UNIVERSITY OF DELHI

MASTER OF SCIENCE
(Electronics)

(Effective from Academic Year 2018-19)

PROGRAMME BROCHURE

As approved by FIAS meeting held on dated 03/07/2018

As approved by Committee of Courses on 28/06/2018

M.Sc. (Electronics) Revised Syllabus as approved by Academic Council on XXXX, 2018 and Executive Council on YYYY, 2018

PROGRAMME BROCHURE

MASTER OF SCIENCE
(Electronics)

DEPARTMENT OF ELECTRONIC SCIENCE

UNIVERSITY OF DELHI SOUTH CAMPUS

BENITO JUAREZ ROAD, NEW DELHI

CONTENTS

I. About the Department

Historical Background of Department

The Department of Electronic Science was established in 1985 and is widely recognized as one of the most prestigious Electronic Science Departments in the country. The Department is conducting courses leading to M.Tech. in Microwave Electronics and M.Sc. in Electronics. The aim of these programmes is to provide the necessary theoretical background and practical experience in order to meet the requirements of the R&D Organizations and Industries. All students joining the M.Sc. course are required to undergo summer training in the Industry or R&D Organisations. In addition, the M.Tech. and M.Sc. students work for one Semester on projects in collaboration with Industry and R&D Organisations. The curriculum of these courses is updated regularly to keep it in consonance with the changing industrial environment involving various stakeholders at different stages. The interface with the Industry is further enhanced by an annual seminar under the Visitor's Programme in which professionals from industry, R&D organizations and academics are invited. The Department started the Ph.D. program as well in Electronics. Since, then, more than one hundred students have carried out their doctoral research work in the Department, and several of them now hold leadership positions in academia and industry. Our alumini, now spread over a large number of government and private organisations, facilitate these interactions.

Department Highlights

The Department is now well established, with seven faculty members currently. Extramural grants from DBT, DST, ICMR, CSIR, UGC, ICAR and DRDO, as well as intramural grants from the University of Delhi, have strengthened the Department's research. The Department has national and international collaborations and projects. The faculty is supported by several research projects funded by the National agencies like UGC, CSIR, DST, MIT, AICTE, DRDO. More than six hundred research papers have been authored by faculty members of the Department in peer-reviewed journals of international repute. The achievements of the Department have been recognized in the form of several awards conferred on the Department's faculty and students. The laboratory training in the department provides students with an exposure to the state of art technologies. This gives them practical skills to meet the growing challenges of industry, R & D and academics. The computer facility of the department is equipped with the latest computers and software packages. A formal course in computational techniques provides all students an understanding of numerical techniques and efficient programming practice in high level programming languages.

A full range of resources and facilities are available to the students. The department has a well equipped computer laboratory with various circuit simulation and microwave design software for students. The computer facility of the department is equipped with the latest computers and software packages. A formal course in computational techniques provides all students an understanding of numerical techniques and efficient programming practice in high level programming languages. Students are encouraged to use both FORTRAN 77 and C/C++. Use of mathematical tools like Mathcad and Matlab for solving class assignments is also encouraged. Circuit simulation tools like PSpice and Electronic Workbench as well as powerful simulation and design tools for microwave circuits are also available. Internet connectivity is available in the computer lab and other laboratories of the Department. The semiconductor devices and materials laboratory provides experimental setups to study and measure various properties of semiconductor materials. These include Hall measurements, Four-probe method, Vander Pauw Method etc. In addition, characteristics of semiconductor devices like UJT, FET, MOSFET, SCR etc. are also studied. Integrated Circuit Technology has revolutionized Electronics. The laboratory provides an exposure to instruments needed in the initial steps for integrated circuits. This includes creation and measurement of vacuum, deposition of thin films on substrates and pattern transfer techniques like photolithography. A C-V plotter is also available to study the characteristics of devices. More recently sophisticated facilities like x-ray diffraction, UV-VIS-NIR spectrophotometer and Keithley source-meter have been added with support from the DST-FIST grant.

In addition, there are well equipped laboratories for experimental work in the following areas: Communication Electronics, Optical Electronics, Circuit Design, Electrical Machines and Control Systems, Electronic Materials and Semiconductor Devices, Microprocessors and Digital Signal Processing and Microwave Measurements. Attempt is made to assess the students' performance through continuous series of tests and presentations in addition to semester end examinations to ensure highest standards. The Department is actively helping the students in their placement through Campus interviews. Students graduating from the Department have found positions in both government and private organizations working in Space Applications, Telecommunications and Semiconductors. The students graduating from the programs have the necessary theoretical and practical skills to take on any R&D and Production responsibilities in today's complex and challenging environment. This is evident from the contributions and achievements of our alumni in organizations like ST MicroElectronics, Cadence, HFCL, Aricent, Transwitch, SAMEER, ISRO, DRDO laboratories and many more.

About the M.Sc. (Electronics) Programme

The M.Sc. (Electronics) programme offered by Delhi University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars and assignments.

Three categories of courses are being offered in this programme: Core Courses (13 theory, 1 dissertation and 1 seminar courses offered by the Department), Elective Courses (students must opt for two out of six Elective Courses), and Open Elective (students may opt for any one Open Elective offered by either the Electronic Science Department or any other Department of the Faculty of Interdisciplinary and Applied Sciences). The Core Courses are of four/six/eight credits and include classroom as well as laboratory courses. A seminar on the recent topics of Electronics will presented by the students in Semester III and is worth two credits as a Core Course. A separate research- based course that leads to a dissertation and is worth eight credits is also one of the Core Courses. The Elective Courses are four credit courses and the Open Elective is a two credit course. The student is required to accumulate twenty-four credits each semester, a total of ninety-six credits, to fulfill the requirements for a Master of Science degree in Electronics.

Thirty percent of the total marks for each course will be awarded through Internal Assessment. Final examinations for two and four credit courses will be of two and three hours duration respectively while examinations for each laboratory-based course will be held over one day of six hours each for two credit courses respectively.

About Post-Graduate Attributes

The curriculum is designed to train the students in basic and advanced areas of Electronics by keeping in mind the latest advances in the field. Particular emphasis is laid on the practical aspects of the field. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively. To enable them to develop speaking and presentation skills, they are encouraged to deliver seminars on a wide range of topics covering the different areas of Electronics. A major component of their course is a dissertation in their final semester. The student is guided in choosing a research problem, executing experiments related to it, collecting data and analyzing it, and presenting the results in the form of an oral presentation as well as a thesis. The student presents his/her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme, the student will be well-versed in basic Electronics as well as be familiar with the most recent advances in Electronics, and will have gained hands-on experience in Electronics. The student will be able to take up a suitable position in industry or academia.

About the process of course development

The Choice- Based Credit System provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses have assigned credits on the basis of teaching hours, which in turn is linked to course content and structure.

When revising the syllabi for the courses of the M.Sc. Electronics Programme, the courses to be implemented as well as the content of each courses was extensively discussed and debated on, during the meetings between the faculty members and the students. Several alumni and Experts from Industry/Academia joined these meetings and gave useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts in the different areas of Electronics were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members of the Department, taking into account the feedback obtained from students, alumni, external experts and members of industry. The syllabi presented here have been discussed and approved by the Committee of Courses of the Department of Electronic Science.

II. Introduction to CBCS (Choice Based Credit System)

Scope of Choice Based Credit System:

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

Definitions:

(i) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.

(ii) 'Course' means a segment of a subject that is part of an Academic Programme

(iii) 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.

(vi) ‘Open Elective’ means an elective course which is available for students of all programmes, including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) ‘Credit’ means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

(viii) ‘SGPA’ means Semester Grade Point Average calculated for individual semester.

(ix) ‘CGPA’ is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

‘Grand CGPA’ is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

III. M.Sc. (Electronics) Programme Details:

Programme Objectives (POs):

At the time of completion of the programme the student will able to develop extensive knowledge in various areas of Electronics. Through the stimulus of scholarly progression and intellectual development, this programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice. By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individual.

Programme Specific Outcomes (PSOs):

At the end of the two year programme, the student will understand and be able to explain different branches of Electronics such as Communication Electronics, Optical Electronics, Circuit Design, Electrical Machines and Control Systems, Electronic Materials and Semiconductor Devices, Microprocessors, Digital Signal Processing, RF & Microwaves. The student will be able to execute a short research project incorporating techniques of Basic and Advanced Electronics under supervision. The student will be equipped to take up a suitable position in industry/academia.

These are given with each course in detail in Section IV.

Programme Structure:

The M.Sc. (Electronics) programme is a two-year course divided into four-semester. A student is required to complete 96 credits for the completion of course and the award of degree.

		Semester	*Semester*
Part-I	First Year	Semester I	Semester II
Part-II	Second Year	Semester III	Semester IV

<u>Course Credit Scheme</u>

Semester	**Core Courses**			**Elective Course**			**Open Elective Course**			**Total Credits**
	No. of papers	Credits (L+T/P)	**Total Credits**	No. of papers	Credits (L+T/)	**Total Credits**	No. of papers	Credits (L+T/P)	**Total Credits**	
I	4	16 + 8	24							**24**
II	4	16 + 4	20				1	4	**4**	**24**
III	4	14 + 6	20	3	4					**24**
IV	3	16 + 4	20	3	4					**24**
Total Credits for the Course										**96**

*For each Core and Elective Course there will be 4 lecture hours of teaching per week.

*Open Electives to the maximum total of 8 credits.

*Duration of examination of each paper shall be 3 hours.

*Each paper will be of 100 marks out of which 70 marks shall be allocated for semester examination and 30 marks for internal assessment.

Semester wise Details of M.Sc.(Electronics) Course

Semester I				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
ESCC101:Network Analysis and Synthesis	4	2	-	6
ESCC102:Semiconductor Devices and Material	4	2	-	6
ESCC103:Digital Circuit Design	4	2	-	6
ESCC104: Mathematical and Computational Techniques	4	2	-	6
Core course ‘n’ (total number) = 4	16	8	-	24
Total credits in core course	**24**			
Number of elective courses	**Credits in each elective course**			
Course	Theory	Practical	Tutorial	Credits
Elective course 1	-	-	-	-
Elective course ‘n’ (total number) = 0	-	-	-	-
Total credits in elective course	**-**			
Number of open electives	**Credits in each open elective**			
Course	Theory	Practical	Tutorial	Credits
Open elective	-	-	-	-
Total credits in open elective	-			

Note: Each theory core paper will be of 100 marks out of which 70 marks shall be allocated for semester examination and 30 marks for internal assessment. Each core paper has practical laboratory of 50 marks which is equivalent to 2 credits.

Semester II				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
ESCC201:Signals & Systems	4	-	-	4
ESCC202:Electromagnetics, Antenna and Propagation	4	2	-	6
ESCC203:Analog Circuit Design	4	2	-	6
ESCC204:Control Systems	4	-	-	4
Core course 'n' (total number) = 4	16	4	-	20
Total credits in core course	**20**			
Number of elective courses	**Credits in each elective course**			
Course	Theory	Practical	Tutorial	Credits
Elective course 1	-	-	-	-
Elective course 'n' (total number) = 0	-	-	-	-
Total credits in elective course	**-**			
Number of open electives	**Credits in each open elective**			
	Theory			Credits
ESOE101: Data Acquisition Systems#	4	-	-	4
Total credits in open elective	**4**			
#Open to students of other departments of FIAS also.				

Note: Each theory core and elective paper will be of 100 marks out of which 70 marks shall be allocated for semester examination and 30 marks for internal assessment. Each core paper has practical laboratory of 50 marks which is equivalent to 2 credits. The Open Elective of four credits will be of 50 marks out of which 38 marks shall be allocated for semester examination and 12 marks for internal assessment.

Semester III				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
ESCC301:Digital and Data Communication Systems	4	2	-	6
ESCC302:Photonics: Principles and Applications	4	2	-	6
ESCC303:Embedded System Design	4	2	-	6
ESCC304:Seminar	2	-	-	2
Core course 'n' (total number) = 4	14	6	-	20
Total credits in core course	**20**			
Number of elective courses	**Credits in each elective course**			
Course	Theory	Practical	Tutorial	Credits
ESEC101: RF and Microwave Systems*	4	-	-	4
ESEC102:VLSI Technology*	4	-	-	4
ESEC103: MEMS Devices*	4	-	-	4
Elective course 'n' (total number) = 1	4	-	-	4
Total credits in elective course	**4**			
***Student must opt for anyone of the three elective courses.**				
Number of open electives	**Credits in each open elective**			
	Theory			Credits
Open elective	-	-	-	-
Total credits in open elective	-			

Note: Each theory core and elective paper will be of 100 marks out of which 70 marks shall be allocated for semester examination and 30 marks for internal assessment. Each core paper except ESCC304 has practical laboratory of 50 marks which is equivalent to 2 credits.

Semester IV				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
ESCC401:Digital Signal Processing	4	2	-	6
ESCC402:Fabrication and Characterization Techniques for Electronics Devices	4	2	-	6
ESCC403: Dissertation	8	-	-	8
Core course 'n' (total number) = 3	16	4	-	20
Total credits in core course	**20**			
Number of elective courses	**Credits in each elective course**			
Course	Theory	Practical	Tutorial	Credits
ESEC104: Photonic Devices & Optical Communication*	4	-	-	4
ESEC105:Modern Communication Systems*	4	-	-	4
ESEC106: EMI & EMC*	4	-	-	4
Elective course 'n' (total number) = 1	4	-	-	4
Total credits in elective course	**4**			
***Student must opt for anyone of the three elective courses.**				
Number of open electives	**Credits in each open elective**			
	Theory			Credits
Open elective	-	-	-	-
Total credits in open elective	-			

Note: Each theory core and elective paper will be of 100 marks out of which 70 marks shall be allocated for semester examination and 30 marks for internal assessment. Each core paper except ESCC403 has practical laboratory of 50 marks which is equivalent to 2 credits. Dissertation (ESCC403) will be of 200 marks.

Selection of Elective Courses:

There should be a minimum 10 students opting for any elective course to run. ESEC101, ESEC102 and ESEC103 are being offered in Semester III. The student would choose any one of these three courses that would be worth four credits. ESEC104, ESEC105 and ESEC106 are being offered in Semester IV. The student would choose any one of these two courses that would be worth four credits. ESOE101 is an Open Elective being offered in Semester II. This course is open to students of other Departments of the Faculty of Interdisciplinary and Applied Sciences also. The students of the M.Sc. Electronics programme can also take up an Open Elective being offered by any of the other Departments of FIAS.

Teaching:

The faculty of the Department is primarily responsible for organizing lecture work for M.Sc.(Electronics). Faculty from some other Departments and constituent colleges are also associated with lecture and practical work in the Department. There shall be 90 instructional days excluding examination in a semester.

A separate research-based course that leads to a dissertation and is worth eight credits is also one of the Core Courses. This course is taken by the student in the final semester of the programme. The student carried out a small research project under the supervision of a faculty member and is evaluated on multiple components including the ability to search, read and assimilate literature related to the problem, to plan and execute experiments carefully and correctly, to observe and meticulously record the data obtained, to analyze the results qualitatively and quantitatively, to present the work carried out and results obtained before an audience of twenty to thirty people, and to defend the work in a viva-voce.

Eligibility for Admissions:

Admissions to this course will be in two categories: (I) 50% seats by direct merit on basis of marks obtained in B.Sc. (Hons.) Electronics, University of Delhi (II) 50% seats by entrance examination. Eligibility requirements are given below:

Category I (Admission on Merit Basis)

1. B.Sc. (Hons.) Electronics as per CBCS guidelines of University of Delhi

Category II (Admission on Entrance Exam Basis)

1.B.Sc. (Hons.) Electronics from University of Delhi 50% or above

2.B.Sc. (Hons.) Electronics from other Universities — 50% or above

3.B. Sc. (Hons.) Electronics, Instrumentation from University of Delhi — 50% or above

4.B. Sc. (Hons.) Electronics, Instrumentation from other Universities — 50% or above

5.B.Sc. (Hons.) Physics from University of Delhi — 50% or above

6.B.Sc. (Hons.) Physics from other Universities — 50% or above

7.B.Sc. programme with Electronics from University of Delhi — 60% or above

8.B.Sc. programme with Electronics from other Universities — 60% or above

9. B.Sc.(H) with atleast 04 courses / 04 Generic Elective courses of Electronics with atleast 24 credits as per CBCS guidelines of University of Delhi

All course requirements after 10+2+3

Seat -distribution under different categories

Course	**Intake Capacity**	**General**	**SC**	**ST**	**OBC**	**Total**
M.Sc. (Electronics)	16	08	03	01	04	**16 (Merit)**
	16	08	03	01	04	**16 (Entrance)**
						= 32

Entrance Test

The entrance test (of 2 or 3 hour duration) is conducted by the Department/University at various centres (list available during online application). In general, the test paper is of multiple choice objective type questions and further detail of the instructions will be available on the test paper. Entrance test is based on the syllabus of eligibility courses of the University with emphasis on Electronics. Syllabus for these B.Sc courses under CBCS are available at the Delhi University website and can be downloaded.

Assessment of Students' Performance and Scheme of Examinations:

1. English shall be the medium of instructions and examination.
2. Assessment of students' performance shall consist of:

    2.1: Each four credit theory course will carry 100 marks of which 30% marks shall be reserved for Internal Assessment (IA) based on class test, seminar/presentation and assignments. A two credit theory course will carry 50 marks of which 30% marks shall be reserved for Internal Assessment. The IA of every course will include at least two of the above components, and the weightage given to each of the components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course.

    2.2 Regarding ESCC403: Project work shall be carried out in Semester IV and will be worth eight credits. The candidate will submit a dissertation at the end of the semester. Total marks for dissertation shall be 200 and evaluation will be based on project work, report and presentation.

    2.3 There shall be FOUR Semester examinations comprised in the course. The minimum pass marks shall be 40% in each theory paper and 40% in practicals in each of the three semesters (I, II & III) and 40% in Seminar. In IV semester it will be 40% in each theory papers, 40% in Project/Dissertation.

Pass Percentage & Promotion Criteria:

Pass percentage: The student is required to pass separately both in theory and laboratory-based examinations. Minimum marks for passing the examination shall be 40% in aggregate in theory courses, 40% in laboratory courses and 40% marks in dissertation.

Pass percentage & Promotion criteria from semester to semester: Within the same Part, the candidate will be promoted from one semester to the next (Semester I to Semester II and Semester III to Semester IV), provided the candidate has passed at least two of the papers of the current semester by securing at least 40% marks in each paper.

Note: A candidate will not be allowed to reappear (even if he/she is absent) in the practical examination except in very special cases with approval of Head of the Department.

Part I to Part II Progression:

Admission to Part II of the progam shall be open to only those students who have fulfilled the following criteria:

1. Have scored at least 40% marks in the laboratory courses of both Semester I and II
2. Have passed at least 75% of the theory papers (6 papers) offered in courses of Part I comprising of Semester I and Semester II by securing at least 40% marks in each of these six papers and
3. Have secured at least 40% in aggregate of all theory papers of Part I.

Note: The candidate however will have to clear the remaining papers while studying in Part II of the programme in order to qualify for the receipt of a Master's degree.

Conversion of Marks into Grades:

As per University Examination rule

Grade Points:

Grade point table as per University Examination rule

CGPA Calculation:

As per University Examination rule.

SGPA Calculation:

As per University Examination rule

Grand SGPA Calculation:

As per University Examination rule

Conversion of Grand CGPA into Marks

As notified by competent authority the formula for conversion of Grand CGPA into marks is: Final %age of marks = CGPA based on all four semesters × 9.5

Division of Degree into Classes:

Post Graduate degree to be classified based on CGPA obtained into various classes as notified into Examination policy.

Attendance Requirement:

Students will be required to show a minimum of 75% attendance in every course in order to appear for the examinations at the end of each semester. In addition, five marks of the Internal Assessment component for every course will be reserved for attendance.

Span Period:

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of four years from the date of admission to the Part-I/Semester-I of the M.Sc.(Electronics) Programme.

Guidelines for the Award of Internal Assessment Marks M.SC.(Electronics) Programme (Semester Wise)

Theory courses: A four credit course will be evaluated for a total of 100 marks while a two credit course will be evaluated for a total of 50 marks. 30% of the total marks of every theory course shall be reserved for Internal Assessment. Internal Assessment (IA) for a theory course will be based on written class test, seminar/presentation and assignment. The IA of a theory course will include at least two of the above components, and the weightage given to each component shall be decided and announced at the beginning of the semester by the teacher (s) responsible for the course. Five marks will be reserved for attendance.

Laboratory courses: A two credit laboratory course will be evaluated for a total of 50 marks. 30% of the total marks of every laboratory course shall be reserved for Internal Assessment. Internal Assessment will be based on performance of experiments, maintenance of records of data and results obtained, and viva-voce.

Project work/dissertation: The eight credit project- based course will be evaluated for a total of 200 marks. Internal Assessment will be based on continuous evaluation of the student. The student will be evaluated on ability to search, read and assimilate literature related to the project, regularity and perseverance at experiments and maintenance of data notebooks.

IV: Course Wise Content Details for M.Sc.(Electronics) Programme:

MASTER OF SCIENCE
(Electronics)

Semester I
Course Code: ESCC101
Course Name: Network Analysis and Synthesis
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

To equip the students with rigorous theoretical and practical knowledge to analyze and synthesize networks.

Course Outcomes:

- Apply the knowledge of basic circuital law and simplify the network using reduction technique.
- Analyze the circuit using Kirchoff's law and network theorem.
- Infer and evaluate transient response, steady state response, network functions.
- Equip with network synthesis study.

Unit I: Network Theorems: Applications of Thevenin and Norton's theorem, Reciprocity theorem, Compensation theorem, Superposition theorem & Tellegen's theorem.

Unit II: Time Domain Analysis of Networks: Differential equation approach (first and higher order differential equations), initial conditions in networks. Laplace Transformation: Introduction to the Laplace transform approach, partial fraction expansion, Heaviside's expansion theorem, transform impedance and transform circuits, network functions, poles and zeroes of network functions and restrictions on pole and zero locations for driving-point functions and transfer function, stability of active network .

Unit III: Two Port Network Parameters: Transmission and inverse transmission parameters, hybrid and inverse hybrid parameters, relation between parameter sets, and interconnection of two port network. Graph Theory: graph tree, link branches, basic tie and cut set, matrices for planar networks, loop and nodal method of analysis

Unit IV: Network Synthesis: Properties of Hurwitz polynomial and positive real function, synthesis of LC, RC and RL network, Foster form and Cauer form.

Suggested Reading:

1. M. E. Van Valkenburg, "Network Analysis", 3rd ed., Pearson.
2. M. E. Van Valkenburg, "Network Synthesis", PHI.
3. DeCarlo, R. A. and Lin, P. M., "Linear Circuit Analysis: Time Domain, Phasor and Laplace Transform Approaches", Oxford University Press.
4. Hayt, Kemmerley and Durbin, "Engineering Circuit Analysis", 8th Ed. Tata McGraw-Hill.
5. Kuo, F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.

<u>List Of Experiments (Marks 50):</u>

Experiments will be based on the above syllabus.

Course Code: ESCC102
Course Name: Semiconductor Devices and Material
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

To provide basic knowledge and concepts of Semiconductor materials and devices.

Course Outcomes:

- Ability to apply basic concepts of Inorganic and Organic Semiconductor materials for electronic device application in modern electronic industry.
- Detailed knowledge of various classifications and applications to VLSI, LEDs and solar cells.
- Holistic view of the latest progress in two-dimensional (2D)-one-dimensional (1D) and nano materials.
- Emphasis on nano-electronic applications such as Schottky barrier transistors, flexible Electronics.

Unit I: Inorganic and Organic Semiconductor: Energy bands, carrier transport, mobility, drift-diffusivity, excess carrier, injection and recombination of the excess carriers, carrier statistics; High field effects: velocity saturation, hot carriers and avalanche breakdown.

Unit II: Majority carrier Devices: MS contacts rectifier and non-rectifier, MIS structures, MESFET, hetero-junction, HEMT and band diagrams, I-V and C-V characteristics.

Unit III: MOS structures: Semiconductor surfaces; The ideal and non-ideal MOS capacitor band diagrams and CVs; Effects of oxide charges, defects and interface states. MOSFET: Structures and Device Characteristics, Short-Channel effects. Charge coupled Devices (CCDs), application to VLSI.

Unit IV: Nonvolatile Memory Device. Optoelectronic Devices: solar cell, photo detectors, LEDs, laser diodes. **Nano structures and concepts:** quantum wells, supper lattice structures, nanorod, quantum dot, CNTs, 2D materials: grapheme, BN, MoS_2 etc, matamaterials.

Suggested Reading:

1. Donald A. Neamen, Semiconductor Physics and Devices Basic Principles, 3rd edn. McGraw-Hil (2003)
2. B.G. Streetman and Sanjay Banerjee, Solid State Electronic Devices, 6th Edn., Prentice Hall, 2006.
3. S. M. Sze and Kwok K. Ng Physics of Semiconductor Devices, Wiley (2013).

4. M. Hussa, A. Dimoulas and A. Molle, 2D Materials for NanoElectronics, CRC press (2016)
5. M.S.Tyagi, Introduction to Semiconductor Materials and Devices, Willey, Student Edition

List Of Experiments (Marks 50):

1. To study the Hall Effect: determine the Hall coefficient, type of semiconductor and carrier concentration in the given semiconductor sample.
2. To study the four probe method: calculate the resistivity and energy band gap of given semiconductor sample.
3. To determine the resistivity of the given semiconductor specimen using Vander Pauw method.
4. To design a MOSFET as switching regulator for given duty cycle and plot the current-voltage (I-V) characteristic of MOSFET using Keithley.
5. To design a phase controlled rectifier using SCR and plot the I-V characteristic of SCR using Keithley.
6. To design a relaxation oscillator using UJT and plot the I-V characteristic of UJT using Keithley.
7. I-V characteristics measurement of a p-n diode/LEDs using Keithley - calculate its ideality factor.

Course Code: ESCC103
Course Name: Digital Circuit Design
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

The course offers students to learn how to minimize the Boolean expression by advanced digital design techniques, programmable logic devices; to understand analysis, designing and reduction techniques for sequential circuits by using Algorithmic state machine and asynchronous sequential circuit design by using transition table. Also course explains concept of fault diagnosis; VHDL programming language and digital designing tools like FPGA, ASIC.

Course Outcomes:

- To learn how to design digital systems, from specification and simulation to construction and debugging.
- To learn techniques and tools for programmable logic design.
- To understand the limitations and difficulties in modern digital design, including wiring constraints, high-speed, etc.
- To design, construct, test, and debug a moderate-scale digital circuit.
- Familiarity with the latest state-of-the-art system on chip (SoC) design methods using FPGAs and ASIC design chips.
- Through the practical assignments, experience will be achieved from both using tools as well as designing their own system.

Unit I: Introduction to Computer-aided design tools for digital systems: SIMO, MIMO. The tabulation method(Quin Mc-clusky), Determination of Prime implicants, Selection of Essential Prime implicants, Iterative Consensus, Generalized Consensus method, Map-entered variables method of Multiple output minimization.
Analysis and Design of combinational System: Multiplexers, ROMs, PLAs, PALs, SPLDs, SRAM.

Unit II: Sequential Circuit Design: Analysis of clocked synchronous sequential circuits and modelling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuit design of iterative circuits-ASM chart and realization using ASM.

Unit III: Asynchronous Sequential Circuit Design: Analysis of asynchronous sequential circuit, flow table reduction, races-state assignment, transition table and problems in transition table, design of asynchronous sequential circuit-Static, dynamic and essential hazards, data synchronizers, mixed operating mode asynchronous circuits, Clock skew, set up and hold time of a flip-flop. Behavioral models of combinational and sequential logics.

Unit IV: Fault Diagnosis and Introduction To VHDL: Introduction to testing and fault diagnosis in digital circuits: fault modeling, test generation and fault simulation, fault diagnosis, design for testability and built-in self-test.
Introduction to VHDL Programming language, data objects, classes and data types, Operators, Overloading, and logical operators. Types of delays Entity and Architecture declaration, Introduction to behavioral, dataflow and structural models Application of Functions and Procedures, Structural Modelling, component declaration, structural layout and generics
Introduction to FPGAs, ASIC Programming Technology for designing and its device Architecture.

Suggested Reading:

1. M Morris Mano, Digital logic and computer design; PHI.
2. J.F.Wakerly: Digital Design, Principles and Practices, 4th Edition, Pearson Education, 2005
3. Ken Martin, "Digital Integrated Circuit Design", Oxford University Press, 2002..
4. N.N.Biswas, "Logic Design Theory ", Prentice Hall, 1993
5. H. Taub and D. Schilling, Digital Integrated Electronics, McGraw Hill, 1977.
6. D. A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International student Edition, McGraw Hill, 1983.
7. F.J. Hill and G.L. Peterson, Switching Theory and Logic Design, John Wiley, 1981.
8. Z. Kohavi, Switching and Finite Automata Theory, McGraw Hill, 1970.
9. Charles H Roth: Digital Systems Design using VHDL, Thomson Learning, 1998
10. Stephen M.Trimberger "Field Programmable Gate Array Technology" Springer International Edn.
11. VHDL, Primer: J Bhasker, 3rd Edn- Pearson Education
12. VHDL, Programming by Example: Douglas L. Perry, 4thEdn.-TMH.

Digital Circuit Design Lab

List of Experiments (Marks 50):

Experiments based on above the theory course.

Course Code: ESCC104
Course Name: Mathematical and Computational Techniques
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

To improve and summarized the mathematical and computational techniques among the students.

Course Outcomes: On completion of this course, student able

- To apply various techniques to solve homogenous and non-homogenous differential equations to describe various physical phenomenon.
- To apply partial differential techniques to solve the physical engineering problems.
- To implement transform techniques to designing electrical circuits, solving differential and integral equations.
- This course also provides a theoretical and practical knowledge of working with MATLAB and helps to get jobs in software industry which also helpful for those who go for higher studies.

Unit-I

Ordinary Differential Equations: Introduction to first order, second order, homogeneous, non-homogeneous equations, system of equations.

Orthogonal Functions in Mathematical Physics and Engineering: Bessel Functions, Spherical Bessel Functions, Legendre Polynomials, Associated Legendre Polynomials, Hermite Polynomials, Laguerre Polynomials, Associated Laguerre Polynomials, Chebyshev Polynomials – corresponding differential equations, graphical representation and orthogonality.

Sturm-Liouville's problem: applications and examples. Green's function technique and its application. Calculus of variations with examples.

Unit-I

Laplace Transform: Definition and Properties, Laplace Transform derivatives and integrals, Evaluation of differential equations using Inverse Laplace Transform, Applications of Laplace Transform to Integral Equations and ODEs. **Fourier Series & Transform**: Definition and Properties, Fourier Series in the Interval, Uses of Fourier Series, Physical Examples of Fourier Series, Fourier sine and cosine transform of Derivatives, Finite Fourier Transform, Applications of Fourier Transform.

Unit II:

Partial differential equations: Homogeneous and non-homogeneous boundary conditions, Solutions by separation of variables and series expansion methods. Laplace, wave and diffusion equations in various coordinate systems. **Integral equations:** methods and solutions,

Unit IV:

MATLAB environment: Managing the workspace, Matrix and Vectors, Matrix and Array operations, Arithmetic and Logical operations. Creating simple plots, MATLAB scripts and functions (m-files), Control structures (if, if-else, else-if, switch, for, while etc).

Computational Techniques using MATLAB: Numerical Integration & Differentiation, Linear system of equations, Fourier and Laplace transform. Plotting of data: contour plot, surface plot, mesh plot, 3-D plot etc.

Suggested Reading:

1. Advanced Engineering Mathematics by E Kreyszig (John Wiley & Sons)
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics, By H. K. Das, S.Chand &company Ltd. Ram Nagar, New Delhi.
4. Getting Started with MATLAB, Fifth Edition by Rudra Pratap, Oxford University Press.
5. A Concise Introduction to MATLAB, Fourth Edition, by William J. Palm III, McGraw Hill Education.
6. Basics of MATLAB and Beyond by Andrew Knight, CRC Press.

List of Experiments(Marks 50):

Experiments based on above theory course.

Semester II
Course Code: ESCC201
Course Name: Signals & Systems
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

- The concepts and theories of signals and systems form the foundation for further studies in areas such as analog and digital communication, analog and digital signal processing, control systems and circuit analysis and synthesis.
- The aim of building complex systems that perform sophisticated tasks imposes on students a need to enhance their knowledge of signals and systems so that they are able to effectively use the rich variety of analysis and synthesis techniques in an application-specific manner.

Course Outcomes:

- By the end of course, students will be able to understand mathematical description and representation of both continuous-time and discrete-time signals and systems and their properties.
- Further, the fundamental input-output relationship for LTI systems and the concept of correlation of energy and power signals will be discussed.
- Through this unit, students will learn about the concept of frequency domain representations and how to decompose periodic signals into their frequency components.
- Through this course, students will learn about sampling of continuous-time and discrete-time lowpass and bandpass signals.
- This course will discuss block diagram representation of a system, and methods of realization of a given system H (z) through different realization structures.
- Students will be able to correlate the Laplace and Z-transforms of sample signals and understand mapping of s-plane into the z-plane.

Unit I: **Introduction to Signals & Systems:** Basic concepts and definitions of continuous and discrete time Signals, their classification, continuous and discrete time system and their properties, linear time invariant systems response for continuous time systems and discrete time systems. Properties of continuous and discrete LTI systems. System representation through differential equations and difference equations.

Unit II: Introduction to Fourier Transform: Fourier analysis, continuous and discrete time Fourier series and its properties, Fourier Transform for continuous and discrete time signals. Magnitude and phase spectra of continuous and discrete time signal, response of LTI system using Fourier transform. Applications of Fourier transform.

Unit III: **Sampling:** Sampling theorem for low-pass signals, aliasing, sampling techniques, Impulse sampling, Natural sampling, Flat-top sampling, Aperture effect.

Unit IV: **The Laplace Transform:** The Region of Convergence for Laplace Transforms. The Inverse Laplace Transform. Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot. Properties of the Laplace Transform. Some Laplace Transform Pairs. The Unilateral Laplace Transform.

Unit V: **The z- Transform:** Basic principles of z-transform, z-transform definition, Unilateral and Bilateral Z-Transform, Relationship between z-transform and Fourier transform, Region of Convergence, Properties of ROC, Properties of z-transform, Poles and Zeros, Inverse z-transform using Contour integration, Power Series expansion and Partial fraction expansion.

Suggested Reading:

1. A.V. Oppenheim, A.S. Willsky, S.H. Nawab, “Signals & Systems”, Prentice Hall Publication
2. S. Haykin, B. V.Veen “Signals & Systems”, Wiley Publication
3. H. P. Hsu,“Signals & Systems” Schaum’sOutline Series

Course Code: ESCC202
Course Name: Electromagnetics, Antenna and Propagation
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:
The student learns the fundamental solutions of time-varying Maxwell's equations, and applies them to design antennas. The student understands radio wave propagation phenomena in modern communication systems, and fundamentals of electromagnetic radiation with application to antenna theory and design.

Course Outcomes:
- Use of electromagnetics, physics, and mathematics to understand fundamentals of antennas.
- Understand important and fundamental antenna engineering parameters and terminology,
- Learn the basic concepts of electromagnetic wave radiation and reception,
- Develop the basic skills necessary for designing a wide variety of practical antennas and antenna arrays.

Unit I: Maxwell's equations and Electromagnetic Wave Propagation: Maxwell's equations, constitutive relations, wave equation, plane wave functions, wave propagation in lossy dielectric, plane waves in lossless dielectrics, power and Poynting vector.

Unit II: Transmission lines: transmission line equation in time and frequency domain, losses and dispersion, reflection from an unknown load; quarter wavelength, single stub and double stub matching; Smith Chart and its applications.

Unit III: Waveguides: Rectangular waveguide, circular waveguide, dielectric slab waveguide surface guided waves, TE and TM modes, waveguide components.

Unit IV: Antennas: Antenna parameters, radiation from simple dipole and aperture, concept of antenna arrays, end fire and broadside arrays, horn antenna, microstrip antenna, parabolic disc antenna. Ground wave, space wave and ionospheric propagation. Communication link budget for ground transmission

Suggested Reading:
1.M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
2. W. H. Hayt and J. A. Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
3. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
4. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
5. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
6. Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)

7. Constantine A. Balanis, “Antenna Theory: Analysis and Design’, 3rd Edition, by, Wiley, 2005
8. John S. Seybold, ‘Introduction to RF propagation’, by, Wiley, 2005.
9. David Pozar, “Microwave Engineering”, 4th edition, by, Wiley, 2012.
10. John Volakis, ‘Antenna Engineering Handbook’, 4th Edition, by, McGraw-Hill, 2007.

<u>List of Experiments (Marks 50):</u>

Experiments will be based on this syllabus.

Course Code: ESCC203
Course Name: Analog Circuit Design
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Course Outcomes:

At the end of the course student will be able

- To draw the equivalent circuits of MOS based analog circuits and analyze their performance.
- To analyze the frequency response of the different configurations of an amplifier.
- To understand the feedback topologies involved in the amplifier design.
- To appreciate the design features of the differential amplifiers.

Unit I: Basic MOS device Physics: MOS I/V characteristics, Second order effects, MOS device models, Short channel effects and device models.
Single-stage amplifiers: Basic concepts, Common source stage, Source follower, Common gate stage, Cascode stage.

Unit II: Differential amplifiers: Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell.
Passive and active current mirrors*:* Basic current mirrors, Cascode current mirrors, Active current mirrors.

Unit III: Frequency response of amplifiers: Common source stage, Source followers, Common gate stage, cascode stage, Differential pair.
Noise: Types of noise, Representation of noise in circuits, Noise in single stage amplifiers, Noise in differential pairs.

Unit IV: Feedback amplifiers: Feedback topologies, Effect of loading.
Operational Amplifiers: One stage OP Amps, two stage OP Amps, Gain boosting, Common-mode feedback, Input range limitations, Slew rate, Power supply rejection, Noise in Op Amps, Stability and frequency compensation.
Bandgap references, Introduction to switched capacitor circuits, Nonlinearity and mismatch.

Suggested Reading:

1. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill edition 2002.
2. Paul. R. Gray and Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, 4th edition, Wiley, 2001.
3. D. A. Johns and K. Martin, “Analog Integrated Circuit Design”, Wiley,1997.
4. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd edition, Wiley, 2010.
5. P. E. Allen and D. R. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, 2002.
6. Adel S. Sedra and K. C. Smith, “MicroElectronics Circuits”, 6th edition, Oxford University Press India
7. Muhammad H. Rashid, “MicroElectronics Circuits: Analysis and Design”, 2nd edition, Cengage, India.

List Of Experiments (Advanced Analog Design**) (Marks 50):**

Experiments will be based on above syllabus.

Course Code: ESCC204
Course Name: Control Systems
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Course Objective:
This course is to develop an understanding of the fundamentals of control theory, determine and use models of physical systems in forms suitable for use in the analysis and design of control systems. In particular understand: the concept of feedback and its properties; stability analysis of a feedback system; the concept of stability and stability margins; the different tools that can be used to analyze the properties of control system and the steady state error in control system.

Course Outcome: This course is to develop an understanding of the elements of classical control theory as applied to the control of real life applications such as spacecraft, car etc. In particular understand: the concept of feedback and its properties; the concept of stability and stability margins; and the different tools that can be used to analyze the properties of control system.

Unit I: Introduction to Control systems: Necessity and examples of control systems, feedback control systems. Mathematical modeling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. State-spacemodelling of dynamical systems, Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula. Linearity, Time-invariance versus nonlinearity and time-variance Linearization, Distributed parameter systems

Unit II: Mathematical models: Obtaining solutions from mathematical models, Poles and zeros and their effects on solutions, Transient response of second order system, Time domain specifications for unit step response, Steady state error-linear continuous data control system. Generalized error coefficient and its evaluation, Correlation between static and dynamic error coefficients.

Unit III: Feedback control systems: Basic idea of feedback control systems, Definition of stability. Routh-Hurwitz test.Lyapunov theory.Bode plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, and robustness. The root-locus technique, steps in obtaining a root-locus. Design of controllers using root-locus,Error analysis,

Unit IV: P, PI, PD and PID controllers: Proportional (P), Proportional Integrator(PI), Proportional Derivative(PD), Proportional Integrator Derivative(PID) controllers, Pole placement with state feedback, controllability. Pole placement with output feedback, observability, Luenberger observer LQR controlLead compensator, lag compensator, lead-lag/lag-lead compensators, and their design.

Suggested Reading:

1. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 5th Edition,2009
2. Automatic Control Systems by Benjamin C.Kuo Wiley Publisher, 9th Edition, 2009.
3. Control Systems by S. HasanSaeed 6th Edition, Katson Books,2011
4. Control Systems Engineering by I.J.Nagrath and M. Gopal, New Age Intl., 2008
5. Control Systems by N.K.Sinha, New Age International (P) Limited Publishers, 3rd Edition, 1998

Course Code: ESOE101
Course Name: Data Acquisition Systems
(Credits: 04)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

In essence, the objective of this course is to reliably and accurately acquire and record data from a variety of sensors and external devices.

Course Outcomes:

- Understanding the concepts of acquiring the data from transducers/input devices, their interfacing and instrumentation system design.
- After the successful completion of the course the students will be able to elucidate the elements of data acquisition techniques.
- The course aims at developing the understanding of design and simulation of signal conditioning circuits.
- To develop and specialize the applications of a data acquisition, compose and organize new applications and to evaluate the system performance.

Unit I: Data Acquisition Techniques: Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.

Unit II: Data Acquisition with Op-Amps: Operational Amplifiers, CMRR, Slew Rate, Gain, Band-width. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits

Unit III: Data Transfer Techniques: Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4 - 20 mA current loop, GPIB/IEEE - 488, LAN, Universal serial bus, HART protocol, Foundation -Fieldbus, ModBus, Zigbee and Bluetooth.

Unit IV: Data Acquisition System using computers (DAS):Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC - Based data acquisition system

Suggested Reading:

1. H. Rosemary Taylor,"Data Acquisition for Sensor Systems",Chapman and Hall.
2. J. Park, S. Mackay,"Data Acquisition for Instrumentation and Control Systems", Elsevier.
3. H. Austerlitz,"Data Acquisition Techniques using Personal Computers", Academic Press.
4. Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education.
5. Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited

Semester III

Course Code: ESCC301
Course Name: Digital and Data Communication Systems
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

At the end of this course students will be able to visualize how analog signals are converted to digital signals for voice and data transmission; the concept of multiplexing to fulfill the demand of high speed digital transmission across the globe; the various methods of generation of digital signals (ASK,FSK,PSK,QAM) according to the application requirements; implement optimization techniques, data coding, channel requirements, signal to noise ratio, bandwidth, error finding within the received information and information theory.

Course Outcomes:

- With advent of areas such as GSM, GPS, Bluetooth, RFID, DTMF, Mobile, Ethernet, RF, XBEE, Networking, Data Acquisition, Smart city and Smart Card, Internet of things the knowledge of the subject is an essential need.
- Today multiplexing have become an extremely important asset to telecommunication processes and has greatly improved the way that we transmit and receive independent signals over AM and FM radio, telephone lines, and optical fibers.
- Digital communication has become ubiquitous for success in the workplace. It helps in networking, demonstrates efficiency, stable foundation for documentation etc.
- The most important part in transmission is noise immunity. So after understanding the above topics the students will be able to implement optimization techniques and will have a better understanding of data coding, channel requirements, signal to noise ratio, bandwidth, error finding within the received information

Unit I: Digital Transmission: Sampling and quantization, Low pass sampling – Aliasing, Signal Reconstruction, Quantization - Uniform & non-uniform quantization - quantization noise - Logarithmic Companding of speech signal.PCM, DPCM, DM, ADM Properties of Line codes-Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ – Manchester, ISI – Nyquist criterion for distortionless transmission Multiplexing**:** Many to one/one to Many, Frequency division Multiplexing, Time division Multiplexing, Multiplexing applications, introduction to multiple access techniques

Unit II: **Digital Modulation Scheme:** Random Processes and Spectral Analysis: Concept of Probability, Random variable, Random Process, Classification of Random Processes, Power spectral density **,** Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, DPSK quadrature modulation/demodulation techniques.(QPSK and MSK),M-ary Digital carrier Modulation/demodulation, QAM

Unit III: Performance Analysis Of Digital Communication System: General Binary Signaling, Coherent Receivers for Digital Carrier Modulations, General Expression for Error Probability of optimum receivers.
Information Theory**:** Measure of Information, Source Encoding, Entropy, Channel capacity, Error Correcting codes: Hamming code, linear block codes, cyclic codes, Huffman coding, Shannon-Fano coding, code tree & Trellis diagram

Unit IV: Introduction To Data Communication and Networking: Data Communication, network architecture, Networks, Protocols and Standards, data link layer Standards Organizations. Line Configuration, Topology, Transmission Modes
Types of transmission media: Guided Media, Unguided Media, Transmission Impairments, Circuit switching

Suggested Reading:

1. B.P.Lathi,"Modern Digital and Analog Communication Systems", Oxford University Press Publication
2. H. Taub, D.L. Schilling, G. Saha,"Principles of Communications", McGraw-Hill International Publication
3. SimonHaykin,"Communication Systems", Wiley India Publication. 3. H.P.HSU and D.Mitra,"Analog and Digital Communications", TataMcGraw-Hill Publication

<u>List Of Experiments (Digital Communication Lab) (Marks 50):</u>

1. To analyze a PCM system and interpret the modulated and demodulated waveforms for a sampling frequency
2. To analyze a Delta modulation-demodulation and observe effect of slope overload
3. To analyze a FSK modulation system and interpret the modulated and demodulated waveforms
4. To analyze a PSK modulation system and interpret the modulated and demodulated waveforms
5. To demonstrate Time Division Multiplexing and De-multiplexing process using Pulse amplitude modulation signals
6. To simulate Binary Amplitude shift keying technique using MATLAB software
7. To simulate Binary Frequency shift keying technique using MATLAB software
8. To simulate Binary Phase shift keying technique using MATLAB software
9. To simulate Quadrature Phase shift keying technique using MATLAB software
10. To simulate Differential Phase shift keying technique using MATLAB software
11. Study of single bit error detection and correction using Hamming code

Course Code: ESCC302
Course Name: Photonics: Principles and Applications
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

- Photonics is a key technology of the 21st century. It forms, for example, the basis for today's optical communications, environmental sensing, biomedical diagnostics in the life sciences, energy efficient lighting and solar energy harvesting.
- Upon completion of this course, students should understand the basic principles of modern physical optics and photonics. They should be able understand the principle of operation of modern photonic devices and optical communication.

Course Outcomes:

- Students will be able to understand the need for an electromagnetic description of propagation and properties of light waves.
- Students should understand the basic principles of light propagation and diffraction. They should be able to read the specifications of commercial optical instruments such as a scanner for a laser printer, or a spectrometer, and determine how these specifications impact the intended application.
- Students should understand the basic principles of various devices used in modern optical devices used in manipulation of optical signals and optical communication.
- Students will understand guided wave propagation, suface plasmon waves at metal interfaces and propagation through optical fibers in context to optical communication**,** the operation of lasers and optical fiber amplifiers which form the backbone of photonics technology.

Unit I: Light as electromagnetic wave: Review of Maxwell's equations and propagation of electromagnetic waves, various states of polarization, reflection and refraction of electromagnetic waves, Brewster angle, total internal reflection and evanescent waves, optics of metals.

Unit II: **Diffraction and Fourier Optics:** Fraunhofer Diffraction of optical waves propagating through apertures, the effects on the resolution of imaging systems and the spreading and focusing of optical beams, Gaussian beams, introduction to Fourier analysis for treating diffraction. Fourier Optics, basics of Fourier transformation, spatial frequency, Fourier transform by diffraction and a lens, spatial frequency filtering.

Unit III: Anisotropic Media and Crystal Optics: Plane waves in anisotropic media, wave refractive index, uniaxial and biaxial media, wave plates and analysis of polarized light, electro-optic effect andacousto-optic effect, application to modulators. Faraday effect, optical isolators.Sagnac effect, gyroscopes. Nonlinear optics and applications.

Unit IV: Guided Waves and Optical Fibers: Planar optical waveguides, Guided modes in symmetric dielectric waveguides, surface plasmon modes at dielectric metal interface, Step- and graded-index optical fibers, Multimode and single mode fibers, attenuation, material and modal dispersion, broadening of optical pulses in fibers. Introduction to guided wave integrated optical devices.

Unit V: Lasers: Interaction of radiation and matter, Einstein's coefficients, line shape function, condition for amplification. Optical resonators, resonator losses and Q-factor, condition for laser oscillations. Longitudinal and transverse modes. Some laser systems including fiber amplifiers and fiber lasers.

References:

1. AjoyGhatak, Optics, Tata-McGraw Hill, 2017.
2. R.D. Guenther, Modern Optics, John Wiley and Sons, 1990.
3. A. K. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University, 1989.
4. M. Born and E. Wolf, Principles of Optics, Cambridge University Press, 1999.
5. B.E.A. Saleh and M.C. Teich, Fundamentals of Photonics, John Wiley and Sons, 2007.
6. O. Svelto, Principles of Lasers, Springer, 2010.
7. A. Yariv and P. Yeh, Optical Waves in Crystals, Wiley-Interscience, 2002 .
8. A. K. Ghatak and K. Thyagarajan, Lasers, Macmillan Publishers, India, 2011.

List Of Experiments (Marks 50):

Experiments based on the above theory course.

Course Code: ESCC303
Course Name: Embedded Systems
(Credits: Theory-04, Practicals-02)

Marks: 100 **Duration: 60 Hrs**

Course Objective:

- Products using microprocessors generally fall into two categories-the first category uses high-performance microprocessors such as the Pentium in applications where system performance is critical.
- In the second category, performance is secondary while issues of space, power and rapid development are more critical than raw processing power.
- From this knowledge, the design and interfacing of microcontroller-based embedded systems can be explored.
- This course is especially important for practicing technicians, hardware engineers, computer scientists and hobbyists for building projects in which data is collected and fed into a PC for distribution on a network.

Course Outcomes:

- Students will be able to understand the general concept of embedded systems.
- Students will learn to compare and contrast microprocessors and microcontrollers, and the advantages of microcontrollers for specific applications.
- This unit will also elaborate on the history, architecture and instruction set of 8051 microcontroller.
- By the end of this unit, students will understand the variations of speed, packaging, memory and cost per unit and how these affect choosing a microcontroller
- To assemble and run an 8051 program, detailing the execution of assembly language instructions.
- Through this unit, students will be able to contrast and compare serial versus parallel communication.
- To assemble and run an 8051 program, detailing the execution of assembly language instructions.
- Through this unit, students will be able to contrast and compare serial versus parallel communication.

Unit I: Introduction to Embedded Systems: Sensors and Actuators, Examples and Real world applications of Embedded Systems, Recent trends in Embedded Systems, Requirements of Embedded Systems.

Unit II: Introduction to Microcontrollers: Overview of Microcontroller 8051, Architecture, Register Banks, Special purpose registers and Stack, On-chip RAM Space, Addressing Modes, Instruction Set.

Unit III: 8051 Microcontroller programming: Assembly language programming of 8051, Timer Programming in Assembly, 8051 Serial communication using USART protocol and Programming.

Unit IV: AVR Microcontroller: Integrated Development Environment (IDE) for Embedded Systems, Introduction to AVR family of Microcontrollers, AVR CPU, System Clock and Clock option.

Suggested Reading:

1. P.H. Dave, H.B. Dave,"Embedded Systems- Concepts Design and Programming", Pearson Publication.
2. Shibu KV,"Introduction to Embedded Systems", Tata McGraw Hill Publication.
3. M.A. Mazidi, J. G. Mazidi, R.D. McKinlay,"The 8051 Microcontroller and Embedded Systems", Pearson Publication.
4. M.A. Mazidi, S.Naimi, S.Naimi,"The AVR Microcontroller and Embedded Systems", Pearson Publication.

List of Experiments (Marks 50):

Experiments based on the above theory course.

Course Code: ESCC304
Course Name: Seminar
(Credits: -02)

Marks: 100 **Duration: …. Hrs**

Students will give presentations on current and emerging topics of Electronics.

Semester III
Course Code: ESEC101
Course Name: RF & Microwave Systems
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Pre-requisites: Maxwell's equations, Electromagnetic theory, basics of transmission lines, TEM, TE and TM modes of propagation, Electromagnetic Wave Propagation in waveguide.

Course Objectives:
Knowledge of microwave technology is essential in developing the systems for mobile communication, satellite and RADAR. Such systems consist of microwave active and passive components. A design concept for RF and microwave systems will enable students to use their expertise in industry as well as R & D institutions.

Course outcomes:
- To understand the basic concepts of microwaves and propagation through the transmission lines, microwave components
- To learn the requirement of impedance matching and techniques
- To understand the generation of microwaves through the vacuum-based tubes
- To understand the working of microwave active circuits and study of various microwave semiconductor devices.
- To learn the test methods at the microwave frequencies
- To understand the design and concepts of microwave communication
- To understand the working of RADAR and its types.

Unit I: Introduction to microwave transmission- applications and limitations: Review of transmission lines and their properties, Microwave components: Directional coupler, E&H plane Tee, Magic Tee, Circulator, Isolator, Frequency meter, Attenuator and Phase Shifter

Unit II: Impedance matching techniques: LC network, single and double stub tuning using the Smith chart, Tube based devices: klystron amplifiers, Reflex klystron oscillators, Magnetron oscillators, TWT amplifiers.

Unit III: Principles of Microwave amplifiers, oscillators and mixer: GUNN, IMPATT, TRAPATT, BARITT devices, PIN diode and TUNNEL diode.
Microwave Measurements: Power, Frequency, Impedance, VSWR, Network analyzer and spectrum analyzer.

Unit IV: Microwave LOS Communicatio: Microwave Transmitter and receiver systems, Introduction to RADAR, range equation, Continuous wave and Pulse radar, Synthetic aperture radar.

Suggested Reading:

1. Samuel Y.Liao, “Microwave Devices and Circuits”, 3rd edition, Pearson education
2. Kai Chang, “RF and Microwave Wireless Systems”, Wiley, 2015.
3. Kennedy, Davis, Prasanna, "Electronic Communication Systems", 5th Edition, Tata McGraw Hill.
4. R.E.Collin, “Foundations for microwave Engineering”, 2nd edition, Tata Mc Graw Hill, 1992.
5. Annapurna Das, Sisir.K.Das, “Microwave Engineering”, Tata McGraw Hill, 2000.

Course Code: ESEC102
Course Name: VLSI Technology
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

- To provide students with rigorous foundation in MOS and CMOS devices and circuits.
- To provide exposure to students and to equip them for semiconductor and VLSI industry, R & D organization in the area of microElectronics.

Course Outcomes:

- Implement the logic circuits using MOS and CMOS technology.
- Acquire the knowledge about various CMOS fabrication process and its modeling.
- Infer about the second order effects of MOS transistor characteristics.
- Analyse various circuit configurations and their applications.
- Analyse the merits of circuits according to the technology and applications.
- Understand the rapid advances in CMOS Technology.

Unit I: Passive element and integrated circuit design: Semiconductor resistors, design of diffused semiconductor resistors, thin-film resistors, resistor tolerances, monolithic and MOS capacitors, Complementary MOS structures, pattern generation, mask-alignment tolerance, minimum layout spacings, layout of silicon integrated circuits.

Unit II: Basic MOS device physics and MOSFET operation: Enhancement and Depletion mode MOSFETs, MOS I-V characteristics, second order effects, MOS device layout, MOS device capacitances, scaling, short channel effects, fundamental limit to scaling, MOS Spice model, Spice level 1 model, level-2 model (including parasitic S/D resistance), Introduction to BSIM models.

Unit III: Basic MOS Inverter design: voltage transfer characteristics, logic threshold, NAND/NOR logic, inverter with resistive, enhancement and depletion loads, noise margin, transit time and inverter delay, CMOS inverter: complete analysis, pass transistor, switch level RC delay model.

Unit IV: MOS design rules: Combinational and sequential CMOS logic design, MOS memories and programmable logic arrays, non-volatile semiconductor memories with MOS technology, MOS layers, Stick diagrams, CMOS design rules and layout, Lambda and micron design rules, DRC, layout *vs* schematic checks.

Unit V: VLSI assembly technology and fabrication technologies: mechanism of yield loss in VLSI, modeling of yield loss mechanism, reliability requirements for VLSI: basic ideas of time dependent dielectric breakdown, antenna effect, IR drop and other reliability issues, Failure mechanism in VLSI, fault finding in VLSI chips, packaging of VLSI device, packaging type, packaging design consideration.

Suggested Reading:

1. N.H.E. Weste, D. Harris, “CMOS VLSI Design (3/e)”, Pearson, 2005.
2. Wayne Wolf, “Modern VLSI Design, 2^{nd} Edition”, Prentice Hall
3. Pucknell and Eshraghian, “Basic VLSI Design”, (3/e), PHI, 1996.
4. J. Rabey, M. Pedram, “Digital Integrated Circuits (2/e)”, PHI, 2003.
5. Sung-Mo (Steve) Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, McGraw Hill, 2002.

Course Code: ESEC103
Course Name: MEMS Devices
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Pre-requisites: Semiconductor theory, Electronics principles, Passive components, IC fabrication, Electromagnetic theory and measurements.

Course Objectives:

The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro Electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components. And to introduce the students various opportunities in the emerging field of MEMS. In addition, students will learn how to design MEMS transducers and to explore design tradeoffs, circuit/system issues, device performance, and manufacturing of microsystems.

Course outcomes:

- To understand the definition of micromachining and MEMS as well as an historical perspective of this emerging field.
- To understand the fundamental properties of materials used for MEMS devices
- To gain a comprehensive perspective of various physical mechanisms for MEMS design
- To understand the fundamental principle of piezoresistive sensing, piezoelectric sensing, magnetostatic actuation and methods for fabricating
- To understand the principle and design of Polymer based MEMS, Optical MEMS, RF MEMS.

Unit-I Introduction to MEMS and microfabrication: History of MEMS development, characteristics of MEMS-miniaturization - micro Electronics integration -Mass fabrication with precision. Micro fabrication - microElectronics fabrication process- silicon based MEMS processes- new material and fabrication processing- points of consideration for processing.

Unit-II Electrical and Mechanical properties of MEMS materials: Conductivity of semiconductors, crystal plane and orientation, stress and stain – definition – relationship between tensile stress and stain- mechanical properties of silicon and thin films, flexural beam bending analysis under single loading condition- types of beam- deflection of beam-longitudinal stain under pure bending spring-constant, torsional deflection, intrinsic stress, resonance and quality factor.

Unit-III Sensing and actuation: Electrostatic sensing and actuation-parallel plate capacitor and its application and tactile sensor parallel Plate actuator- comb drive.
Thermal sensing and actuations-thermal sensors-actuators and its applications.

Piezoresistive sensors- piezoresistive sensor material- stress in flexural cantilever and membrane and its application.
Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF –ZnO and its applications.
Magnetic actuation- micro magnetic actuation principle- deposition of magnetic materials-design and fabrication of magnetic coil.

Unit-IV Polymer, RF and Optical MEMS: Polymers in MEMS- polymide-su-8 liquid Crystal polymer(LCP)-PDMS-PMMA-parylene- flurocorbon, application-acceleration, pressure, flow and tactile sensors.
RF MEMS- Impedance tuners, Tunable filters, Phase shifters, Reconfigurable antennas
Optical MEMS-passive MEMS
Optical components-lenses-mirrors-actuation for active optical MEMS.

Suggested Reading:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Gaberiel M.Rebiz, “RF MEMS Theory,Design and Technology”, John Wiley & Sons,2003
3. Charles P.Poole, Frank J.Owens, “Introduction to nanotechnology” John Wiley & sons, 2003.
4. Julian W.Gardner, Vijay K Varadhan, “Microsensors, MEMS and Smart devices”, John Wiley & sons, 2001.
5. Stepan Lucyszyn, "Advanced RF MEMS", Cambridge University Press, 2010.

Semester-IV

Course Code: ESCC401
Course Name: Digital signal Processing
(Credits: Theory-04, Practical-02)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

The field of digital signal processing has grown enormously in the past decade to encompass and provide firm theoretical backgrounds for a large number of applications such as communication and speech, seismology, Radar and Sonar theory, etc. The importance of digital signal processing will eventually surpass that of analog signal processing for the same reasons that digital computers have surpassed analog computers.Since digital signal processing, for the most part, relies on the theory of discrete-time linear time-invariant systems, this will be studied as a major unifying influence for the entire field.

Course Outcomes:

- This course will explain the methods of windowing, frequency sampling design and minimum peak error design used in algorithms for designing digital filters.
- Through this unit, students will learn the techniques of mapping of differentials, impulse invariant transformation, bilinear transformation and matching poles and zeros.
- The course will also enable students to design filters using modern optimization algorithms such as minimum mean square method, minimum absolute error method, equiripple methods and time domain optimization to match a prescribed time response.
- Students will be able to understand tradeoffs in complexities between the two classes of filters-FIR and IIR.
- By the end of this course, students will be able to understand the effect of quantization on digital filters and alsotwo-dimensional signal processing techniques.
- This course will also elaborate the application of DSP in Speech and RADAR.
- The course provides a comprehensive summary of the major areas of digital signal processing, including a powerful tool for analyzing discrete-time signals with the help of Z-transforms.

Unit I: Introduction to DSP: An overview of Digital Signal Processing (DSP), Theory of Discrete time Linear System (Representation of sequences, arbitrary sequences, LTI Systems, Causality, Stability, Difference Equations, Frequency response of 1^{st}& 2^{nd} Order Systems, Discrete Fourier series), Z-Transform(Unilateral & Bilateral Z-transform), Inverse Z-Transform, Properties of Z-Transforms, Convolution of Sequences (Infinite, Finite), Sectioned Convolution.

Unit II: **FIR Filters:** The Theory and Approximation of Finite duration Impulse Response Digital Filters (Issues in Filter Design), Characteristics of FIR filter with Linear phase and its frequency response, Positions of Zeros of linear phase FIR filters, Design techniques-windowing, Rectangular window, Generalized Heming window, Kaiser window, Examples of Window Low-Pass Filter, Issues with windowing and Solution for optimization.

Unit III: **IIR Filters:** Theory and Approximation of Infinite response Digital Filter, Some Elementary properties of IIR filters-Magnitude squared Response, Phase Response, Grouped Delay, Impulse invariant Transformation, Bilinear Transformation, Matched Z-Transformation, optimization method for designing IIR Filter.

Unit IV: Finite word length effects in digital filters, Spectrum Analysis and Fast Fourier Transformation, An Introduction to the theory of Two-dimensional Signal Processing, Applications of Digital Signal Processing to Speech, RADAR.

Suggested Reading:

1. L.R. Rabiner, B. Gold, "Theory and Applications of Digital Signal Processing", Pearson Publication.
2. A.V. Oppenheim,"Digital Signal Processing", PearsonPublication.
3. J.G. Proakis, D.G.Manolakis,"Digital Signal Processing", Pearson Publication.
4. A. Antoniou, "Digital Signal Processing", Tata McGRAW Hill Publication.

<u>List of Experiments (Marks 50):</u>

Experiments based on above theory course.

Course Code: ESCC402
Course Name: Fabrication and Characterization Techniques for Electronic Devices
(Credits: Theory-04, Practical-02)

Marks: 100 **Duration: 60 Hrs**

Objective:

- The main objective is to train the manpower/students in the field of semiconductor science and technology relevant to modern electronic industry/technology.

Course Outcomes:

- Understanding the fabrication and characterization technology for electronic (micro & nano) and opto-electronic devices based on Inorganic and Organic materials
- Knowledge and skills necessary for device fabrication. This includes developing the ability to use clean room and vacuum techniques besides making them understand the basic concepts of electronic device fabrication at micro and nano-scale level.
- Trained manpower will be conversant with various processes and instruments to characterize the electronic materials and devices at different level for real time application.

Unit I: Vacuum Science and thin film technology: Kinetic theory of gases, Production of Vacuum: Mechanical pumps, Diffusion pump, Getter and Ion Pumps. High Vacuum and Ultra High vacuum Systems: thermal and e-beam evaporation, sputtering, MBE etc. Atomic layer deposition, Electrodeposition, Spray pyrolysis, Spin coating.

Unit II: Surface modification of materials: thermal treatment, thermomechanical treatment, ion beam irradiation. Etching: dry etching, plasma etching, sputter etching, control of etch rate and selectivity, control of edge profile. **Lithography:** optical, electron beam, ion beam, X-ray lithography, lift off, dip pen nanolithography. Pattern generation. Fabrication of few devices like MMIC, laser diode etc.

Unit III: Spectroscopic Techniques: UV-visible-NIR Spectroscopy, Photoluminescence (PL), Raman Spectroscopy, X-ray photoelectron spectroscopy (XPS) and Transform Spectroscopy (FTIR).
Electrical Characterization: current-voltage (I-V) and capacitance-voltage (C-V), Deep Level Transient Spectroscopy (DLTS).

Unit IV: X-Ray Diffraction (XRD): The Bragg‘s condition, Laue method, Rotating crystal method, powder method, Determination of lattice type and crystal structure.

Electron Microscope: Scanning electron microscope (SEM), Transmission electron microscopy (TEM), Field Emission SEM.
Scanning probe microscopy: Atomic Force microscopy (AFM), Scanning tunneling microscopy (STM).

Suggested Reading:

1. Preparation of Thin Films, Joy George, Marcel Dekkar (1992)
2. Thin Film Phenomena, K. L. Chopra, Mc Graw Hill, (1970)
3. Physics of thin films by Ludmila Eckertova-Envas Press NY 1986 2nd Ed.
4. VLSI Fabrication Principles (Si and GaAs) by Sorab K. Gandhi , 2nd Ed. John Wiley 1994
5. Integrated Circuit Engineering-Design, Fabrication and Application by Arther B Glaser and Gerald E Subak-Sharpe, Addison Wesley Pub.Company, Reading, Massachusetts, BellTel Lab, Copyright 1977.
6. Semiconductor Material and Device Characterization, Dieter K. Schroder, John Wiley & Sons inc. (1998)
7. Modern Semiconductor Fabrication Technology by Peter Gise and Richard Blanchard, Prentice Hall, NJ

List Of Experiments (Fabrication and Characterization Techniques for Electronic Devices**)**
(Marks 50):

1. To study the process of etching using ITO coated glass and design different shapes and copper cladded sheets for PCB design..
2. To determine the crystallinity of given semiconductor sample and crystallite size using Scherer formula using XRD technique.
3. To deposit the thin of MEHPPV on glass substrate using spin coating technique.
4. To calculate the band gap of thin film using UV-VIS absorption spectroscopy.
5. To study the photoluminescence in the deposited thin film.
6. To study the process of vacuum generation in a bell jar system and to deposit Aluminum thin film on glass substrate using thermal evaporation method.
7. Fabrication of Metal/Semiconductor contact and their characterization.

Course Code: ESCC403
Course Name: Dissertation
(Credits: 08)

Marks: 100 **Duration: 60 Hrs**

Students will undertake projects to enhance their understanding in various emerging areas. This will help to equip students with the current trends and will instill in them a spirit of enquiry and scientific temperament.

Semester IV
Course Code: ESEC104
Course Name: Photonic Devices and Optical Communication
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Course Objectives:

- Photonic Devices have emerged as the key technology for optical communications, environmental sensing, biomedical diagnostics in the life sciences, energy efficient lighting and solar energy harvesting.
- Upon completion of this course, students should understand the functioning and design of most photonic devices in use.

Course Outcomes:

- At the end of the Course students will be able to understand the basic components and devices of photonic integrated circuits.
- At the end of the Course, students should understand propagation in optical fiber couplers, fiber Bragg grating and long period fiber gratings and their applications
- At the end of Course, students should understand the area of silicon photonics which is an upcoming area of photonic integration with Electronics.
- At the end of Course students will understand the operation of optical communication systems, the limitations of photodiodes and avalanche photodiodes, understand direct optical amplification. explain the basics of optical modulation and multiplexing, design a fiber link of given length operating at a given wavelength, and at a prescribed bit error rate by use of optical repeaters and relate an integrated view of engineering by explaining the fundamental analogies between electrical and optical communication systems.

Unit I: Guide Wave Integrated Optic Devices: Planar and channel waveguides,Waveguide platforms on various materials and their fabrication techniques. Waveguide directional couplers,tapered waveguides and *Y*-junction splitters/combiners, Ring resonators, Mach-Zehnder interferometers/modulators.Sagnac interferometer/gyroscope. Coupling in and out of Photonic Integrated Circuits: Optical mode converters, prism and grating couplers.Wavelength-division multiplexing components: Mulitplexers, Demultiplexers, Multimode interferometers, Arrayed-waveguide gratings.

Unit II: **Fiber Optic Devices:** Splitters and combiners in optical fibers, fiber directional couplers as WDM component. Coupled mode analysis optical fiber Bragg and long period gratings, applications of fiber gratings as WDM components in add-drop multiplexers/circulators and fiber sensors.

Unit III: Silicon Photonics: Motivation towards silicon photonics, Silicon on Insulator (SOI) waveguides or nanowires.Optical fiber to silicon waveguide: edge, grating, evanescent coupling, spot-size converters.III-V integration with silicon photonics.Photonic modulators: electro-optical and thermo-optical effects. Phase and amplitude modulators.Thermal phase shifter, thermo-optic switch.Franz-Keldysh effect and FK electro-optical modulators.

Unit IV: Computational Photonics: Concepts of eigenmodesapproach, finite difference and finite element methods, finite difference timedomain(FDTD) methods and beam propagation methods. Identification of method that is amenable to a specific class of photonic structures, and themethod that should be avoided except in special circumstances and developand use basic computational codes for a variety of realistic applications inintegrated photonic structures.

Unit V: Solar Photovoltaics: Solar cell materials and their properties. Solar cell research: technology (silicon, organic, Dye sensitized, peroviakites), applications and limitations.Characterization and analysis: ideal cell under illumination- solar cell parameters,optical losses; electrical losses, surface recombination velocity, quantum efficiency - measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal quantum yield measurements – effects of seriesand parallel resistance and temperature - loss analysis.Solar photovoltaic(PV) modules from solar cells, series and parallel connections, design and structure of PV modules.

Unit VI: Optical Fiber Communication: The fiber as a communication link, Step- and graded-index optical fibers. Multimode and single mode fibers, attenuation and dispersion, broadening of optical pulses in fibers.Transmitters and receivers, interaction of light with semiconductor materials: absorption and electroluminescence. Semiconductor light sources (Light emitting diodes and laser diodes) and photodetectors (PIN photodiodesand avalanche photodiodes), Semiconductor and fiber optical amplifiers. Optical Link Design: System Considerations, Photoreceiver noise, Bit error rates for attenuation and dispersion limited systems, Link Power Budget, Rise-Time Budget, Line Coding. Optical Networking and Switching: General Network Concepts, SONET/SDH, Optical Ethernet, Network Management, WDM light wave systems and WDM components.

References:

1. A. K. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University, 1989.
2. Optical Electronics in Modern Communications by A. Yariv, Oxford, 5th Edition, 1997B.E.A. Saleh and M.C. Teich, Fundamentals of Photonics, John Wiley and Sons, 2007.
3. J.M. Senior, Optical Fiber Communications: Principles and Practice, Pearson Education India, 2010.
4. Gerd Keiser, Optical Fiber Communication, McGraw Hill Education, 2017.

<u>List Of Experiments (Marks 50):</u>
Experiments based on the above theory course.

Semester IV
Course Code: ESEC105
Course Name: Modern Communication Systems
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Pre-requisites: Signals and systems, Fourier Transforms, concept of multiplexing and various modulation techniques, channel requirements, signal-to noise ratio and bandwidth.

Course Objective:
This course enables students to attain successful professional careers by applying their engineering skills in communication system design to meet out the challenges in industries and academia. The course develops a strong foundation in the field of Satellite Communication, earth and space subsystems involved and their importance; multiple access techniques, recent technological developments in Mobile communication systems; Understand what Internet of Things is, RFID Technology, Sensor Technology and Satellite Technology.

Course Outcomes:
- To provide students with strong fundamental concepts and also advanced techniques and tools to build various communication systems.
- To enable students to attain successful professional careers by applying their engineering skills in communication system design to meet out the challenges in industries and academia.
- To engage students in lifelong learning, adapt emerging technology and pursue research for the development of innovative products.

Unit I: Satellite Communication: Radiation and propagation of waves**:** fundamental of EM waves and their effects ground, sky and space waves propagation, Orbits and Launching Methods, Space Link Budget, Space and Earth Segment, Satellite Services;

Unit II: Wireless Communication: Fundamental concepts in wireless, Basic Terminologies, cellular technology, Standards evolved, Mobile Radio Propagation, Mobile System and Network Architectures, Advanced Wireless IP network Architectures, Wireless Standards.

Unit III: Data transfer and Computer Networking: Packet switching, ISDN, ATM, LAN, WAN, Internet and WAP, Digital Radio Communication Systems; Multiple Access Techniques: Frequency Hopping Spread Spectrum (FHSS) systems, Direct Sequence Spread Spectrum, Code Division Multiple Access of DSSS;

Unit IV: Internet of Things: Introduction, Fundamental IoT Mechanisms and Key Technologies, Radio Frequency Identification Technology, Resource management in IoT, IoT Privacy, Security and Governance, Business models for IoT

Suggested Reading (Unit-I):

1. Dennis Roddy, "Satellite Communications", McGraw Hill, 1996.
2. Tri.T.Ha, "Digital Satellite Communications", Mcmillan Publishing Company, 1986.
3. Dr.D.C. Agarwal, "Satellite Communications", Khanna Publishers, 2001.
4. Trimothy Pratt, Charles W. Bostian, "Satellite Communications", John Wiley & Sons, 198

Suggested Reading (Unit-II):

1. Rappaport, T.S., "Wireless Communications", Principles and Practice, Prentice Hall, NJ, 1996.
2. William Stallings, "Wireless Communication and Networking", Pearson Education, 2002.
3. Siegmund M. Redl, Mathias K. Weber, Malcolm W. Oliphant, "An Introduction to GSM", Artech House Publishers, 1995.
4. Kraus, J.D., "Antennas", II Edition, John Wiley and Sons, NY, 1977.
5. Collin, R.E. and Zucker, F., - "Antenna theory: Part I", Tata McGraw Hill, NY, 1969

Suggested Reading (Unit-III):

1. Mani Subramanian, "Network Management Principles and Practice", Addison Wisely, New York,
2000.

Suggested Reading (Unit-IV):

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
3. Parikshit N. Mahalle&Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).
4. HakimaChaouchi, "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications
5. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
6. Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things",. Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978-0989973700.
7. Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5.

Semester IV
Course Code: ESEC106
Course Name: Electromagnetic Interference and Compatibility (EMI & EMC)
(Credits: Theory-04)

Marks: 100 **Duration: 60 Hrs**

Pre-requisites: Maxwell's equations, Electromagnetic theory, basics of transmission lines, microwave parameters and measurements.

Course Objectives:

Importance of product marking like CE is essential for widely acceptance for the electrical and electronic products. Knowledge of EMI generation and its reduction methods is integral part for designing any product at initial stage. A good design practice for compliance will make the students to incorporate their skills in the commercial world.

Course outcomes:

- To understand the EMI and EMC concepts and their importance for the electrical and electronic products
- To understand EMC standards and various test methods for EMI/EMC
- To learn the control techniques for EMI
- To understand the design process for EMC systems

Unit I: Introduction to EMI/EMC: EMI scenarios, EMI sources, coupling mechanism & modes- common and differential modes, EMI victims, classification of disturbance phenomena, Time & frequency domain analysis, Emission and Susceptibility.

Unit II: EMI/EMC Standards & Measurements: Standard making bodies, commercial & MIL Standards (FCC, CISPR etc.), Emission and Immunity tests, Test instrumentation, compliance & diagnostic testing.

Unit III: EMI Control Techniques: Grounding & Cabling, Filtering & Shielding, Transient suppression & ESD Control.

Unit IV: Design for EMC (Emission & Susceptibility control at PCB level): Components & Circuit selection, Circuit layout, Partitioning, Chassis bonding, Grounding, PCB stack-up, Transmission line termination, Decoupling, PSU design.

Suggested Reading:

1. Dipak L. Sengupta, Valdis V. Liepa "Applied Electromagnetics and Electromagnetic Compatibility" Wiley Inter Science, 2006.

2. Clayton R. Paul, “Introduction to Electromagnetic Compatibility”, 2nd edition, Wiley, 2006.
3. Bogdan Adamczyk “Foundations of Electromagnetic Compatibility” Wiley, 2017.
4. Xingcun Colin Tong, “Advanced Materials and Design for Electromagnetics Interference Shielding” CRC Press.