Learning Outcomes based Curriculum Framework (LOCF)

for

B.Sc (Honours) Electronic Science

Undergraduate Programme

2019

ज्ञान-विज्ञान विमुक्तये

UNIVERSITY GRANTS COMMISSION
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Foreword

UGC has been taking several initiatives for quality improvement in higher education system in the country. Curriculum revision is one of the focus areas of these initiatives. Curriculum development is defined as planned, a purposeful, progressive, and systematic process to create positive improvements in the higher educational system. The ever evolving and fast changing educational technology have posed various challenges as far as curriculum in the Higher Educational Institutions (HEIs) is concerned. The curriculum requires to be updated more often keeping in view the latest developments in the society and to address the society's needs from time to time.

The Quality Mandate notified by UGC was discussed in the Conference of Vice-Chancellors and Directors of HEIs during 26-28th July, 2018; wherein it was inter-alia resolved to revise the curriculum based on Learning Outcome Curriculum Framework (LOCF).

Learning Outcome Curriculum Framework (LOCF) aims to equip students with knowledge, skills, values, attitudes, leadership readiness/qualities and lifelong learning. The fundamental premise of LOCF is to specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. Besides this, students will attain various 21st century skills like critical thinking, problem solving, analytic reasoning, cognitive skills, self directed learning etc.. A note on LOCF for undergraduate education is available on the UGC website www.ugc.ac.in. It can serve as guiding documents for all Universities undertaking the task of curriculum revision and adoption of outcome based approach.

To facilitate the process of curriculum based on LOCF approach, UGC had constituted subject specific Expert Committees to develop model curriculum. I feel happy to present the model curriculum to all the HEIs. Universities may revise the curriculum as per their requirement based on this suggestive model within the overall frame work of Choice Based Credit System (CBCS) and LOCF.

I express my gratitude and appreciation for the efforts put in by the Chairperson/Member/Co-opted members/experts of the committees for developing model curriculum. I also take the opportunity to thank Prof. Bhushan Patwardhan, Vice-Chairman, UGC for providing guidance to carry forward this task. My sincere acknowledgement to Prof. Rajnish Jain, Secretary, UGC for all the Administrative support. I also acknowledge the work done by Dr. (Mrs.) Renu Batra, Additional Secretary, UGC for coordinating this important exercise.

All the esteemed Vice-Chancellors are requested to take necessary steps in consultation with the Statutory Authorities of the Universities to revise and implement the curriculum based on the learning outcome based approach to further improve the quality of higher education.

New Delhi
30th July, 2019

(Prof. D. P. Singh)
Chairman
University Grants Commission

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Preamble

The UGC Committee constituted for Learning Outcomes based Curriculum Framework for B.Sc (Honours) Electronic Science is pleased to submit its report.

The Committee suggests that the following remarks may be taken into account by the faculty members, departments/schools, Boards of Studies in Electronic Science, Institutes and Universities, while considering the recommendations for their use:

i. The learning outcomes are designed to help learners understand the objectives of studying B.Sc (Honours) in Electronic Science, that is, to analyze, appreciate, understand and critically engage with learning of the subject.

ii. It is significant to mention here that the B.Sc (Honours) Electronic Science syllabus under CBCS remains the point of reference for the LOCF recommendations. However, stakeholders (departments or universities or institutions) may make suitable alterations with justifications while selecting texts, finalizing objectives and organizing principles keeping in view global, national and regional contexts of analysis and appreciation.

iii. To this end, the texts mentioned in the LOCF document are indicative. Similarly, the organization of divisions/themes/genres/periods/authors/areas, etc. is specific to contexts identified in the course(s) and does not pre-empt further rethinking or selection with clear justification for the choices exercised therein.

iv. Learning outcomes are modifiable with due justification in view of contexts, texts selected in the course and requirements of the stakeholders, which are as diverse as are regions in the country.

v. The overarching concern of the LOCF committee in Electronic Science is to have definite and justifiable course outcomes and their realization by the end of the course/programme.

vi. The Department/Institute/University is expected to encourage its faculty concerned to make suitable pedagogical innovations, in addition to teaching/learning processes suggested in the LOC Recommendations, so that the Course/Programme learning outcomes can be achieved.

1. Introduction

The learning outcomes based curriculum framework (LOCF) for B.Sc (Honours) 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 (Honours) Electronic Science program. The framework intends to allow for greater flexibility and innovation in curriculum design and syllabus development, teaching learning process, assessment of student learning levels.

The LOCF for B.Sc (Honours) Electronic Science is prepared on the contours and curricular structure provided by the UGC, and may be modified without sacrificing the spirit of CBCS and LOCF.

2. Learning outcomes based approach to Curriculum Planning

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

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

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

2.1 Nature and extent of B.Sc (Honours) Electronic Science

B.Sc (Honours) 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 and computation techniques for Electronics, computer coding/programming in high level languages etc.

B.Sc (Honours) 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 etc.

The present learning outcomes based model curriculum of B.Sc (Honours) 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 Aim of B.Sc (Honours) Electronic Science

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

- 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

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 (Honours) 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

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

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

4.1 Qualification descriptors for B.Sc (Honours) Electronic Science programme:

Some of the expected learning outcomes that a student should be able to demonstrate on completion of a B.Sc (Honours) 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 of B.Sc (HONOURS) Electronic Science

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

Course Structure

B.Sc. (Honours) Electronic Science

A. Credits –

Total 148 credits will be required for a student to be eligible to get degree of B.Sc (Honours) Electronic Science.

B. Structure of B.Sc. (Honours) Electronic Science

	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 (7 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.

Note: - Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester

SEMESTER-WISE SCHEDULE

FOR

B.Sc. (HONOURS) ELECTRONIC SCIENCE

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 *Theory*	4	4/5*
6		GE-1 *Practical/Tutorial*	4	2/1*
7	AEC	AEC-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: *Theory*	4	4/5*
6		GE-2: *Practical/Tutorial*	4	2/1*
7	AEC	AEC-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*	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 Lab*	4	2
6		Core Lab VII: *C Programming and Data Structures Lab*	4	2
7	GE	GE-3 *Theory*	4	4/5*
8		GE-3: *Practical/Tutorial*	4	2/1*
9	SEC	SEC-1	4	4
			Total Credits	**28**

Semester IV				
	Course Type	**Course Name**	**Hours/week**	**Credit**
1	Core	Core VIII: *Operational Amplifiers and Applications*	4	4
2		Core IX: *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: *Theory*	4	4/5*
8		GE-4: *Practical/Tutorial*	4	2/1*
9	SEC	SEC-2	4	4
			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: *Theory*	4	4
6		DSE-2: *Theory*	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: *Theory*	4	4
6		DSE-4: *Theory*	4	4
7		DSE-3: *Practical*	4	2
8		DSE-4: *Practical*	4	2
		Total Credits		**24**

Note:- Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester

A. CORE COURSE(C):

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 (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 *(at least one course through MOOC/SWAYAM)*

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

1. Power Electronics (4+4)
2. Numerical Analysis (4+4)
3. Modern Communication Systems (4+4)
4. Semiconductor Fabrication and Characterization (4+4)
5. Electrical Machines (4+4)
6. Basic VLSI Design (4+4)
7. Digital Signal Processing (4+4)
8. Control Systems (4+4)
9. Computer Networks (4+4)

10. Nanoelectronics (4+4)
11. Embedded Systems (4+4)
12. Biomedical Instrumentation (4+4)
13. Transmission Lines, Antenna and Wave Propagation (4+4)
14. Dissertation (4+4)

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

(at least one course through MOOC/SWAYAM)

1. Design and Fabrication of Printed Circuit Boards (4)
2. Robotics (4)
3. Mobile Applications Development (4)
4. Internet Technologies (4)
5. Programming with LabVIEW (4)
6. Cyber Security (4)
7. Electrical Vehicles (4)
7. IoT(4)

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

(at least one course through MOOC/SWAYAM)

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. Electrical Vehicles
9. Artificial Intelligence
10. Telecom Billing

Important:

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

Note:

1. Universities/Institutions/Departments may wish to add more courses against categories marked B, C, D and E 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.*

5. UGC has emphasized on the use of SWAYAM and MOOCs, which can be adapted to the extent of 20% of the credits. In view of this, it is recommended that at least one course in each category B (DSE), C (SEC) and D (GE) should be through MOOC/SWAYAM portal. Additional courses though MOOC/SWAYAM may also be introduced after consultations in appropriate departmental/institutional bodies.

Recommended Online Resources

1. MIT open courseware: *Lectures & Assignemnts* (https://ocw.mit.edu/index.htm)
   Videos (https://www.youtube.com/user/MIT/playlists)
2. Arduino https://www.arduino.cc
3. NPTEL E-Learning Courses
4. Coursera https://www.coursera.org/

6.3 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	PLO3. Design and manage electronic systems	PLO4. Identify, formulate, solve and assess the problems in Electronics.	PLO5. function as a member of a multidisciplinary team	PLO6. Communicate effectively	PLO7. Life long learning & Professional Development	PLO8. Use techniques, skills and modern technological/scientific/engineering software/tools
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		√			V	√		√

11	Digital Electronics and Verilog	√		√	√				
12	Digital Electronics and Verilog 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	Electronic Instrumentation	√		√	√				
20	Electronic Instrumentation Lab		√			√	√		
21	Microprocessors and Microcontrollers			√	√				
22	Microprocessors and Microcontrollers Lab		√			√	√		√
23	Electromagnetics	√							
24	Electromagnetics Lab					√			
25	Communication Electronics	√			√				
26	Communication Electronics lab		√			√	√		√
27	Photonics	√		√	√				
28	Photonics lab		√			√	√		
29	Dissertation	√	√	√	√	√	√	√	√

Details of Core courses

Basic Circuit Theory and Network Analysis

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

Course Outcomes

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

CO1 Study circuits in a systematic manner suitable for analysis and design.

CO2 Understands how to formulate circuit analysis problems in a mathematically tractable way with an emphasis on solving linear systems of equations.

CO3 Analyze the electric circuit using network theorems.

CO4 Determine Sinusoidal steady state response.

CO5 Understand the two–port network parameters with an ability to find out two-port network parameters & overall response for interconnection of two-port networks.

Syllabus Contents

Unit- 1 (13 Lectures)

Basic Circuit Concepts: Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Color coding of resistors, resistors in series and parallel.

Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel, Testing of resistance and inductance using multimeter.

Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors, testing of capacitors using multimeter.

Unit- 2 (13 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. Voltage-Current relationship in Resistor, Inductor and Capacitor, 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 (16 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.

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Basic Circuit Theory and Network Analysis Lab

(Hardware and Circuit Simulation Software)

Credits: 02 Theory Lectures: 60h

Course Outcomes

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

CO1 Verify the network theorems and operation of typical electrical and electronic 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 series, parallel and series – Parallel
   e) Voltage and Current dividers
2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's Theorem.
6. Verification of Superposition Theorem.
7. Verification of the Maximum Power Transfer Theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

Mathematics Foundation for Electronics

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

Course 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. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited.
6. MITopencourseware, Course no. 6.094, Introduction to Matlab, https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-094-introduction-to-matlab-january-iap-2010/

Mathematics Foundation for Electronics Lab

(Scilab/MATLAB/ any other Mathematical Simulation software)

Credits:02 **Lectures 60**

Course 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. Convergence of a given series.
5. 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.

Semiconductor Devices

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

Course 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) Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons (2001)

4) Kanaan Kano, Semiconductor Devices, Pearson Education (2004)

5) MITopencourseware, MIT Course Number 6.012 https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-fall-2009/

Semiconductor Devices Lab

(Hardware and Circuit Simulation Software)

Credits:02 **Lectures 60**

Course 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.

Applied Physics

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

Course 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 60**

Course 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.

Electronics Circuits

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

Course 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 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
8. Swayam Portal, Analog Electronic Circuits, Prof. Shouri Chatterjee
   https://swayam.gov.in/nd1_noc19_ee38/preview

9. MITopencourseware, MIT Course No. 6.012, https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/lecture-notes/

Electronics Circuits Lab

(Hardware and Circuit Simulation Software)

Credits:02 **Lectures 60**

Course Outcomes

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

CO1 Understand and analyze electronic circuits.

CO2 Choose the appropriate equipment for measuring electrical quantities and verify the same for different circuits.

CO3 Ability to understand and apply circuit theorems and concepts in engineering applications

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.

Digital Electronics and Verilog/VHDL

Credits: Theory-04 Theory Lectures: 60h

Course 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 combinatorial 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, Test Benches. Verilog Modules, Delays, data flow style, behavioral style, structural style, mixed design style, simulating design.

Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format,

Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets,

Register type, Parameters. Expressions, Operands, Operators, types of Expressions

Data flow Modeling and Behavioral Modeling: Data flow Modeling: Continuous assignment, net declaration assignments, delays, net delays. Behavioral Modeling: Procedural constructs, timing controls, block statement, procedural assignments, conditional statement, loop statement, procedural continuous assignment.

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

OR

Introduction to VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, data flow style, behavioral style, structural style, mixed design style, simulating design.

Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format.

VHDL terms, describing hardware in VHDL, entity, architectures, concurrent signal assignment, event scheduling, statement concurrency, structural designs, sequential behavior, process statements, process declarative region, process statement region, process execution, sequential statements, architecture selection, configuration statements, power of configurations.

Behavioral Modeling: Introduction to behavioral modeling, inertial delay, transport delay , inertial delay model, transport delay model, transport vs inertial delay, simulation delta drivers, driver creation, generics, block statements, guarded blocks.

Sequential Processing: Process statement, sensitivity list, signal assignment vs variable assignment,

sequential statements, IF, CASE ,LOOP, NEXT, ,EXIT and ASSERT statements, assertion BNF, WAIT ON signal, WAIT UNTIL expression, WAIT FOR time expression, multiple wait conditions, WAIT Time-Out, Sensitivity List vs WAIT Statement Concurrent Assignment, Passive Processes.

Data types: Object types-signal, variable, constant, Data types –scalar types, composite types, incomplete types, File Type caveats, subtypes, Subprograms and functions

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 60**

Course 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 Verlog/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.

C Programming and Data Structures

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

Course Outcomes

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

CO1 Write code in C language for arithmetic and logical problems

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 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.
9. MITOpeneourseware, Course No. 6.S096, Introduction to C and C++. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-s096-introduction-to-c-and-c-january-iap-2013/lectures-and-assignments/

C Programming and Data Structures Lab

Credits:02 **Lectures 60**

Course Outcomes

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

CO1 Implement conditional branching, iteration and recursion.

CO2 Write Programs in C for arithmetic and logical operations.

CO3 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.

Operational Amplifiers and Applications

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

Course Outcomes

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

CO1 Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.

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

CO3 Explain and compare the working of multi vibrators using special application IC 555 and general purpose op-amp.

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.

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 60**

Course Outcomes

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

CO1 Interpret op-amp data sheets.

CO2 Analyze and prepare the technical report on the experiments carried out.

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

CO4 Create and demonstrate live project using ICs.

CO5 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.

Signals & Systems

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

Course 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)

8. MITopencourseware, Course No. 6.003, Signals and Systems, https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/

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

Credits:02 **Lectures 60**

Course Outcomes

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

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

CO2 Learn the use of simulation tools and design skills.

CO3 Learn to work in groups and to develop MATLAB 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

Electronic Instrumentation

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

Course 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 (ex. LM335 -temperature 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 60**

Course 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

Microprocessor and Microcontrollers

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

Course 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 (10 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

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-3 (18 Lectures)

PIC16F887 Microcontroller: Core features, Architecture, pin diagram, memory organization-Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2), comparator module, analog-to-digital converter (ADC) module, data EEPROM, Enhanced capture/compare/PWM module, EUSART, master synchronous serial port (MSSP) module, special features of the CPU, interrupts, addressing modes, instruction set.

Unit-4 (14 Lectures)

Interfacing to PIC16F887: LED, Switches, Solid State Relay, Seven Segment Display, 16x2 LCD display, 4x4 Matrix Keyboard, Digital to Analog Converter, Stepper Motor and DC Motor. Interfacing program examples using C 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. Arduino https://www.arduino.cc

Microprocessor and Microcontrollers Lab

Credits:02 **Lectures 60**

Course 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.

PIC Microcontroller Programming

Note: Programs to be written using C programming language

1. LED blinking with a delay of 1 second.
2. Solid State Relay Interface
2. Interfacing of LCD (2X16).
3. Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/anticlockwise with speed control.
4. To test all the gates of a given IC74XX is good or bad.
5. Generate sine, square, saw tooth, triangular and staircase waveform using DAC interface.
6. Display of 4- digit decimal number using the multiplexed 7-segment display interface.
7. Analog to digital conversion using internal ADC and display the result on LCD.
8. Implementation of DC-Volt meter (0-5V) using internal ADC and LCD
9. Digital to analog conversion using PWM (pulse delay to be implemented using timers).
10. Speed control of DC motor using PWM (pulse delay to be implemented using timers).
11. Interfacing of matrix keyboard (4X4).
12. Serial communication between microcontroller and PC.

Electromagnetics

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

Course Outcomes

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

CO1 Understand the fundamentals of Electrostatics and Magnetostatics hence get the insight of
the characteristics of materials and their interactions with electric and magnetic fields

CO2 Understand the application of Vector Differential and Integral operators in Electromagnetic Theory.

CO3 Interpret Maxwell's equations in differential and integral forms, both in time and frequency domains..

CO4 Describe the complex ε, μ, and σ, plane waves, Snell's laws from phase matching, and calculate the reflection and transmission coefficients at the interface of simple media

CO5 Calculate input impedance and reflection coefficient of an arbitrarily terminated transmission-line and can use Smith chart to convert these quantities.

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/ any other similar freeware)

Credits:02 **Lectures 60**

Course 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.

Communication Electronics

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

Course Outcomes

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

CO1 Design basic digital communication systems to solve a given communications problem and they become conversant with the requirements and the protocols employed in the fundamental components in a communication network.

CO2 Understand simple block forward error correction codes and basic dispersion compensation concepts and also the concepts of up/down conversion and modulation

CO3 Determine the suitability of a particular communication system to a given problem

CO4 Describe the concept of "noise" in analog and digital communication systems. Also, get insight on the trade-offs (in terms of bandwidth, power, and complexity requirements) in basic digital communication systems.

Syllabus Contents

Unit-1 (10 Lectures)

Electronic communication: Block diagram of an electronic communication system, electromagnetic spectrum-band designations and applications, need for modulation, concept of channels and base-band signals. Concept of Noise, Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature, Friss formula.

Unit-2 (20 Lectures)

Amplitude Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM, Amplitude Demodulation (diode detector), Concept of Double side band suppressed carrier, Single side band suppressed carrier, other forms of AM (Pilot Carrier Modulation, Vestigial Side Band modulation, Independent Side Band Modulation). Block diagram of AM Transmitter and Receiver

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). Block diagram of FM Transmitter and Receiver Comparison between AM, FM and PM.

Unit -3 (14 Lectures)

Pulse Analog Modulation: Channel capacity, Sampling theorem, PAM, PDM, PPM modulation and detection techniques, Multiplexing, TDM and FDM.

Pulse Code Modulation: Need for digital transmission, Quantizing, Uniform and Nonuniform Quantization, Quantization Noise, Companding, Coding, Decoding, Regeneration.

Unit -4 (16 Lectures)

Digital Carrier Modulation Techniques: 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)

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, S. Haykin, Wiley India (2006)

Communication Electronics Lab
(Hardware and Circuit Simulation Software)

Credits:02 **Lectures 60**

Course 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
2. Study of Amplitude Demodulation
3. Study of Frequency Modulation
4. Study of Frequency Demodulation
5. Study of Pulse Amplitude Modulation
6. AM Transmitter/Receiver
7. FM Transmitter/Receiver
8. Study of TDM, FDM
9. Study of Pulse Width Modulation
10. Study of Pulse Position Modulation
11. Study of Pulse Code Modulation
12. Study of Amplitude Shift Keying
13. Study of Phase Shift Keying,
14. Study of Frequency Shift Keying.

Photonics

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

Course 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 60**

Course 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.

Discipline specific Electives

Power Electronics

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

Course 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 generators 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 V-I 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 60**

Course 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. VI Characteristic of MOSFET and IGBT (Both)
11. Study of chopper circuits

Numerical Techniques

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

Course 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 Techniques Lab

(C language/ Scilab/MATLAB/Other Mathematical Simulation software)

Credits:02 **Lectures 60**

Course Outcomes

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

CO1 Implement numerical methods in Matlab.

CO2 Write efficient, well-documented Matlab code 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

Modern Communication Systems

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

Course Outcomes

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

CO1 Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.

CO2 Apply the knowledge of digital electronics and understand the error control coding techniques.

CO3 Summarize different types of communication systems and its requirements.

CO4 Design and Analyse the performance of communication systems.

Syllabus Contents

Unit-1 (16 Lectures)

Advanced Digital Modulation Technique: DPCM, DM, ADM. 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 (17 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 (17 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, TCP/IP 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 60**

Course 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 Diagram
4. Study of DPCM and demodulation.
5. Study of DM, ADM
6. Study of architecture of Mobile phone.
7. Study of Satellite Communication System.
8. Study of Optical Fiber Communication System

Semiconductor Fabrication and Characterization

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

Course 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).

3. MITopencourseware, Course No. 6.774, Physics of Microfabrication, https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-774-physics-of-microfabrication-front-end-processing-fall-2004/

Semiconductor Fabrication and Characterization Lab

Credits:02 **Lectures 60**

Course Outcomes

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

CO1 Operate the advanced computer simulations tools 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.

Electrical Machines

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

Course 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

Basic VLSI Design

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

Course 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

Credits:02 **Lectures 60**

Course 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.

Digital Signal Processing

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

Course 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 60**

Course 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.

Control Systems

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

Course 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

Unit1 (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.

Unit2 (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.

Unit3 (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.

Unit4 (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 60**

Course 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 Design interfacing circuits for peripherals like I/O, A/D, D/A, timer etc.

CO4 Develop systems using different microcontrollers.

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.

Computer Networks

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

Course 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 60**

Course 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

Nanoelectronics

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

Course 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 nano-materials and appropriate use in solving practical problems.

CO3 Explain the various aspects of nano-technology and theprocesses 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 nano materials.

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 60**

Course 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 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.

Embedded Systems

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

Course 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: 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

Embedded Systems Lab

Credits:02 **Lectures 60**

Course 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 LCD I/O Board and print 'Hello World' on the LCD. 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 d.c. motor.
14. Speed control of stepper motor.

Biomedical Instrumentation

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

Course 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 60**

Course 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.

Transmission Lines, Antenna and Wave Propagation

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

Course 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 and its types.

CO3 Perform calculation for finding out performance parameters of transmission lines like losses SWR

CO4 Understand the modes of transmission in waveguides and other components involved in microwave communications.

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 60**

Course Outcomes

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

CO1 Understand the working of various components involved in antenna and wave propagation.

CO2 Perform experiments for studying the performance of transmission lines, waveguides and antenna.

CO3 Prepare a technical report on the experiment performed

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

Skills Enhancement Electives

Mobile Application Programming

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

Course 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.

Suggested Books:

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

Programming with LabVIEW

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

Course 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.

Suggested Books:

1. Virtual Instrumentation using LabVIEW, II Edition, Sanjay Gupta, Joseph John, TMH Pvt. Ltd.

2. LabVIEW for Everyone, III Edition, J. Travis, J. King, Prentice Hall, 2006

3. LabVIEW Graphical Programming, IV Edition, G.W. Johnson, R. Jeninngs, Mcgraw Hill, 2006

Design and Fabrication of Printed Circuit Boards

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

Course 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.

Suggested Books:

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

Robotics

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

Course 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)

Suggested Books:

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.
3. MITopencoursware, Course No. 2.12, Introduction to Robotics, https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/

Internet and Java Programming

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

Course 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 Write a program in java language for solving internet issues.

Syllabus Contents

Internet: Introduction, Understanding the Internet, Internet Addressing, Hardware Requirements to Connect to the Internet.

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

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

3. MITopencourseware, Course No.6.092, Introduction to Programming in Java, https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-introduction-to-programming-in-java-january-iap-2010/

Electrical Vehicles

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

Course Outcomes

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

CO1 Describe the operation principles of electric cars

CO2 Familiarize with charging infrastructure technologies

CO3 Understand future technology of Electrical Vehicles.

Syllabus Contents

Operation principle of electric cars

Motors and power electronics in an electric cars

EV Vs gasoline car, Electric car drivetrain, Electric motor, Power electronic in an electric car

Regenerative braking

Battery technology

Storage technologies for EV, Battery working principles, Battery losses, Li-ion batteries, Battery pack and battery management system

Relevant charging infrastructure technologies and innovations, such as smart charging

AC charging - Type 1,2, 3, DC charging – Chademo, Tesla, CCS, Fast charging and its limitations, Smart charging and applications, Vehicle to grid (V2G) technology

Future technology for EVs such as wireless charging and solar EVs

Wireless charging of EV, On-road charging of EV, Battery swap technology, Solar powered EVs, Charging EVs from renewable

Suggested Books:

1. TUDelft OpenCourseware, Course Name- Electric Car Technology
https://ocw.tudelft.nl/courses/electric-cars technology/#1544015082085-720c3675-29b9
2. Coursera, Electric Vehicle & Mobility
https://www.coursera.org/learn/electric-vehicles-mobility

IoT

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

Course Outcomes

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

CO1 Describe the operation principles IoT

CO2 Familiarize with Applications of IoT

CO3 Design an Application of IoT in the daily life

Syllabus Contents

Introducton to IoT: Sensing, Actuaton, Basics of Networking: Communicaton Protocols, Sensor Networks, Sensor Networks, Machine-to-Machine Communicatons, Interoperability in IoT,

Introducton to Arduino Programming: Integraton of Sensors and Actuators with Arduino: Introducton to Python programming, Introducton to Raspberry Pi, Implementaton of IoT with Raspberry Pi, Implementaton of IoT with Raspberry Pi,

Introducton to SDN: SDN for IoT, SDN for IoT, Data Handling and Analytcs,

Cloud Computng: Sensor-Cloud, Fog Computng, Smart Cites and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Industrial IoT

Case Study: Agriculture, Healthcare, Actvity Monitoring

Suggested Books:

1. NPTEL, introduction to IoT https://nptel.ac.in/courses/106105166/
2. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by

Pethuru Raj and Anupama C. Raman (CRC Press)

Cyber Security

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

Course Outcomes

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

CO1 Understand the issues of cyber security

CO2 Familiarize with cyber security law

CO3 Learn the techniques of for detection and prevention of cyber threat

Syllabus Contents

Unit 1

Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats:- Cyber Warfare-Cyber Crime-Cyber terrorism-Cyber Espionage, Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace.

Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.

Unit 2

Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware

software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.

Unit 3

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.

Unit 4

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, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time

Suggested Books:

1. "Cryptography and Network Security - Principles and Practice", by William Stallings (Pearson) 2017
2. "Cyber Security", by Nina Godbole and Sunit Belapure (Wiley) 2011

Dissertation/Summer Internship

Credits:Theory-06 **Total Lectures: 30h**

Course Outcomes

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

CO1 Survey and study of published literature on the assigned topic;

CO2 Working out a preliminary Approach to the Problem relating to the assigned topic;

CO3 Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;

CO4 Preparing a Written Report on the Study conducted for presentation to the Department;

CO5 Final Seminar, as oral Presentation before a departmental committee.

Syllabus Contents

The object of Internship/Project Work is to enable the student to take up investigative study in the broad field of 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.

7. Teaching-learning Process for B.Sc (HONOURS) Electronic Science

As a program of study, B.Sc (HONOURS) 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.

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

Simulations: 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, PSPICE, labview etc.

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

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

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

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

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

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

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

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

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

- Recognize the duties, responsibilities and ethics of profession.
- Ability to communicate effectively in the work environment.
- Understand general and specific work procedures in 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.

8. Assessment Methods

Electronic science is a professional academic program, so there is need to focus more on activity based evaluation rather than purely written examination. A variety of assessment methods that are appropriate within the disciplinary area of electronics must be used. The assessment of learners' achievement in B.Sc Electronic Science (Honours) 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 in in-semester and end-semester examination should preferably be in the ratio of 40:60.

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.

Table 1: Suggestive Learning and evaluation strategies for B.Sc (HONOURS) Electronic Science

Skills	Program Outcomes	Graduate Attributes	Teaching/Learning Methods	Assessment
Remembering & Understanding	PO1: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	PO2: 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 • Seminars
Applying & Analyzing	PO3: 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	PO4: 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	PO5: 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	PO6: 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	PO7: Recognize the need for, and be able to engage in lifelong learning.	Life-long Learning:	• Project work • Literature survey, Self Study • Project implementation	• Project Reports • Presentations • Rubrics
Apply	PO8: Use Modern Tools/Techniques	Use of Modern Tools	• Lab work • Projects • Internship/training	• Lab reports • Practical Exams • Rubrics

9. Keywords:

Learning Outcome based on Curriculum Frame work (LOCF)

Program Learning Outcomes (PLO)

Course Outcomes (CO)

Discipline Specific Electives (DSE)

Skill Enhancement Courses (SEC)

Ability Enhancement Compulsory Course (AECC)

Generic Elective Courses (GEC)

Learning Outcomes

Teacher Centric Teaching Learning Methodology

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