning Windows 8 Application Development, István Novák, Zoltan Arvai, György Balássy and David Fulop
5. Professional Windows 8 Programming: Application Development with C# and XML, Allen Sanders and Kevin Ashley, Wrox Publication

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 with LabVIEW

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

Course Learning Objectives

- Familiarize students with Graphical Programming Language LabVIEW
- Familiarize students with Virtual Instrumentation concept
- Use modular programming practices using LabVIEW libraries and pallettes
- Develop, debug, and test LabVIEW VIs
- To use LabVIEW for data acquisition and to create applications

Course Learning Outcomes

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

CO1 Familiarize with the concepts of Virtual Instrumentation and Graphical user interface
CO2 Operate LabVIEW to design Virtual instruments
CO3 Develop, debug, and test LabVIEW VI's for specific applications

Syllabus Contents

Introduction to Virtual Instrumentation: Computers in Instrumentation, concept of Virtual Instrumentation (VI), History of VI, LabVIEW and VI, Conventional and Graphical Programming, Distributed Systems

Basics of LabVIEW: Components of LabVIEW, Owned and Free Labels, Tools and Other Palettes Arranging Objects, Pop-Up Menus ,Colour Coding, Code Debugging, Creating Sub-Vis, For Loop, While Loop, Loop Behaviour and Interloop Communication, Local Variables, Global Variables, Shift Registers, Feedback, Autoindexing, Loop Timing, Timed Loops Sequence Structures, Case Structure, Formula Node, Event Structure, Arrays, Clusters, Inter-Conversion of Arrays and Clusters, Waveform Chart, Resetting Plots, Waveform Graph, Use of Cursors, X-Y Graph, introduction to a State Machine, Event Structures, The Full State Machine, File Formats, File I/O Functions, Path Functions

Basics of Data Acquisition: Classification of Signals, Real-World Signals, Analog Interfacing, Connecting the Signal to the Board, Practical vs. Ideal Interfacing, Bridge Signal Sources.

Data Acquisition with LabVIEW: Measurement and Automation Explorer, Waveform Data Type, Working in DAQmx ,Working in NI-DAQ, Use of Simple analog and digital Vis, Continuous data acquisition, acquisition of data in bursts, DAQ Assistant, Analysis Assistant, Instrument Assistant, Instrument Interfacing and LabVIEW, Data Sockets.

PRACTICALS

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

1. Write and design a program for temperature conversion.
2. Basic arithmetic operations
3. Boolean operations
4. Sum of 'n' numbers using 'for' loop
5. Factorial of a give number using for loop
6. Sum of 'n' natural numbers using while loop
7. Factorial of a give number using while loop

8. Design a water tank alarm system for determining the level of water and stop.
9. Program to design a calculator that can perform simple mathematical operations using labview. (using case structure)
10. Program to design traffic signal.
11. Sorting even numbers using while loop in an array
12. Array maximum and minimum
13. Bundle and unbundle cluster
14. Flat and stacked sequence
15. Application using formula node
16. Median filter
17. Discrete cosine transform
18. Convolution of two signals
19. Design of a state machine.
20. To study waveform graph.
21. Windowing technique
22. Interfacing experiments with data acquisition hardware
23. Instrumentation amplifier to acquire an ecg signal
24. Acquire, analyse and present an eeg using virtual Instrumentation
25. Mini project

References

26. Virtual Instrumentation using LabVIEW, II Edition, Sanjay Gupta, Joseph John, TMH Pvt. Ltd.
27. LabVIEW for Everyone, III Edition, J. Travis, J. King, Prentice Hall, 2006
28. LabVIEW Graphical Programming, IV Edition, G.W. Johnson, R. Jeninngs, Mcgraw Hill, 2006

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.

Design and Fabrication of Printed Circuit Boards

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

Course Learning Objectives

The main objective of the course is to introduce the students to the industrial tools, Protocols and Design Specifics used in PCB Designing, so that students are able to design an electronic printed circuit board for a specific application using industry standard software after going through the complete procedural steps of developing circuit schematic, board files, image transferring, assembly, soldering and testing.

Course Learning Outcomes

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

CO1 Familiarize with the type of devices/components that may be mounted on PCB

CO2 Understand the PCB layout techniques for optimized component density and power saving.

CO3 Perform design and printing of PCB with the help of various image transfer and soldering techniques

CO4 Understand the trends in the current PCB industry

Syllabus Contents

PCB Fundamentals: PCB Advantages, components of PCB, Electronic components, Microprocessors and Microcontrollers, IC's, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer and flexible boards, Manufacturing of PCB, PCB standards.

Schematic & Layout Design: Schematic diagram, General, Mechanical and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for library, Tracks, Pads, Vias, power plane, grounding.

Technology OF PCB: Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper clad laminates materials of copper clad laminates, properties of laminates (electrical & physical), types of laminates, soldering techniques. Film master preparation, Image transfer, photo printing, Screen Printing, Plating techniques etching techniques, Mechanical Machining operations, Lead cutting and Soldering Techniques, Testing and quality controls.

PCB Technology: Trends, Environmental concerns in PCB industry.

PRACTICALS

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

Starting PCB Designing

- Understanding the schematic Entry
- Creating Library & Components
- Drawing a Schematic
- Flat Design / hierarchical Design
- Setting up Environment for PCB
- Design a Board

Autorouting

- Introduction to Autorouting
- Setting up Rules
- Defining Constraints
- Autorouter Setup

PCB Designing Practice

- PCB Designing of Analog Electronic Circuits
- PCB Designing of Digital Electronic Circuits
- PCB Designing of Power Supplies
- PCB Designing of Different Sensor modules
- PCB Designing of Electronics Projects
- PCB Designing of Embedded Projects

Post Designing and PCB Fabrication Process

- Printing the Design
- Etching
- Drilling
- Interconnecting and Packaging electronic Circuits (IPC) Standards
- Gerber Generation
- Soldering and Desoldering
- Component Mounting
- PCB and Hardware Testing

Project work

- Making the schematic of Acedemic and Industrial projects
- PCB Designing of these projects
- Soldering and Desoldering of components as per Design
- Testing and Troubleshooting Methods

References

1. Printed circuit Board – Design & Technology by Walter C. Bosshart, Tata McGraw Hill.
2. Printed Circuit Board –Design, Fabrication, Assembly & Testing, R.S. Khandpur, TATA McGraw Hill Publisher

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.

Robotics

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

Course Learning Objectives

After completion of this course students should be well versed in programming a micro controller. They should be able to use various sensors and make microcontroller respond to the external environment. Student would be in a position to make rudimentary robot which is capable of moving along a predetermined path, follow a drawn line and equivalent applications.

Course Learning Outcomes

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

CO1 Familiarize with the programming environments used in robotics applications.
CO2 Understand the working of sensors, actuators and other components used in design and implementation of robotics.
CO3 Design timer/counter circuits and display their outputs using LCD and other indicator devices
CO4 Understand the communication standards like RS232 etc.

Syllabus Contents

Programming Environments: Integrated Development Environment (IDE) for AVR microcontrollers, free IDEs like AVR Studio, WIN AVR. Installing and configuring for Robot programming, In System Programmer (ISP), loading programmes on Robot

Actuators: DC Motors, Gearing and Efficiency, Servo Motors, Stepper motors, Motor Control and its implementations

Sensors: White line sensors , IR range sensor of different range, Analog IR proximity sensors , Analog directional light intensity sensors, Position encoders, Servo mounted sensor pod/ Camera Pod, Wireless colour camera, Ultrasound scanner, Gyroscope and Accelerometer, Magnetometer, GPS receiver, Battery voltage sensing, Current Sensing

LCD interfacing with the robot (2 x 16 Characters LCD)

Other indicators: Indicator LEDs, Buzzer

Timer / Counter operations: PWM generation, Motor velocity control, Servo control, velocity calculation and motor position Control, event scheduling

Communication: Wired RS232 (serial) Communication, Wireless ZigBee Communication, USB Communication, Simplex infrared Communication (IR remote to robot)

PRACTICALS

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

1. Interfacing experiment using available hardware like LCD, LED, Buzzer, Motors.
2. Read IR proximity sensor to determine if there is some object nearby and thus Control the motion of robot using IR sensors.
3. Control a robot using LDR and laser.

4. Simple Motion Control (programming the robot to move forward, backward, left and right)
5. Line following Robot (programming the robot to move along a define path, white line or black line)
6. Obstacle Detection (programming the robot for obstacle detection)
7. Designing a simple Robotic Arm and programming it for picking and placing of objects
8. Control experiment using available hardware or software.
9. Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro controllers and ROS (Robot Operating System) in a robotic system.
10. Project work

References

1. Saha, S.K., Introduction to Robotics, 2nd Edition, McGraw-Hill Education, New Delhi, 2014
2. R.K. Mittal, I.J. Nagrath, “Robotics & Control”, Tata McGraw & Hills, 2005.

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.

Internet and Java Programming

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

Course Learning Objectives

The objective of the paper is to familiarize the students with networks and internet and to build a solid foundation in java programming language for internet through knowledge and use of structure, object, class and model.

Course Learning Outcomes

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

CO1 Describe the various aspects of internet technologies, java programming

CO2 Familiarize with data type, data operators, exception handling and file management

CO3 To use Java Applets

Syllabus Contents

Internet: Introduction to networks and internet, history, Working of Internet, internet and its applications- E- mail, telnet, FTP, e-commerce, video conferencing, e-business. Modes of Connecting to Internet, Internet Service Providers(ISPs), Internet address, standard address, domain name, DNS, IP.v6.Modems , World Wide Web and its evolution, uniform resource locator (URL), browsers , Search engine, web saver - apache, IIS, proxy server, HTTP protocol.

Data types, Arrays, Operators, Flow control: Branching, Looping. Classes, New Operator, Dot Operator, Method Declaration and Calling, Constructors, Inheritance, Super, Method Overriding Final, Finalize, Static, Package and Import Statement, Interface and Implements

Exception Handling: Exception Types, Uncaught and Calling, Nested Try Statements, Java Thread Model, and Thread, Runnable, Thread Priorities, Synchronization, Deadlock

File: Input Stream, Output Stream, and File Stream. Applets-Tag, Order of Applet Initialization, Repainting, Sizing Graphics- Abstract Window Tool Kit Components

PRACTICALS

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

1. Introductory Programs:
   a. To print a phrase “Hello World”.
   b. To print details: Name, Course name and Semester, Roll No. and paper name.
2. Program on Integer Arithmetic operator: To simplify a given expression. (e=d*a/b+c)
3. Program on Arithmetic Operators using floating point arithmetic (perform +,-,*,/, and %).
4. Program on Arithmetic Operators using Integer arithmetic (perform +,-,*,/, and%).
5. Program on Addition of two numbers (using double type), Subtraction of two numbers (using double type), Multiplication of two numbers (using int type), Division of two numbers (using double type), and Modulo (using double type) using casting.
6. Use of operators

a. Relational operator
b. Conditional operator

7. Program on Increment and decrement operator.
8. Program to understand the difference between prefix and postfix: to increment sum and number and display old and new values both.
9. Swapping of two numbers without using third variable.
10. Program on importing math library and using various functions available in that library. (math.sqrt, math.abs, math.pow, math.min, math.max, math.log)
11. Determine largest of three numbers using nested if-else.
12. Find the average of three subjects and grade the students according to their average marks using else-if ladder.

Average Marks	Grade
80-100	Honors
60h-79	First Division
50-59	Second Division
40-49	Third Division
0-39	Fail

13. Sum of squares of numbers from 1 to 10 numbers using while loop.
14. Print numbers from 1 to 10 using while and do-while loop.
15. Compute the power of 2 using for loop.
16. Display right angle triangle using of * using nested for loop
17. Find area of a rectangle by creating objects, methods and classes.(input parameters 10,10)
18. Find area of rectangle using constructor(input parameters 10,10).
19. Find area and volume using single inheritance(input parameters 14,12,10).
20. Calculate area of a room using method overloading(input parameters 10.0,10.0).
21. Program on methodoverriding(print name and salary)
22. Compute the area of a rectangle and a circle using **implementing interfaces**
23. Program using the concept of multiple inheritance using interfaces(print roll no,marks obtained(part1 , part2, sports),total score).
24. Handle an arithmetic expression x=a/(b-c) using try and catch for expression handling.
25. Program on nested try statements.
26. Program on multiple catch blocks.
27. Writing bytes to a file.
28. Reading bytes from a file.

PROJECT:

Draw a human face using applet

Suggested Books:

1. Harley Hahn, The internet complete reference, Tata McGraw publicity,2nd Edition, 1997
2. Patrick Naughton, The Java hand book, Tata McGraw,1997

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-02 **Total Lectures: 30h**

Course Learning Objectives

Artificial Intelligence is a major step forward in how computer system adapts, evolves and learns. It has widespread application in almost every industry and is considered to be a big technological shift, similar in scale to past events such as the industrial revolution, the computer age, and the smart phone revolution.

This course will give an opportunity to gain expertise in one of the most fascinating and fastest growing areas of Computer Science through classroom program that covers fascinating and compelling topics related to human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence.

Course Learning Outcomes

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

CO1 Build intelligent agents for search and games

CO2 Solve AI problems through programming with Python

CO3 Learning optimization and inference algorithms for model learning

CO4 Design and develop programs for an agent to learn and act in a structured environment

Syllabus Contents

Introduction: Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

Search Algorithms: Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

Probabilistic Reasoning: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.

Markov Decision process: MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

PRACTICALS

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

1. Write a programme to conduct uninformed and informed search.
2. Write a programme to conduct game search.
3. Write a programme to construct a Bayesian network from given data.
4. Write a programme to infer from the Bayesian network.

5. Write a programme to run value and policy iteration in a grid world.
6. Write a programme to do reinforcement learning in a grid world.
7. Mini Project work.

References

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. Trivedi, M.C., “A Classical Approach to Artifical Intelligence”, Khanna Publishing House, Delhi.
4. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011
5. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010

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.

Internet of Things

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

Course Learning Objectives

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Course Learning Outcomes

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

CO1 Understand internet of Things and its hardware and software components
CO2 Interface I/O devices, sensors & communication modules
CO3 Remotely monitor data and control devices
CO4 Develop real life IoT based projects

Syllabus Contents

Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT

Elements of IoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

PRACTICALS

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

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor

data to smartphone using Bluetooth.

8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when ‘1’/’0’ is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

References

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, “A Hands on Approach”, University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
3. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press
4. Jeeva Jose, “Internet of Things”, Khanna Publishing House, Delhi
5. Adrian McEwen, “Designing the Internet of Things”, Wiley
6. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill 7. Cuno Pfister, “Getting Started with the Internet of Things”, O Reilly Media

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.

Data Sciences

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

Course Learning Objectives

The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Course Learning Outcomes

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

CO1 Demonstrate understanding of the mathematical foundations needed for data science.
CO2 Collect, explore, clean, munge and manipulate data
CO3 Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
CO4 Build data science applications using Python based toolkits.

Syllabus Contents

Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting

Introduction to Programming Tools for Data Science: Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK; Visualizing Data: Bar Charts, Line Charts, Scatterplots; Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Mathematical Foundations: Linear Algebra: Vectors, Matrices; Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation; Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem ; Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference

Machine Learning: Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning And Generalization, Overview of Deep Learning.

Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

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

1. Write a programme in Python to predict the class of the flower based on available attributes.
2. Write a programme in Python to predict if a loan will get approved or not.

3. Write a programme in Python to predict the traffic on a new mode of transport.
4. Write a programme in Python to predict the class of user.
5. Write a programme in Python to indentify the tweets which are hate tweets and which are not.
6. Write a programme in Python to predict the age of the actors.
7. Mini project to predict the time taken to solve a problem given the current status of the user.

References

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., “Data Sciences”, Khanna Publishing House, Delhi.
4. Jain V.K., “Big Data and Hadoop”, Khanna Publishing House, Delhi.
5. Jeeva Jose, “Machine Learning”, Khanna Publishing House, Delhi.
6. Chopra Rajiv, “Machine Learning”, Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press http://www.deeplearningbook.org
8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

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.

Cyber Security

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

Course Learning Objectives

The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains. The course aims at providing students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. The course will help students to gauge understanding in essential techniques in protecting Information Systems, IT infrastructure, analysing and monitoring potential threats and attacks, devising security architecture and implementing security solutions. The students will also have a wider perspective to information security from national security perspective from both technology and legal perspective.

Course Learning Outcomes

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

CO1 Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.

CO2 Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios

CO3 Identify common trade-offs and compromises that are made in the design and development process of Information Systems

CO4 Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection

Syllabus Contents

Cyber Security Concepts: Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

Cryptography and Cryptanalysis: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec. Open Source/ Free/ Trial Tools: Implementation of Cryptographic techniques, OpenSSL, Hash Values Calculations MD5, SHA1, SHA256, SHA 512, Steganography (Stools)

Infrastructure and Network Security: Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation. Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/ Windows Firewall, snort, suricata, fail2ban

Cyber Security Vulnerabilities& Safe Guards: Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment. Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit.

Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.

Security in Evolving Technology: Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Introduction, Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. Open Source/ Free/ Trial Tools: adb for android, xcode for ios, Implementation of REST/ SOAP web services and Security implementations.

Cyber Laws and Forensics: Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013. Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations. Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device

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

1. Implementation to gather information from any PC's connected to the LAN using whois,port scanners, network scanning, Angry IP scanners etc.
2. Implementation of Symmetric and Asymmetric cryptography.
3. Implementation of Steganography.
4. Implementation of MITM- attack using wireshark/ network sniffers
5. Implementation of Windows security using firewall and other tools
6. Implementation to identify web vulnerabilities, using OWASP project
7. Implementation of IT Audit, malware analysis and Vulnerability assessment and generate the report.
8. Implementation of OS hardening and RAM dump analysis to collect the Artifacts and other information's.
9. Implementation of Mobile Audit and generate the report of the existing Artiacts.
10. Implementation of Cyber Forensics tools for Disk Imaging, Data acquisition, Data extraction and Data Analysis and recovery.

References

1. William Stallings, “Cryptography and Network Security”, Pearson Education/PHI, 2006.
2. V.K. Jain, “Cryptography and Network Security”, Khanna Publishing House.
3. Gupta Sarika, “Information and Cyber Security”, Khanna Publishing House, Delhi.
4. Atul Kahate, “Cryptography and Network Security”, McGraw Hill.
5. V.K. Pachghare, “Cryptography and Information Security”, PHI Learning
6. Nina Godbole, “Information System Security”, Wiley 7. Bothra Harsh, “Hacking”, Khanna Publishing House, Delhi.

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.

3D Printing and Design

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

Course Learning Objectives

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Learning Outcomes

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

CO1 Develop CAD models for 3D printing.
CO2 Import and Export CAD data and generate .stl file.
CO3 Select a specific material for the given application.
CO4 Select a 3D printing process for an application.
CO5 Produce a product using 3D Printing or Additive Manufacturing (AM).

Syllabus Contents

3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.

Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

Process, Process parameter, Process Selection for various applications.

Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

Materials:

Polymers, Metals, Non-Metals, Ceramics

Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.

Support Materials

Additive Manufacturing Equipment

Process Equipment- Design and process parameters

Governing Bonding Mechanism

Common faults and troubleshooting

Post Processing: Requirement and Techniques

Product Quality

Inspection and testing

Defects and their causes

Process Design

PRACTICALS

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

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.

5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

References

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
4. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
5. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
6. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
7. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

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 Reality

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

Course Learning Objectives

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications.

Course Learning Outcomes

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

CO1 Understand geometric modelling and Virtual environment.
CO2 Study about Virtual Hardware and Software
CO3 Develop Virtual Reality applications.

Syllabus Contents

Introduction to Virtual Reality: Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Geometric Modelling: Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Virtual Environment: Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

VR Hardware and Software Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML

VR Applications: Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction

PRACTICALS

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

1. Developing architecture of a house using Virtual Reality.
2. Perform CRO based experiment using Virtual Reality.
3. Undertaking qualitative analysis in Chemistry using Virtual Reality.
4. Carry out assembly/disassembly of an engine using Virtual Reality.

5. Explore human anatomy using Virtual Reality.
6. Simulation of circulation of blood in heart.
7. Simulation of Fight/Vehicle/Space Station.
8. Building Electronic circuit using Virtual Reality, given basic electronic components.
9. Developing concept of Virtual class room with multiplayer.

Suggested Books:

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
4. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
5. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

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

Electronic Circuits and PCB Designing

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

Course Learning Objectives

Electronics industry is ever-growing involving technological advances for new era. The paper equips the learners about basic circuit knowledge. This course enables the students about circuit assemblies and how these to be transformed to printed circuit boards (PCBs). The practical exposure enables students to learn circuit implementations and troubleshooting.

Course Learning Outcomes

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

CO1 Analyze the electric circuit using network theorems.
CO2 Illustrate about rectifiers, transistor based amplifiers and its biasing.
CO3 Understand the PCB layout techniques, design and printing of PCB with the help of various image transfer and soldering techniques

Unit-1 (12 Lectures)

Network theorems (DC analysis only): Review of Ohms law, Kirchhoff's laws, voltage divider and current divider theorems, open and short circuits.

Thevenin's theorem, Norton's theorem and interconversion, superposition theorem, maximum power transfer theorem.

Unit-2 (13 Lectures)

Semiconductor Diode and its applications: PN junction diode and characteristics, ideal diode and diode approximations. Block diagram of a Regulated Power Supply, Rectifiers: HWR, FWR- center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor & efficiency(no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms.

Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

Unit-3 (17 Lectures)

BJT and Small Signal amplifier: Bipolar Junction Transistor: Construction, principle & working of NPN transistor, terminology. Configuration: CE, CB, CC. Definition of α, β and γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters . Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor.

Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing.

Small signal CE amplifier: circuit, working, frequency response, re model for CE configuration, derivation for Av, Zin and Zout.

Unit-4 (18 Lectures)

Types of PCB: Single sided board, double sided, Multilayer boards, Plated through holes technology, Benefits of Surface Mount Technology (SMT), Limitation of SMT, Surface mount components: Resistors, Capacitor, Inductor, Diode and IC‘s.

Layout and Artwork: Layout Planning: General rules of Layout, Resistance, Capacitance and Inductance, Conductor Spacing, Supply and Ground Conductors, Component Placing and mounting, Cooling requirement and package density, Layout check.

Basic artwork approaches, Artwork taping guidelines, General artwork rules: Artwork check and Inspection.

Laminates and Photoprinting: Properties of laminates, Types of Laminates, Manual cleaning process, Basic printing process for double sided PCB‘s, Photo resists, wet film resists, Coating process for wet film resists, Exposure and further process for wet film resists, Dry film resists

Etching and Soldering: Introduction, Etching machine, Etchant system. Principles of Solder connection, Solder joints, Solder alloys, Soldering fluxes. Soldering, Desoldering tools and Techniques.

Suggested Books:

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI
2. Electronics text lab manual, Paul B. Zbar.
3. Electric circuits, Joeseph Edminister, Schaum series.
4. Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.
5. Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.
6. Walter C.Bosshart ―PCB DESIGN AND TECHNOLOGY‖ Tata McGraw Hill Publications, Delhi. 1983
7. Clyde F.Coombs ―Printed circuits Handbook‖ III Edition, McGraw Hill.

Electronic Circuits and PCB Designing 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 Verify the network theorems and operation of typical electrical circuits.
CO2 Study various stages of a zener diode based regulated power supply.
CO3 Understand various biasing concepts, BJT and FET based amplifiers.
CO4 Familiarize with PCB layout techniques

1. Verification of Thevenin‘s theorem
2. Verification of Super position theorem
3. Verification of Maximum power transfer theorem.
4. Half wave Rectifier – without and with shunt capacitance filter.
5. Centre tapped full wave rectifier – without and with shunt capacitance filter.
6. Zener diode as voltage regulator – load regulation.
7. Transistor characteristics in CE mode – determination of ri, ro and β.
8. Design and study of voltage divider biasing.
9. Designing of an CE based amplifier of given gain
10. Designing of PCB using artwork, its fabrication and testing.
11. Design, fabrication and testing of a 9 V power supply with zener regulator

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

Digital System Design

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

Course Learning Objectives

In addition to familiarization with the combinational and sequential circuits, students will be adept in using one high-level hardware description languages (VHDL or Veriliog), which is in high demand, for designing combinational or sequential circuits. As there are lot of industrial and research based job opening in the area, the course offers a hands-on in designing digital systems on hardware (fabrication) and testing with a holistic approach to the subject, making students ready for the industry or research.

Course Learning Outcomes

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

CO1 Understand and represent numbers in powers of base and converting one from the other

CO2 Understand basic logic gates, concepts of Boolean algebra and techniques

CO3 Analyze and design combinatorial as well as sequential circuits

CO4 Familiar with VHDL design flow

<u>Unit-1</u> (15 lectures)

Number System and Codes: Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1‘s and 2‘s), Signed and unsigned numbers, addition and subtraction, multiplication and subtraction, Gray Codes

Boolean algebra and Logic gates: Boolean algebra- Positive and negative logic. Boolean laws. De Morgan‘s theorems, simplification of Boolean expressions-SOP and POS. Logic gates- basic logic gates-AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map-3 and 4 variable expressions. Characteristics of logic families: Fan In and Fan out, power dissipation and noise Immunity, propagation delay, comparison of TTL and CMOS families.

<u>Unit-2</u> (11 lectures)

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full) and their use as subtractor, Encoder and Decoder, Code Converter (Binary to BCD and vice versa)

<u>Unit-3</u> (16 lectures)

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (ripple, synchronous and asynchronous, ring, modulus)

Unit-4 (18 Lectures)

Introduction to VHDL : A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Design flow, Simulation and Synthesis tools, Translation of VHDL code into a circuit. Code Structure: library, entity, architecture, package. Data object, class constant, variable, signal, file. Modes in, out, inout, buffer. Data types, operators. Concurrent code: Difference between concurrent and sequential code, concurrent code using operators, When statement, Select statement.

References

1. M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
5. A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
6. Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

Digital System Design 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 Familiarize with combinational circuit design.

CO2 Familiarize with sequential circuit design.

CO3 Write programs in VHDL/Verilog

CO4 Prepare the technical report on the experiments carried.

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.

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.

GENERIC ELECTIVE 3

Instrumentation

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

Course Learning Objectives

- Explain the importance and working principle of different electronic measuring instruments.
- Use the complete knowledge of various instruments and transducers to make measurements in the laboratory.

Course Learning Outcomes

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

CO1 Familiarize with the working principle of different measuring instruments

CO2 Understand measuring instruments used in the laboratory like oscilloscopes, signal generators

CO3 Understand working principle of transducers

CO4 Familiarize with the working principle of data acquisition devices and biomedical instruments.

<u>Unit-1</u> (10 Lectures)

DC and AC indicating Instruments: Accuracy and precision, Types of errors, PMMC galvanometer, sensitivity, Loading effect , Conversion of Galvanometer into ammeter, Voltmeter and Shunt type ohmmeter, Multimeter.

<u>Unit-2</u> (18 Lectures)

Oscilloscopes: CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Dual trace oscilloscope, Sampling Oscilloscope, DSO and Powerscope: Block diagram, principle and working, Advantages and applications, CRO specifications (bandwidth, sensitivity, rise time).

Signal Generators: Audio oscillator, Pulse Generator, Function generators.

<u>Unit - 3</u> (12 Lectures)

Transducers: Basic requirements of transducers, Transducers for measurement of nonelectrical quantities: Types and their principle of working , measurement of Linear displacement, Acceleration, Flow rate, Liquid level, strain, Force, Pressure, Temperature.

<u>Unit – 4</u> (20 Lectures)

Data acquisition systems: Block diagram, brief description of preamplifier, signal conditioner, instrumentation amplifier, waveform generator, A/D and D/A converter blocks, computer controlled test and measurement system.

Bio-medical instrumentation: Bio-Amplifiers: Bio potentials - Bio-electricity – Necessity for special types of amplifiers for biological signal amplifications - Different types of Bio-OP - Amps. Electrodes for ECG, EEG, and EMG, block diagram of ECG and EEG systems, brief analysis of graphs.

Suggested Books:

1. Electrical Measurement in Measuring Instruments. Goldwing E.W. and Widdies
2. Electrical and Electronics Measurement and Instrumentation Sahwany A.K.
3. Instrumentation devices and systems: Rangan, Sarma, Mani, TMH
4. Instrumentation measurement and analysis: Nakra B C, Chaudry K K, TMH
5. Handbook of biomedical instrumentation: Khandpur R S, TMH
6. Measurement systems applications and design: Doeblin E O, McGraw Hill, 1990.
7. Electron measurements and instrumentation techniques: Cooper W D and Helfric A D, PHI, 1989.
8. Biomedical instrumentation and measurements: Leslie-Cromwell, Fred J Weibell, Erich A Pfieffer, PHI, 1994.
9. Mechatronics – principles and applications, Godfrey C Onwubolu, Elsevier, 2006

Instrumentation Lab

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

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

CO1 To measure various electrical parameters.
CO2 To measure characteristics of various sensors and transducers.
CO3 Understand ECG pattern.
CO4 Prepare the technical report on the experiments carried.

1. Design of multi range ammeter and voltmeter using galvanometer.
2. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
3. To determine the Characteristics of LVDT.
4. To determine the Characteristics of Thermistors and RTD.
5. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminal temperature sensor), PT-100, J- type, K-type.
6. Characterization of bio potential amplifier for ECG signals.
7. Study on ECG simulator
8. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
9. Study of pulse rate monitor with alarm system
10. Measurement of respiration rate using thermister /other electrodes.

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

Practical Electronics

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

Course Learning Objectives

- To understand the basics of operational amplifier and it's linear and nonlinear applications.
- To familiarize IC 555 Timer and it's application
- Understand the working of multivibrators and phase lock loop
- To understand working of various types of transducers.
- To introduce concept of embedded systems using arduino.

Course Learning Outcomes

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

CO1 Familiarize with design of the linear and non-linear applications of an op-amp.
CO2 Understand the working of multivibrators and phase lock loop
CO3 Understand working of various types of transducers.
CO4 Understand working of arduino.

Unit-1 (10 Lectures)

Timer and PLL: Functional block diagram of 555 timer, Monostable operation and its Application, Astable operation and its Applications,

Phase Locked Loop: Functional block diagram – Phase detector / Comparator, Voltage Controlled Oscillator, Low pass filter, Applications: Frequency multiplier/ Division, AM detection

Unit-2 (16 Lectures)

Operational Amplifier: Inverting and non-inverting amplifier, Op-amp parameters, Summing Amplifier, Difference Amplifier, Integrator, Differentiator, Instrumentation Amplifier, Audio Amplifier(LM386), Voltage to current converter, Current to Voltage converter, Sample and Hold circuits.

First order active filters (Circuit diagram and formula only): low pass, high pass, band pass, band reject and all pass filters.

Phase-shift & Wein bridge oscillator using op-amp.

Unit-3 (14 Lectures)

Transducers (Basic Working): Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge) Capacitive (diaphragm), Hall effect sensors, magneto-strictive transducers, Microphone, Touch Switch, Piezoelectric sensors, light(photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature(electrical and non-electrical), Pressure sensor.

A-D and D-A Conversion: D-A conversion: 4 bit binary weighted resistor type, circuit and working. Circuit of R-2R ladder- Basic concept. A-D conversion characteristics, successive approximation ADC. (Mention the relevant ICs for all).

<u>Unit-4</u> (20 lectures)

Data Acquisition using Arduino: Arduino: Birth, Open Source community, Functional Block Diagram, Functions of each Pin, Arduino Development Boards: IDE, I/O Functions, Looping Techniques, Decision Making Techniques, Designing of 1st sketch, Programming of an Arduino (Arduino ISP) , Serial port Interfacing, Basic Interfacing and I/O Concept, Interfacing LED,Switch,7seg LED, different sensors.

References

1. Measurement Systems, 4/e, Doeblin McGraw Hill, New York, 1992.
2. Electrical Measurements & Electronic Measurements by A.K. Sawhney
3. Instrumentation- Devices and Systems By Rangan, Sarma, and Mani, Tata-McGraw Hill
4. Electronic Instrumentation by H.S Kalsi, McGraw Hill
5. Instrumentation measurements and analysis by Nakra & Choudhary
6. Measurement & Instrumentation- DVS Murthy
7. R. A. Gayakwad, Op-Amps and Linear IC‘s, Pearson Education (2003)
8. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.
9. Timer, Op Amp, and Optoelectronic Circuits & Projects, Forrest M Mims, Master Publishing Inc.
10. Exploring Arduino, Jeremy Blum, Wiley
11. Beginning Arduino, Michael McRobetrs, Technology in Action
12. Beginning Arduino Programming, Brian Evans ,Technology in Action
13. Practical Arduino Engineering, Harold Timmis, Technology in Action
14. Practical Arduino : Cool Projects for open source hardware, Jonathan Oxer, Hugh Blemings, Technology in Action

Practical Electronics 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 Design application oriented circuits using Op-amp
CO2 Design application oriented circuits using timer IC
CO3 Familiarization with different specifications of arduino boards.
CO4 Interfacing of various sensors with arduino.

1. Study of basic monostable multivibrator
2. Study of basic astable multivibrator
3. Light detection using 555 timer
4. Rain alarm using 555 timer
5. Motor control by PWM using 555 timer
6. LED flasher circuit using 555 timer
7. Analog lightwave Transmitter/Receiver using 555 timer
8. Study of basic inverting and non-inverting amplifier
9. Study of basic integrator circuit
10. Study of basic differentiator circuit
11. Design of first order LPF
12. Study of first order HPF
13. Designing of fiber optic based Transmitter /Receiver using LM386
14. Temperature to voltage converter using 741.
15. Shadow sensing using 741
16. Light based PWM using 741 and V-F converter
17. Test the different Arduino Boards, Open-Source and Arduino Shields.
18. Install Arduino IDE and its development tool.
19. Develop a program to Blink LED for 1second.
20. Develop a program to interface Input Switches and output LEDs with development board (arduino).
21. Interface 7 segment display with development board(arduino)
22. Interface LM35 temperature sensor with arduino and monitor temperature on serial monitor.
23. Interface DC motor using L293D Motor Driver.
24. Interfacing of various sensors with arduino development board

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

Communication Systems

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

Course Learning Objectives

- Basic concept & block diagram of communication system, types of noise & noise parameters.
- Need of modulation, AM , types of AM & their comparison , block diagram of AM transmitter & receiver
- Frequency modulation basics, bandwidth requirements of FM, block diagram of FM transmitter & receiver, comparison of AM & FM.
- Need for sampling & types of pulse communication, types of digital communication techniques, concepts of TDMA, FDMA and their comparison.
- Basic concepts of cellular mobile communication, architecture of cellular mobile network, techniques like GSM , CDMA , concepts of 2G, 3G & 4G , basic block diagram & introduction to satellite communication.

Course Learning Outcomes

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

CO1 Familiarization with the basic concept of a communication system and need for modulation

CO2 Familiarization with various continuous modulation techniques

CO3 Familiarization with various digital modulation techniques

CO4 Familiarization with mobile and satellite communication.

Unit-1 (16 Lectures)

Noise and Transmission lines: Noise-Introduction, internal and external noises, signal to noise ratio and noise figure

Amplitude Modulation/demodulation techniques: Block diagram of electronic communication system. Modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM. Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms.

Block diagram of AM transmitter and Receiver.

Unit-2 (12 Lectures)

Frequency Modulation/demodulation techniques: Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator.

FM detector – principle, slope detector-circuit, principle of working and waveforms.

Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Unit-3 (16 Lectures)

Digital communication: Introduction to pulse and digital communications, digital radio, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, MODEM– modes, classification, interfacing (RS232). TDMA, FDMA, CDMA concepts, comparison of TDMA and FDMA

Unit-4 (16 Lectures)

Cellular Communication: Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers (ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data encryption, architecture (block diagram) of cellular mobile communication network, CDMA technology, CDMA overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Satellite communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

References

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
4. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition- Pearson education

Communication Systems Lab

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

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

CO1 Basic understanding of analog modulation and demodulation techniques.
CO2 Basic understanding of digital modulation and demodulation techniques.
CO3 Basic understanding of various types of pulse modulation.
CO4 Prepare the technical report on the experiments carried.

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator using IC8038
3. Study of VCO using IC 566
4. Study of Time Division Multiplexing and de multiplexing
5. Study of AM Transmitter/Receiver
6. Study of FM Transmitter/Receiver

7. ASK modulator and demodulator
8. Study of FSK modulation
9. Study of PWM and PPM
10. Study of PAM modulator and demodulator

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

Microprocessor and Microcontroller System

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

Course Learning Objectives

- Know the number system, basic blocks of microcomputers.
- Write assembly language programs for 8085 microprocessor
- Understand 8051 microcontroller and its programming.
- Interface various peripheral devices to microprocessors and microcontrollers.
- Design microcontroller based system for various applications.

Course Learning Outcomes

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

CO1 Understand various number systems and their inter-conversion.

CO2 Understand the basic blocks of microcomputers i.e CPU, Memory, I/O and architecture of microprocessor's and Microcontroller's

CO3 Familiarization with internal architecture of 8085 microprocessor, its instruction set and basic programming.

CO4 Familiarization with internal architecture of 8051 microcontroller, its instruction set and basic programming.

Unit-1 (10 Lectures)

Number systems: Binary, hexadecimal – conversion from binary to decimal and vice-versa, binary to hexadecimal and vice-versa, decimal to hexadecimal and vice versa, addition and subtraction of binary numbers and hexadecimal numbers. Subtraction using 2's complement, signed number arithmetic.

Introduction to Microprocessor: Introduction, applications, basic block diagram, speed, word size, memory capacity, classification of microprocessors (mention different microprocessors being used)

Microprocessor 8085: Features, architecture -block diagram, internal registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085.

Unit-2 (18 Lectures)

8085 Instructions: Operation code, Operand & Mnemonics.

Instruction set of 8085, instruction classification, addressing modes, instruction format.

Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions.

Stack operations, subroutine calls and return operations. Delay loops, use of counters, timing diagrams-instruction cycle, machine cycle, T- states, time delay

Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time

Interfacing of memory chips, address allocation technique and decoding; Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure; Input/output techniques: CPU initiated unconditional and conditional I/O transfer.

Unit-3 (12 Lectures)

Introduction to Microcontrollers: Basic block diagram, comparison of microcontroller with microprocessors, comparison of 8 bit, 16 bit and 32 bit microcontrollers.

Microcontroller 8051- architecture -internal block diagram, key features of 8051, pin diagram, memory organization, Internal RAM memory, Internal ROM. General purpose data memory, special purpose/function registers, external memory.

Counters and timers: 8051 oscillator and clock, program counter, TCON, TMOD, timer counter interrupts, timer modes of operation. Input / output ports and circuits/ configurations, serial data input / output – SCON, PCON, serial data transmission modes.

Unit-4 (20 Lectures)

8051 Interrupts, Addressing modes and Instruction set: Interrupts – IE, IP, time flag interrupts, serial port interrupt, external interrupts, reset, interrupt control, interrupt priority, interrupt destinations & software generated interrupts.

Addressing modes, immediate addressing, register addressing, direct and indirect addressing, Data transfer instructions, internal data move, external data move, code memory read-only data move, Push and Pop and data exchange instructions.

Logical Instructions, byte level logical operations, bit level logical operations, rotate and swap operations.

Arithmetic Instructions, flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic, simple programs in assembly language.

Timer / Counter Programming in 8051: Programming 8051 timers, counter programming, programming timers 0 and 1 in 8051 C

References

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - Wiley Eastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram—Danpat Rai Publications.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. MCKinlay ―The 8051
4. Microcontroller and Embedded Systems‖ , 2nd Edition, Pearson Education 2008.
5. Muhammad Ali Mazidi, ―Microprocessors and Microcontrollers‖ , Pearson, 2006

Microprocessor and Microcontroller System Lab

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

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

CO1 Simple programs to understand the instruction set of 8085 microprocessor.
CO2 Simple programs to understand the instruction set of 8051 microcontroller.
CO3 Interface various I/O devices with microprocessor and microcontroller.
CO4 Prepare the technical report on the experiments carried.

1. Program to transfer a block of data.
2. Program for multibyte addition
3. Program for multibyte subtraction
4. Program to multiply two 8-bit numbers.
5. Program to divide a 16 bit number by 8 bit number.
6. Program to search a given number in a given list.
7. Program to generate terms of Fibonacci series.
8. Program to sort numbers in ascending/descending order.
9. Program to find the square root of an integer.
10. To study interfacing of IC 8255.
11. Program to verify the truth table of logic gates.

8051 Microcontroller Programming

1. Program to find the sum of N 8-bit numbers.
2. Program to find largest of N numbers.
3. Program to find smallest of N numbers
4. Program to find whether the given data is palindrome.
5. Program to arrange the numbers in ascending order.
6. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/ anticlockwise with speed control.
7. LCD interfacing.
8. Speed control of DC motor using PWM (pulse delay to be implemented using timers).

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

Consumer Electronics

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

Course Learning Objectives

This paper aims to familiarize the students with latest consumer electronics devices so that they can relate to the various devices and gadgets used at home and in offices. They get an idea about the working of various audio, TV and video systems. They also learn the working of commonly used modern telecommunication devices and GPS navigation system.

Course Learning Outcomes

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

CO1 Familiarization with various types of audio systems.
CO2 Familiarization with TV and video systems.
CO3 Familiarization with telephony and office equipment.
CO4 Familiarization with various domestic gadgets/appliances..

Unit -1 (10 Lectures)

Audio systems: PA system, Microphone, Amplifier, Loudspeakers. Radio receivers, AM/FM. Audio recording and reproduction, Cassettes, CD and MP3.

Unit-2 (16 Lectures)

TV and Video systems: Television standards, BW/Colour, CRT/HDTV. Video system, VCR/VCD/DVD players, MP4 players, Set Top box, CATV and Dish TV, LCD, Plasma & LED TV. Projectors: DLP, Home Theatres, Remote Controls

Unit-3 (17 Lectures)

Landline and Mobile telephony: Basic landline equipment, CLI, Cordless. Intercom/ EPABX system. Mobile phones: GPRS & Bluetooth. GPS Navigation system. Smart Phones

Office Equipment: Scanners, Barcode / Flat bed, Printers, Xerox, Multifunction units (Print, Scan, fax, and copy)

Unit-4 (17 Lectures)

Electronic Gadgets and Domestic Appliances: Digital clock, Digital camera, Handicam, Home security system, CCTV. Air conditioners, Refrigerators, Washing Machine/Dish Washer, Microwave oven, Vacuum cleaners

References

1. R. P. Bali Consumer Electronics Pearson Education (2008)
2. R. G. Gupta Audio and Video systems Tata McGraw Hill (2004)

Consumer Electronics Lab

Credits: 02 **Lectures: 60h**

Course Learning Outcomes

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

CO1 Study and installation of audio and video systems.
CO2 Familiarization with the specifications and performance parameters of various electronic gadgets/domestic appliances.
CO3 Prepare the technical report on the experiments carried.

1. Study of PA systems for various situations – Public gathering, closed theatre /Auditorium, Conference room, Prepare Bill of Material (Costing)
2. Installation of Audio /Video systems – site preparation, electrical requirements, cables and connectors
3. Market Survey of Products (at least one from each module)
4. Identification of block and tracing the system. Assembly and Disassembly of system using Toolkit

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

Computational Mathematics

Credits: 06 **05 Lectures per week + 01 Tutorial (per week per student)**

Course Learning Objectives

Algebraic solutions of mathematical problems of real situation are rare. Computational mathematics are the foundational algorithms for computational predictions of solutions in modern systems science. Such methods include techniques for simple optimisation, interpolation, ordinary differential equations, differentiation, integration and solution of systems of linear and nonlinear equations to simulate systems.

Course Learning Outcomes

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

CO1 Understand the common numerical methods and how they are used to obtain approximate solutions to mathematical problems.

CO2 Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

CO3 Analyze and evaluate the accuracy of common numerical methods.

Unit-1

Numerical Errors: Floating point, Round-off error, Error propagation, Stability, Programming errors.
Solution of Transcendental and Polynomial Equations f(x)=0: Bisection method, Secant and Regula Falsi Methods, Newton Raphson method, Muller Method, Rate of convergence, General Iteration Methods, Newton's Method for Systems, Method for Complex Roots, Roots of Polynomial Equations.

Unit-2

Interpolation and Polynomial Approximations: Taylor Series and Calculation of Functions, Langrange Interpolation, Newton Divided Difference Interpolation (forward and backward difference formulae), Truncation errors.
Curve Fitting: Least square fitting, Curve fitting, Interpolation by Spline functions.

Unit-3

Numerical Integration: Trapezoidal Rule, Error bounds and estimate for the Trapezoidal rule, Simpson's Rule, Error of Simpson's rule, Gauss Integration formula.
Numerical Differentiation: Finite difference method.
Numerical methods for first order differential equations: Euler-Cauchy Method, Heun's Method, Classical Runge Kutta method of fourth order. Methods for system and higher order equations.

Unit-4

Numerical Methods in Linear Algebra: Linear systems Ax=B, Gauss Elimination, Partial Pivoting, LU factorization, Doolittle's, Crout's and Cholesky's method. Matrix Inversion, Gauss-Jordon, Iterative Methods: Gauss-Seidel Iteration, Jacobian Iteration.
Matrix Eigenvalue: Power Method.

References

1. E. Kreyszig , Advanced Engineering Mathematics, John Wiley & Sons (1999).
2. J. H. Mathews and K.D. Fink, Numerical Methods using MATLAB, Prentice Hall India (2005)
3. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods: Problems And Solutions, New Age International (2007)
4. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall India (2008).
5. A. K. Ghatak, I. C. Goyal and S. J. Chua, Mathematical Physics: Differential Equations and Transform Theory, McMillan India (2006)

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-I

Credits: 06 **05 Lectures per week + 01 Tutorial (per week per student)**

Course Learning Objectives

The purpose of this course is to provide students with the skills and knowledge to perform calculations for solution of problems related to various topics they would study in their programmes. The course aims to prepare students with the mathematical foundation/tools in matrices, special functions, Laplace transforms, Fourier Series and Fourier Transforms.

Course Learning Outcomes

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

CO1 Understand methods to diagonalize square matrices and find eigenvalues and corresponding eigenvectors for a square matrix, and check for its diagonalizability

CO2 Recognize Differential Equations of varying order and use these to model engineering problems

CO3 Demonstrate the utility of Laplace transform

CO4 Familiarize with the concept of Fourier transform & Fourier series

Unit-1

Matrices: Rank of a matrix, Inverse of a matrix using elementary transformations, Consistency of linear system of equations, Eigenvalues and Eigenvectors of a matrix, Cayley Hamilton theorem, Diagonalization of matrix.

Special Functions: Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel functions of first kind, Orthogonal property.

Unit-2

Ordinary differential equations: Second & higher order linear differential equations with constant coefficients, General solution of homogenous and non - homogenous equations, Method of variation of parameters, Euler-Cauchy equation, Simultaneous linear equations, Applications to Modeling of forced oscillations, Resonance, Electric Circuits, System of Simultaneous Linear Differential Equations with Constant Coefficients.

Unit-3

Laplace Transforms: Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, Unit step function, Periodic function, Applications of Laplace transform to initial and boundary value problems.

Unit-4

Fourier Series: Fourier series, Fourier Series of functions of arbitrary period, Even and odd functions, half range series, Complex form of Fourier Series, Numerical Harmonic analysis.

Fourier Transforms: Fourier Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).

References

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008)
2. B. V. Ramana, Higher Engineering Mathematics, Tata Mc-Graw Hill Publishing Company Limited (2007)
3. R. K. Jain, and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007)
4. C. R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)

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 10

Applied Mathematics-II

Credits: 06 **05 Lectures per week + 01 Tutorial (per week per student)**

Course Learning Objectives

The purpose of this course is to provide students with the skills and knowledge to perform calculations for solution of problems related to various topics they would study in their programmes. The course aims to prepare students with the mathematical foundation/tools in sequence and series, partial differential equations, applications of integration, differential and integral vector calculus.

Course Learning Outcomes

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

CO1 Use mathematics as a tool for solving/modeling systems in real life

CO2 Familiarize with the concept of sequences, series and recognize convergent, divergent, bounded, Cauchy and monotone sequences.

CO3 Solve the most common Partial Differential Equations using standard techniques.

CO4 Perform operations with Vector Differential and Integral Calculus

Unit-1

Sequences and series: Sequences, Limit of a sequence, Convergence, Divergence and Oscillation of a sequence, Infinite series, Necessary condition for Convergence, Standard Infinite Series: Geometric Series and Harmonic series, Tests for Convergence and Divergence, Comparison Test: Only for Series with Positive Terms, Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Raabe's Test (Higher Ratio Test), Logarithmic Test, De Morgan's and Bertrand's Test, Alternating Series Leibnitz's Theorem, Absolute Convergence and Conditional Convergence, Power Series .

Mean Value Theorems: Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem, Generalized Mean Value Theorem.

Unit-2

Partial Differentiation: Functions of Several Variables: Limit and continuity, Partial Differentiation, Variable Treated as Constant, Total Derivative, Partial Differentiation of Composite Functions: Change of Variables, Differentiation of an Implicit Function, Euler's Theorem, Jacobian, Functional Dependence.

Maxima and Minima: Taylor's Theorem for Functions of Two Variables, Maxima and Minima of Functions of Two Variables: with and without Constraints, Lagrange's Method of Undetermined Multipliers.

Curve Tracing: Curves in Cartesian Form, Polar Curves, Parametric Curves.

Unit-3

Application of Integration: Length of Plane Curve: Rectification, Volume of solids of Revolution, Area of the Surface of a Solid of Revolution.

Multiple Integrals: Introduction, Double Integral, Evaluation of a double Integral, Application of double Integral, Change of Order of Integration: Double Integral, General Change of Variable in double Integral,

Change Of Variable: Cartesian to Polar Coordinates, Triple Integrals, General Change of Variable in Triple Integral.

Unit-4

Vector Differential Calculus: Scalar and Vector, Vector Differentiation, Directional Derivative, Gradient of a Scalar Function and Conservative Field, Divergence, Curl, Related Properties of Gradient, Divergence and Curl of Sums, Second-Order Differential Operator, Curvilinear Coordinates: Cylindrical and Spherical Coordinates.

Vector Integral Calculus: Vector Integration: Integration of a Vector Function of a Scalar argument, Line

Integrals: Work Done, Potential, Conservative field and Area, Surface Integrals: Surface area and Flux, Volume integrals, Green's Theorem in a Plane: Transformation between Line integral and Double integral Area in Cartesian and Polar Coordinates, Stokes's Theorem, Gauss Divergence Theorem.

References

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008)
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007)
3. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007)
4. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)

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 11

Artificial Intelligence

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

Course Learning Objectives

Artificial Intelligence is a major step forward in how computer system adapts, evolves and learns. It has widespread application in almost every industry and is considered to be a big technological shift, similar in scale to past events such as the industrial revolution, the computer age, and the smart phone revolution.

This course will give an opportunity to gain expertise in one of the most fascinating and fastest growing areas of Computer Science through classroom program that covers fascinating and compelling topics related to human intelligence and its applications in industry, defence, healthcare, agriculture and many other areas. This course will give the students a rigorous, advanced and professional graduate-level foundation in Artificial Intelligence.

Course Learning Outcomes

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

CO1 Build intelligent agents for search and games

CO2 Solve AI problems through programming with Python

CO3 Learning optimization and inference algorithms for model learning

CO4 Design and develop programs for an agent to learn and act in a structured environment

Syllabus Contents

Introduction to Python

Introduction: Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

Overview of Programming: Structure of a Python Program, Elements of Python

Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators(Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator)

Creating Python Programs: Input and Output Statements, Control statements(Branching, Looping, Conditional Statement, Exit function, Difference between break, continue and pass.), Defining Functions, default arguments, Errors and Exceptions.

Iteration and Recursion: Conditional execution, Alternative execution, Nested conditionals, The return statement, Recursion, Stack diagrams for recursive functions, Multiple assignment, The while statement, Tables, Two-dimensional tables

Strings and Lists: String as a compound data type, Length, Traversal and the for loop, String slices, String comparison, A find function, Looping and counting, List values, Accessing elements, List length, List membership, Lists and for loops, List operations, List deletion. Cloning lists, Nested lists

Object Oriented Programming: Introduction to Classes, Objects and Methods, Standard Libraries.

Search Algorithms: Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

Probabilistic Reasoning: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.

Markov Decision process: MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

PRACTICALS

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

1. Write a programme to conduct uninformed and informed search.
2. Write a programme to conduct game search.
3. Write a programme to construct a Bayesian network from given data.
4. Write a programme to infer from the Bayesian network.
5. Write a programme to run value and policy iteration in a grid world.
6. Write a programme to do reinforcement learning in a grid world.
7. Mini Project work.

References

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. Trivedi, M.C., “A Classical Approach to Artifical Intelligence”, Khanna Publishing House, Delhi.
4. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011
5. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010

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 12

Internet of Things

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

Course Learning Objectives

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Course Learning Outcomes

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

CO1 Understand internet of Things and its hardware and software components
CO2 Interface I/O devices, sensors & communication modules
CO3 Remotely monitor data and control devices
CO4 Develop real life IoT based projects

Syllabus Contents

Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT

Elements of IoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

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.
Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc.
Introduction to Cameras: Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations

IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

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

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

References

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill 7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

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 13

Data Sciences

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

Course Learning Objectives

The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Course Learning Outcomes

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

CO1 Demonstrate understanding of the mathematical foundations needed for data science.
CO2 Collect, explore, clean, munge and manipulate data
CO3 Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
CO4 Build data science applications using Python based toolkits.

Syllabus Contents

Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting

Overview of Programming: Structure of a Python Program, Elements of Python

Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators(Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator)

Creating Python Programs: Input and Output Statements, Control statements(Branching, Looping, Conditional Statement, Exit function, Difference between break, continue and pass.), Defining Functions, default arguments, Errors and Exceptions.

Iteration and Recursion: Conditional execution, Alternative execution, Nested conditionals, The return statement, Recursion, Stack diagrams for recursive functions, Multiple assignment, The while statement, Tables, Two-dimensional tables

Strings and Lists: String as a compound data type, Length, Traversal and the for loop, String slices, String comparison, A find function, Looping and counting, List values, Accessing elements, List length, List membership, Lists and for loops, List operations, List deletion. Cloning lists, Nested lists

Object Oriented Programming: Introduction to Classes, Objects and Methods, Standard Libraries.

Introduction to Programming Tools for Data Science: Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK; Visualizing Data: Bar Charts, Line Charts, Scatterplots; Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Mathematical Foundations: Linear Algebra: Vectors, Matrices; Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation; Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem ; Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference

Machine Learning: Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning And Generalization, Overview of Deep Learning.

Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

PRACTICALS

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

1. Write a programme in Python to predict the class of the flower based on available attributes.
2. Write a programme in Python to predict if a loan will get approved or not.
3. Write a programme in Python to predict the traffic on a new mode of transport.
4. Write a programme in Python to predict the class of user.
5. Write a programme in Python to indentify the tweets which are hate tweets and which are not.
6. Write a programme in Python to predict the age of the actors.
7. Mini project to predict the time taken to solve a problem given the current status of the user.

References

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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 programme of study, B.Sc. (Hons) Electronic Science is designed to encourage the acquisition of knowledge of electronics, 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 electronics 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, LabVIEW etc. to support their laboratory work.

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 programme 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 electronics 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 Visits are 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 in 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

Electronic Science is a professional academic programme, 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 electronics must be used. The assessment of learners' achievement in B.Sc. (Hons) Electronic Science will be 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 for 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

Electronic Science, Industry 4.0 Standards, Microprocessors, Microcontrollers, Communication System, VLSI, Artificial Intelligence, Internet of Things, IoT, Data Science, LabVIEW, Mobile

Programming, Satellite Communication, Mobile Communication, PCB Designing, Photonics, Computational Mathematics, Power Electronics, Semiconductor Fabrications, Nanoelectronics, VHDL, Analog Electronics, Digital Electronics, Embedded System, Antenna, Transmission Lines, DSP, Virtual Reality, Robotics, Java Programming

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

Skills	Program Learning Outcomes	Graduate Attributes	Teaching-Learning Methods	Assessment Methods
Remembering & Understanding	PLO1:Ability to apply knowledge of mathematics and science for solving electronics related problems	Scholarship of Knowledge	• Lectures, Self Readings, • Demonstration, • Discussion	• Written Exams • Seminars • Quizzes, Assignments
Applying & Analyzing	PLO2: Ability to perform electronics 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 electronic 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 electronics.	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 skills	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