

Academic Regulations
for
4-Year B. Tech. Program in
Electronics and Communication Engineering
(ECE)
Academic Year 2025

Bahadurpally, Hyderabad 500043, India

**ACADEMIC REGULATIONS FOR FOUR-YEAR UNDERGRADUATE DEGREE
PROGRAM**

(Applicable to students joining in the Academic Year 2025-26 and thereafter)

1) COURSES OF STUDY AND AWARD OF B. TECH. DEGREE

The Institute awards B.Tech. degree in the following four-year undergraduate (UG) programs:

S. No.	B. Tech. Degree Program
1	Civil Engineering (CE)
2	Computer Science and Engineering (CSE)
3	Electronics and Communication Engineering (ECE)
4	Mechanical Engineering (ME)
5	Computation & Mathematics (CM)
6	Electronics and Computer Engineering (ECM)
7	Artificial Intelligence (AI)
8	Mechatronics (MT)
9	Nano-Technology (NT)
10	Bio-Technology (BT)
11	Computational Biology (CB)
12	VLSI Design and Technology (VDT)
13	Aerospace Engineering (AE)
14	Electrical Engineering and E-Mobility (EEM)

- A student who has passed all the individual courses listed under the corresponding curriculum is entitled to be awarded the Bachelor of Technology (B. Tech.) degree provided he complies with the associated rules.
- A student must earn cumulative performance index (CPI) of at least 4.0 Cumulative Grade Point Average (CGPA) for the award of the B.Tech. degree.

- c) A student must earn specified credits for individual UG program for the award of the B.Tech. degree.
- d) A student after securing admission into one of the B. Tech. degree programs must pursue the course of study for a duration of 8 semesters (or 4 years). Each semester shall have a minimum of 90 days of instruction including Examinations, as per UGC norms. The B. Tech. degree program has to be completed within at most 8 consecutive years from the date of admission to the program.
- e) The first two years of the B. Tech. degree program are termed as the Core Program and the last two as the Professional Program. The maximum duration to complete all academic requirements of either the Core or the Professional Program is four consecutive years from the year of registration into the corresponding program; students who fail to do so shall forfeit their seats in the B. Tech. course.
- f) Elective courses are available in the professional program. Students in consultation with faculty members may propose their choices from among the offered list of elective courses; the proposal needs approval by a departmental committee nominated by the Dean of Academics.
- g) Cancellation of Admission: All students admitted provisionally or otherwise to any program shall submit copies of their mark sheets, provisional certificates, etc. of the qualifying examination and other documents by the last date specified for the purpose in the Academic Calendar. MU reserves the right to cancel the admission at any later time if it is found that the student had supplied false information or suppressed relevant information while seeking admission.
- h) Any matter relating to the award of the B. Tech. degree that is not covered in the existing regulations is to be decided upon by a standing committee (nominated by the VC) composed of faculty members and chaired by the Dean Academics.

2) CREDITS AND ACADEMIC PERFORMANCE

- a) Credit representation: Each lecture and tutorial hour contribute to *one credit*, while one laboratory hour contributes toward *half a credit*. Example:

No. of lecture hours per week	No. of tutorial hours per week	No. of practical hours per week	Total credits
3	1	2	$3*1 + 1*1 + 2*0.5 = 5$

- b) Grades and Grade Points: At the end of the semester, a student is awarded a letter grade (based on a prescribed process) in each of his courses by the concerned Instructor-in-Charge considering his performance in the various components of evaluation like Minor examinations I and II, quizzes, assignments, laboratory work (if any), etc., besides regularity of attendance in classes. The grades are submitted to the undergraduate office within the prescribed time limit of 72 hours, except for courses having more than 500 students, after conclusion of the end-semester major examination. There are eight letter grades: A⁺, A, B⁺, B, C⁺, C, D, and F. The letter grades and their numerical equivalents on a 10-point scale (called Grade Points) are as follows:

The letter grades: A⁺, A, B⁺, B, C⁺, C and D are considered as passing grades; students who are awarded any of these grades in a course, acquire the corresponding number of credits allotted to the course. The letter grade F is considered as fail grade; students who are awarded F grade in a course, do not acquire the corresponding number of credits allotted to the course; such students have to write a supplementary examination in that subject (s) to earn a minimum passing grade, which is “D” grade.

Letter Grades	A ⁺	A	B ⁺	B	C ⁺	C	D	F
Grade Points	10	9	8	7	6	5	4	0

In addition to the letter grades mentioned above, there is an additional letter grade, viz., ‘I’ which stands for Incomplete. A student may be awarded the grade ‘I’ (Incomplete) in a course if he has missed, for a genuine reason such as a medical reason, as decided by the instructor in charge or the Dean Academics, a part of the course requirement but otherwise has performed satisfactorily in all other parts. An ‘I’ grade must, however, be converted by the Instructor-in Charge into an appropriate letter grade and communicated to the Examination Cell by the last date specified in the academic calendar. Any outstanding ‘I’ grade after this date shall be automatically converted into the ‘F’ grade.

- c) Project Grades: Project grades shall be submitted by the last date specified for the submission of grades. An ‘I’ grade may be given only on medical grounds or by recommendation of the project evaluation committee to the Dean Academics.
- d) Change of Grade: A letter grade once awarded shall not be changed unless the request made by the Instructor-in-Charge of the course is approved by Dean Academics. However, any such request for change of grade must be made within six weeks of the start of the next semester in the prescribed form with all relevant records and justification.
- e) Semester Performance Index (SPI): The Semester Performance Index (SPI) is a weighted average of the grade points earned by a student in all the courses credited and describes his/her academic performance in a semester. If the grade points associated with the letter grades awarded to a student are g₁, g₂, g₃, g₄, and g₅ in five courses and the corresponding credits are c₁, c₂, c₃, c₄, and c₅, the SPI is given by:

$$SPI = \frac{c_1g_1+c_2g_2+c_3g_3+c_4g_4+c_5g_5}{c_1+c_2+c_3+c_4+c_5}$$

- f) Cumulative Performance Index (CPI): The Cumulative Performance Index (CPI) indicates the overall academic performance of a student and is computed in the same manner as SPI by considering the grades in all the courses registered up to and including the most recently completed semester/ summer term, if any. When a student is permitted to repeat or substitute a course/examination, the new letter grade replaces the old letter grade in the computation of CPI; however, the previous grades remain in the Grade Report.
- g) Grade Report: A copy of the Grade Report is issued to each student at the end of the semester. A duplicate copy, if required, may be obtained on payment of a prescribed fee.

3) DISTRIBUTION AND WEIGHTAGE OF MARKS

- a) The performance of a student in each course by including all the components of evaluation as was announced by the concerned instructor at the beginning of the semester in the first class shall be evaluated out of a possible maximum of 100 marks. The resulting marks will then be converted to appropriate letter grade.
- b) Specifics of breakup of marks shall be defined at course level. This breakup of marks will be communicated by the instructor in charge at the beginning of the semester on Day1. The below-mentioned guidelines shall be followed:
 - i. The distribution of marks for all the courses shall follow the principles of continuous evaluation. Continuous evaluation during the semester – through minor I, minor II, and mid-term examinations, quizzes, assignments, team projects, term papers, seminars, presentations, etc., (whichever of these are applicable for a particular course) – typically constitute between 40-50% of the total marks, whereas, the end-semester examination including lab will, in general, constitute 50-60% of the marks.
 - ii. For courses without a laboratory, there shall be at least one mid-semester examination along with any other forms of continuous evaluation methods described above (i.). The first mid-semester examinations namely, Minor I shall cover units taught during the first spell of instructions i.e. from the beginning of the semester until the first mid-semester examination held typically after 5 weeks. A second mid-semester examination namely, Minor II shall cover the units taught during the second spell of instructions i.e. the intervening period between Minor I and Minor II examinations. The end-semester examination will cover all the units taught during the entire semester. All end-semester examinations namely, Major examinations shall be for a total of 100 marks in each subject having a final weightage of 40 to 50 % and the rest together having a weightage of 50-60%.

- iii. For courses consisting of both theoretical and laboratory components or design or drawing or project (such as but not limited to Engineering Graphics, Engineering Drawing, Machine Drawing) as a part of the course, the evaluation process for the theory part shall follow the same procedure as described above, with typically a total mark for theory between 60-70 (out of the maximum of 100) and the rest of 30-40 marks being awarded to the laboratory part. The evaluation of the laboratory/practical part of the course shall also follow the principle of continuous evaluation. The instructor-in-charge shall inform the students whether an independent minimum passing mark in the theory part of the course as well as an independent minimum passing mark in the laboratory part of the course is required.
- c) There shall be an industry-internship, in collaboration with industry/academia, to be taken up before the beginning of the 4th year. The evaluation of the internship shall be based on the performance evaluation report from the industrial/academic partner and may be complemented with a viva voce. There shall be no credits awarded for the internship.
- d) Project beginning during the first semester of academic year III may extend over the second semester. Provisional grade will be awarded at the end of the first phase of the project and upon successful completion of the project this grade is subject to revision at the end of the second phase. For each semester it shall be evaluated for a total of 100 marks. The evaluation shall be based on the report submitted at the end of the project and the presentation of the project to a committee constituted by the parent department of the student. The committee shall consist of the supervisor of the team project and other members constituted by the concerned HoD. It will carry a weightage of 3 credits.
- e) B. Tech project shall begin in IV year I semester (phase-I) and will continue during IV-year II semester (phase-II). Out of the total 100 marks for the project work, 25 marks shall be allotted for internal evaluation and 75 marks for final project report and end semester examination (viva voce). The project will normally be an extension of the III-year project so as to reach a comprehensive and substantial result(s) on the topic. The end semester examination of the project work shall be conducted by an expert committee (to be constituted by the HoD) consisting of at least two faculty members with relevant subject specialization. In addition, the project supervisor shall also be a member of the committee. Evaluation of the progress of the project shall be done one at the end of the first phase (semester) and a provisional grade is awarded. Upon successful completion of the project evaluation process a revised grade for both first and second phases shall be awarded.

4) ATTENDANCE REQUIREMENTS

- a) A student shall be eligible to receive a passing grade in a course offered in a specific semester, if he acquires a minimum of 75 % attendance in lectures, tutorials and lab individually in that course during the same semester.

- b) A student with up to 10% of shortage of attendance in a course (i.e. an attendance of at least 65%) in a semester may apply to the Dean of Academics; such exceptions shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence, and on payment of a stipulated fee.
- c) A student with attendance below 65% in a course in a semester could be condoned on a case by case basis at the discretion of the Vice Chancellor; such exceptions shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence, and on payment of a stipulated fee.
- d) A student with attendance below 75% in a course during a semester, who has not been exempted by the Dean of Academics, will receive an F grade by default in the corresponding course.

5) ACADEMIC PROGRESSION REQUIREMENTS

- a) The Student Performance Committee, chaired by the Dean of Academic Affairs informs and advises students on their academic performance.
- b) The Student Performance Committee, gives their recommendation to the Vice Chancellor on the academic progression of all admitted students.
- c) A student completing an academic year (N) may be promoted to the next academic year (N+1) when he has acquired at least:
 - a. 60% of the credits in the current academic year (N)
 - b. 90% of the credits in all previous academic years (<N)
- d) Students who receive F grades in any course(s) are permitted to avail supplementary examinations for those courses.
- e) In a supplementary examination, a student at best can earn “D” grade and no higher grade.
- f) When a student in any given semester acquires at least 60% of the credits prescribed during that semester, he may be permitted to take up the full course load during the next semester; otherwise, the student may be advised to take up a reduced course load.
- g) Marks obtained in the supplementary examination(s) of a course(s) will be used to re-compute the SGPA and/CGPA.

6) WITHHOLDING OF RESULTS

If the student has not paid dues, if any, to the University or if any case of disciplinary punishment is pending against him/her, the result of the student will be withheld and he will not be allowed into the next semester and/or his degree will be withheld.

7) TRANSITORY REGULATIONS

Students of previous batches may be given equivalent subjects as per the revised regulations, which they have to pass in order to obtain the required number of credits.

8) **GENERAL**

1. Wherever the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".
2. The academic regulations should be read as a whole for the purpose of any interpretation.
3. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice Chancellor is final.
4. The University may change or amend the academic regulations or syllabi from time to time and the changes or amendments made shall be applicable to all the students with effect from the corresponding notification date.

Overview of B.Tech in Electronics and Communication Engineering

The *Electronics and Communication Engineering (ECE)* program is offered as part of the Electrical and Computer Engineering Department at Mahindra University. This is a four-year program that starts with strengthening their concepts in Physics, Chemistry, and Mathematics and introducing them to the basics of Electrical and Electronic engineering concepts in the first two semesters of study. Progressively, the students delve into the more complex subjects and learn with an emphasis on Electronics and Communication engineering. In addition to the core subjects, there will be electives that will be offered which allow students to get more in-depth insight into certain areas of the subject and develop further expertise. Many of the core subjects also have laboratories associated with them that will expose the students to practice what they learn in the classroom.

Students that will successfully complete this four-year program can go on for further studies or research in many different areas, or can join many different companies that operate in this field. Some companies that can be potential employers are Juniper Networks, Thales, Nokia Networks, Qualcomm, Silicon Labs, Untangle, Advansis Consulting, Schlumberger, Accolite Digital, Telstra, L&T, M&M, and many others.

Program Specific Outcomes (PSO) for B.Tech in Electronics and Communication Engineering

Graduates of the program will be able to

- 1:** Demonstrate a knowledge and understanding of contemporary technologies, their applications and limitations in the broader context of the relevant fields of electronics, signal processing, and communication engineering.
- 2:** Demonstrate proficiency in utilization of the state-of-the-art software and hardware tools along with analytical skills to arrive at appropriate solutions.
- 3:** Demonstrate a degree of competency to identify, formulate and research complex engineering problems, to understand and design the national and international standards, and develop solutions in the area of communication systems, signal processing, VLSI, and embedded systems using first principles of mathematics and engineering sciences.

4: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and provide and receive clear instructions.

5: Demonstrate the ability to succeed in national and international competitive events in the relevant fields of electronics and communication engineering.

Semester wise course list

Semester 1

Course Code	Course Title	L	T	P	C
MA 1101	Calculus and ODE	4	1	0	5
CH 1101	Quantum Chemistry & Spectroscopy	2	1	2	4
CS 1001	Introduction to Computing	3	0	2	4
CE 1101	Earth and Environmental Sciences	2	0	0	2
EC 1102	Introduction to Electrical Engineering	2	1	2	4
HS 1101	English	0	3	0	3
HS 1102	Media Project	1	0	2	1.5
HS 1103	French - I	0	2	0	0.5
ET 1101	Introduction to Entrepreneurship	0	0	2	1
Total credits for Semester 1					25

Semester 2

Course Code	Course Title	L	T	P	C
MA 1202	Linear Algebra and Complex Analysis	3	1	0	4
PH 1201	Classical & Quantum Mechanics	2	1	2	4
BI 1201	Introduction to Biology	3	0	0	3
CS 1002	Data Structures	3	0	2	4
CS 1202	Discrete Mathematical Structures	3	0	0	3
EC 1202	Introduction to Electronics	2	1	2	4
ET 1201 F	Entrepreneurship Practice	0	0	2	1
HS 1202	Professional Ethics	0	1	0	1
HS 1203	French - II	0	2	0	0.5
Total credits for Semester 2					24.5

Semester 3

Course Code	Course Title	L	T	P	C
MA 2103	Probability and Statistics	3	1	0	4
PH 2102	Electromagnetics & Optics	3	1	2	5
EC 2102	Signals and Systems	3	1	0	4
EC 2103	Digital System Design	3	0	2	4
EC 2104	Network Analysis and Synthesis	3	1	0	4
ET 2101 F	Lean Start-up	0	0	3	1
HS 2102	Principles of Economics	1	1	0	1.5
HS 2103	French - III	0	2	0	0.5
Total credits for Semester 3					24

Semester 4

Course Code	Course Title	L	T	P	C
EC 2202	Electromagnetic Waves	3	1	0	4
EC 2204	Random Processes for Electrical Engineering	3	1	0	4
EC 2207	Analog Circuits	3	1	2	5
EC 2210	Control Systems	2	1	0	3
HS 2201	Design Thinking	1	0	2	2
HS 2202	Financial Accounting	1	1	0	1.5
HS 2203	French - IV	0	2	0	0.5
Total credits for Semester 4					20

Semester 5

Course Code	Course Title	L	T	P	C
EC 3101	Introduction to VLSI Design	3	0	3	4.5
EC 3102	Communication Theory and Systems	3	0	2	4
EC 3103	Programmable Devices	3	0	2	4
EC 3109	Digital Signal Processing	2	1	2	4
CS 3102	Machine Learning	3	0	0	3
ZZ 31XX	Liberal Arts Elective I	2	0	0	2
HS 3111	French - V (optional)	0	2	0	0.5
Total credits for Semester 5					21.5

Semester 6

Course Code	Course Title	L	T	P	C
EC 3201	Principles of Wireless Communication	3	0	0	3
EC 3202	Computing systems Architecture	3	0	0	3
EC 3203	Communication Electronics	3	0	2	4
EC 3206	Computer and Communication Networks	3	0	0	3
EC 32XX	Program Elective I	3	0	0	3
EC 32XX	Program Elective II	3	0	0	3
ZZ 32XX	Liberal Arts Elective II	2	0	0	2
HS 3201	Introduction to professional development	2	0	0	2
HS 3222	French - VI (optional)	0	2	0	0.5
Total credits for Semester 6					23

Semester 7

Course Code	Course Title	L	T	P	C
EC 4100	Embedded Hardware Project	0	0	6	3
EC 4102	Optical Communication	3	0	0	3
EC 41XX	Program Elective III	3	0	0	3
EC 41XX	Program Elective IV	3	0	0	3
PR 4000	Research Project Phase I	0	0	6	3
ZZ 41XX	Liberal Arts Elective III	2	0	0	2
HS 4111	French - VII (optional)	0	2	0	0.5
Total credits for Semester 7					17

Semester 8

Course Code	Course Title	L	T	P	C
PR 4000	Research Project Phase II	0	0	24	12
HS 4222	French - VIII (optional)	0	2	0	0.5
Total credits for Semester 8					12

List of Departmental Electives

S. No.	Course Title	L	T	P	Credits
1	MIMO Wireless Communication	3	0	0	3
2	Mobile Communications	3	0	0	3
3	Wireless Sensor Networks	3	0	0	3
4	Antenna and Wave Propagation	3	0	0	3
5	Mobile broadband technologies for 5G and beyond	3	0	0	3
6	Cellular broadcasting in 5G networks	3	0	0	3
7	Software defined networking	3	0	0	3
8	Statistical Signal Processing	3	0	0	3
9	Cellular Broadband IoT	3	0	0	3
10	Advanced Digital Circuits or Systems	3	0	0	3
11	Testing and Verification	3	0	0	3
12	Advanced Analog Integrated Circuits	3	0	0	3
13	IoT System Architecture and Design	2	0	2	3
14	Sensors and Instrumentation	3	0	0	3
15	Advanced VLSI Design	3	0	0	3
16	Solid State Devices	3	0	0	3
17	VLSI Technology	3	0	0	3
18	RF IC Design	3	0	0	3
19	Terahertz Communication Systems	3	0	0	3
20	Radar Signal Processing	3	0	0	3
21	Machine Learning	3	0	0	3
22	Robotics	3	0	0	3
21	Cyber Physical Systems	3	0	0	3
24	Big Data Analytics/Computing	3	0	0	3
25	Advanced Optimization	3	0	0	3
26	Wireless Network Protocols	3	0	0	3
27	VLSI Signal Processing (GPU Design)	3	0	0	3
28	Supply Chain Management	3	0	0	3
29	Memory Design & Testing	3	0	0	3
30	Digital Image Processing	3	0	0	3
31	Biomedical Engineering	3	0	0	3
32	Cryptography and Network Security	3	0	0	3
33	Information Theory and Coding	3	0	0	3

List of HSS/Management Electives					
S. No	Course Title	L	T	P	Credits
1	Continuity Film Making	2	0	0	2
2	Design Transformation	2	0	0	2
3	Documentary Film Making	2	0	0	2
4	Short Film Making	2	0	0	2
5	Performance Exploration	2	0	0	2
6	Organizational Behavior	2	0	0	2
7	Consumer Behavior	2	0	0	2
8	Strategic Management	2	0	0	2
9	Enterprise Risk Management Level 1	2	0	0	2
10	Business Communication	2	0	0	2
11	Inter Personal Communication	2	0	0	2
12	Professional Communication	2	0	0	2
13	Academic Writing	2	0	0	2
14	Written Analysis and Communication	2	0	0	2
15	Intercultural Communication	2	0	0	2
16	Introduction to Linguistics	2	0	0	2
17	Identifying and Evaluating Business Opportunities	2	0	0	2
18	Entrepreneurial Finance	2	0	0	2
19	Launching and Scaling -up New Ventures	2	0	0	2
20	Technological Innovation & It's Commercialization	2	0	0	2

21	Cinema and Philosophy	2	0	0	2
22	Philosophical Arguments	2	0	0	2
23	Reading Indian Short Stories	2	0	0	2
24	Topics in Visual Culture I: Advertising and Photography	2	0	0	2
25	Introduction to Cultural Studies	2	0	0	2
26	Urban Studies- Reading the City	2	0	0	2
27	Science Fiction Film and Literature	2	0	0	2
28	Myths and Indian Literatures	2	0	0	2
29	Understanding Literary Genres: An Introduction to Indian English Poetry	2	0	0	2
30	The World as We Read It	2	0	0	2
31	The Humanities for a Critical Understanding of the World	2	0	0	2
32	The world of history and the history of the world	2	0	0	2
33	Exploring the Tangible Heritage of India	2	0	0	2
34	Incredible India: A Historical Journey through Food, Culture & Material Objects	2	0	0	2
35	The World at War: A Global History of the 20 th century	2	0	0	2
36	Introduction to India's Health Systems	2	0	0	2
37	Economics of Information	2	0	0	2
38	Introduction to Social Psychology	2	0	0	2

39	Society and Social Change: An Introduction to Sociology	2	0	0	2
40	Innovations and Everyday Life	2	0	0	2
41	History of Modern Science: A Brief Introduction	2	0	0	2
42	Expressions of the Self and the Social	2	0	0	2
43	Values and Social Harmony	2	0	0	2
44	Intellectual Property Rights (IPR) and Cyber Law	2	0	0	2

Detailed Syllabus for Individual Courses

Calculus and ODE (MA 1101)

Module 1. Single variable calculus: Limit, Continuity, Integration and its Applications, Polar Coordinates, Differentiability, Applications of Differentiation, Mean value theorem and its Applications, Curve Sketching, Indeterminate Forms, Taylor's and Maclaurin's theorems, Fundamental Theorem of Calculus.

Module 2. Functions of Several Variables: Limit, Continuity, Total Differential, Extrema of functions, Lagrange multiplier method, Double and Triple integrals, Change of Order of Integration.

Module 3. Vector Calculus: Gradient, Divergence and Curl, Line, Surface and Volume Integrals, Theorems of Green, Stokes and Gauss and their applications.

Module 4. Infinite Series: Sequences, Convergence and Divergence of a series, Tests for Convergence, Conditional and Absolute Convergence, uniform convergence of sequence of functions.

Module 5. Ordinary Differential Equations: The existence and uniqueness theorem on the general first order differential equations (statement, without proof, with some simple examples). Variable separable method, reducible to variable separable. Exact differentiable equations, integrating factors. Linear differential equations, Bernoulli's equation. The general solution of the second order linear homogeneous equations with constant coefficients. Undetermined coefficients, Variation of parameters. Cauchy problem for differential equation systems. Existence theorem (without proof), differential linear systems with constant coefficients. Geometric study in phase plane of simple equations, orthogonal polynomials.

Textbooks:

1. Tom M. Apostol, One Variable Calculus, with an Introduction to Linear Algebra (Text Book for First, Second and Fifth Modules).
2. Tom M. Apostol, Multi-Variable Calculus and Linear Algebra, with Applications to Differential Equations and Probability (Text Book for Third and Fourth Modules).
3. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications (Reference Book).
4. E. Kreyszig, Advanced Engineering Mathematics, John Wiley (1999). George B. Thomas, Jr., Maurice D. Weir, Joel Hass, Thomas' Calculus.
5. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).

Quantum Chemistry & Spectroscopy (CH 1101)

Module 1: Atomic structure and periodic properties (6 lectures): Wave-particle duality. Schrodinger equation. Principles of quantum mechanics. Particle in a one-dimensional box solution and its applications. Hydrogen atom wave functions. Shape and size of atomic orbitals. Multi-electron atoms – shielding – effective nuclear charge – orbital penetration. Periodic table and periodic properties of elements: electronic configuration, ionization energy and electron affinity.

Module 2: Chemical bonding and intermolecular interactions (8 lectures): Molecular orbitals as linear combinations of atomic orbitals. Molecular orbital energy level diagrams of homonuclear and heteronuclear diatomic molecules - electronegativity. Multi-atomic molecules, molecular geometry and symmetry. Crystal field theory of transition metal ions. Band theory of solids. Molecular properties: Dipole moment and Polarizability. Intermolecular interactions: dipolar and van der Waal's interactions.

Module 3: Analytical methods (10 lectures): Theoretical background of UV-Visible Spectroscopy, Infrared and Raman spectroscopy, Microwave spectroscopy, NMR spectroscopy and magnetic resonance imaging. Introduction to surface analytical techniques: X-ray photoelectron Spectroscopy, Atomic force microscopy.

Module 4: Structure determination using spectroscopic methods (6 lectures): Introduction to chemical analysis of organic molecules. Elemental analysis and Mass spectrometry. Structural elucidation of simple organic molecules using combination of different spectroscopic data.

Textbooks:

1. Atkin's Physical Chemistry; 10th edition; Peter Atkins and Julio De Paula; ISBN 978-0-19-954337-3
2. Organic Chemistry; Jonathan Clayden, Nick Greeves and Stuart Warren; ISBN: 978-0-19-927029-3
3. Fundamentals of Molecular Spectroscopy; 4th edition; Colin N. Banwell and Elaine M. McCash; ISBN-13: 978-9352601738
4. Organic Spectroscopy; 3rd Edition; William Kemp; ISBN 978-1-4039-0684-7

Introduction to Electrical Engineering (EC 1102)

Module 0: Background, Importance of EE and its everyday applications

Module 1: Circuit elements, R, L and C, voltage and current sources. Series and parallel combination of resistances, network reduction, KVL, KCL, nodal and mesh analysis, superposition and linearity

Module 2: Y-delta transformation, network theorems such as Thevenin's, Norton's and maximum power transfer theorem with dependent and independent sources

Module 3: RL, RC and RLC circuits excited by DC: Transient (forced, natural and total responses) and steady state responses. Sinusoidal steady state circuit analysis, Series and parallel resonance

Module 4: Complex representation of sinusoidal quantities, phasors, phasor diagram, concept of impedance and admittance, low pass/high pass/band pass characteristics of RC/RL/RLC circuits, complex power, real and reactive power, power factor, PF improvement. Three-phase circuits: Y and Delta; Three-phase power and power measurement.

Module 5: Magnetic circuits and transformers. Introduction to Transducers/sensors and Electro-mechanical energy conversion.

Reference books:

1. V. Del Toro, Electrical Engineering Fundamentals, 2nd Edition, Pearson.
2. Nagrath and Kothari, Basic Electrical and Electronics Engineering, McGraw-Hill.
3. W. H. Hayt, J. E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill.

Introduction to Computing (CS 1001)

Module 1 - Representation of data: Number systems; Conversion from one base to the other; Binary number system; Representation of Binary numbers using Physical devices; Basic logic gates and binary logic; Short, Int, Long types; Integer arithmetic using logic gates; Float point representation; Float, Double, long Double data types; Characters - ascii codes; Boolean variables; IEEE standards and history.

Module 2: Von Neumann architecture of modern computing system; Low level languages vs High level Languages; Compilation and byte code; Introduction to C programming language; Variables, type declaration and operations. Control structures and manipulation of data: Conditional Constructs if, ifelse, while, for, do-while, switch, break, continue. Functions: Implementation of functions in C, recursion, Iteration vs recursion.

Module 3 - Pointers and Arrays: The pointer datatype; Declaring pointer variables; Passing a reference using pointers; Null pointers. Arrays; Declaring and using arrays; Arrays as

parameters; Strings in C; Relation between arrays and pointers; N-dimensional arrays; What is an algorithm?

Algorithms: Sorting examples - Insertion sort, Bubble sort, mergesort. Searching examples - linear search, Binary search. Structures; Dynamic Memory Allocation; Malloc - Free functions; Dynamically Sized arrays; Implementation of Linked lists. File handling: Reading and writing files; Writing header files; Make and Installation Packages.

Module 4: Introduction to interpreted languages; Introduction to Python; Dynamic typing; inbuilt data types - Strings, Lists, Tuples, Sets, Dictionaries, and methods. Subscriptables and Iterables; the while and for loops; Functions – Polymorphism in Python functions; Introduction to Python classes; Brief introduction to Object Oriented Programming.

Module 5: Standard modules in Python for scientific computing and plotting; Handling files; Implementation of various algorithms (search, sort etc) in Python; Speed comparison with C; Integration of C programs into Python scripts.

Textbooks:

1. Introduction to Computing Systems: From Bits & Gates to C & Beyond; Yale Patt & Sanjay Patel
2. C: How to Program; Paul Deitel, Harvey Deitel
3. Dive into Python; Mark Pilgrim
4. Beginning Python: Novice to Professional; Magnus Lie Heitland
5. Python Algorithms; Magnus Lie Heitland

Earth and Environmental Sciences (CE 1101)

Module 1 - The earth system: Earth in the solar system. Atmosphere and oceans: Origin and evolution; Atmosphere-ocean interaction; Air pollution, Greenhouse effect, Ozone layer; Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions.

Module 2: Environment and Environmental Studies: Definition and Components of Environment, Relationship between the different components of Environment, Man and Environment relationship, Impact of technology on Environment, Environmental Degradation, Multidisciplinary nature of the Environment studies, its scope and importance in the present-day education system

Module 3: Ecology and Ecosystems: Introduction: Ecology- Objectives and Classification, Concept of an ecosystem- structure and functions of ecosystem, Components of ecosystem- Producers, Consumers, Decomposers. Bio-Geo- Chemical Cycles- Hydrologic Cycle, Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their

Interactions, Carbon cycle, Energy Flow in Ecosystem, Food Chains, Food webs, Ecological Pyramids Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem.

Module 4: Population and Economic Growth: The nature of human population growth, population parameters, industrialization, urbanization, sustainable development, sustainable consumption, health and the environmental impacts. Environmental pollution: Types of Environmental Pollution: Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution: Industrial Agricultural, Municipal; Classification of water pollutants, Effects of water pollutants, Eutrophication Marine pollution- Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO₂, NO_x, Natural & Anthropogenic Sources, Effects of common air pollutants Land Pollution: Land uses Land degradation: causes, effects and control, soil erosion. Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects Thermal Pollution: Causes and effects, Role of individual in the prevention of pollution

Module 5: Social Issues and the Environment: From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization. Environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, and ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation – consumerism and waste products. Environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

Textbooks:

1. The Good Earth: Introduction to Earth Science. 2nd Edition, McConnell, Steer, Knight, Owens & Park (2010), McGraw-Hill, New York, USA.
2. Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press
3. Basics of Environmental Studies, Varandani, LAP -Lambert Academic Publishing , Germany.
4. Basics of Environmental Studies U K Khare, 2011 ,Tata McGraw Hill
5. Rajagopalan, R, ‘Environmental Studies-From Crisis to Cure’, Oxford University Press, 2005.
6. Dharmendra S. Sengar, ‘Environmental law’, Prentice hall of India Pvt Ltd, New Delhi, 2007.
7. Erach Bharucha, “Textbook of Environmental Studies”, Universities Press(I) Pvt, Ltd, Hyderabad, 2015.
8. G. Tyler Miller and Scott E. Spoolman, “Environmental Science”, Cengage Learning India PVT, LTD, Delhi, 2014.

Media Project (HS 1102)

Module 1: Introduction to image, properties, elements, technology of imaging. **LAB:** sketching images, 5 hand drawn images leading to a comic strip, uses of color for the images, INSTAGRAM usage for capturing images.

Module 2: Visual Design, Visual and Aural Story telling. **LAB:** Introduction to Camera, Microphones, Report writing, Editing software.

Module 3: Introduction to moving images, building up a narrative. **LAB:** Advance training in camera handling, sound recording, dealing with real life situations, editing to form a narrative with actual footage and writing scripts.

Module 4: Production of a 30 to 45 second narrative, using various images set to a pre-recorded audio track in real life situations, dealing with challenges, start of postproduction of documentaries.

Module 5: Post production editing of the raw footage to form a structured narrative, dealing with sound and music to enhance the narrative and finalizing the project. Discussing the learning outcomes from the project.

English (HS 1101)

Module 1:

- The Bet - Anton Chekhov
- Seven Ages of Man/ To be or not to be/ Mark Antony's Speech in Julius Caesar- William Shakespeare
- London- William Wordsworth; Ode on a Grecian Urn- John Keats

Skills: Paragraph Writing: types, structure, features; Topic, supporting and concluding sentences; Definition, Description, Illustration; Concord.

Module 2:

- Ulysses- Tennyson
- The Second Coming- W. B. Yeats
- Destructors- Graham Greene

Skills: Expository and Argumentative writing, Fact versus Opinion, Connectors, Noun and Adverbial clauses

Module 3:

- A Homemade Education: Malcom X

- I have a Dream: Martin Luther King OR “The Meaning of July Fourth for the Negro” by Frederick Douglas
- The Danger of a Single Story- Chimamanda Adichie

Skills: Essay – Structure, organisation, unity, coherence, cohesion; Developing the thesis; Narrative essay; Active/Passive voice

Module 4:

- Wife’s Letter- Rabindranath Tagore
- Toba Tek Singh- Sadat Hassan Manto
- Imaginary Homelands- Salman Rushdie

Skills: Close reading and Comprehension; Compare/Contrast and Cause and Effect Essays; Conditionals

Module 5:

- Where I live- Arundhati Subramaniam
- Dance Like a Man- Mahesh Dattani

Skills: Process Analysis Essay; Summarizing; Translation (from Indian language to English)

Lab Component: Phonetics & Communication Skills practice cycles (14 weeks):

I. Introduction to Phonetics: Phonetics- a branch of Linguistics, International Phonetic Alphabet (IPA), Phonetic Symbols, English as an international language.

Introduction: Introduction to effective communication, verbal/non-verbal aspects of communication, components of communication, introducing oneself and others

II. Sounds of English: Classification of English phonic sounds into Vowels and Consonants, Description and Characteristic features

Situational Dialogues: Role plays, greeting, making requests, seeking permissions, asking for and giving instructions/directions, turn taking, telephone etiquette.

III. Vowels: Classification, Description, Articulation, Acoustics, Prosody and Transcription

Debates: Stating points of view, agreeing/disagreeing, asking for and giving information, negotiation and persuasion, making suggestions.

IV. Consonants: Classification, Description, Articulation, Acoustics, Prosody and Transcription

Presentation Skills: Individual/group presentations, poster presentations, PowerPoint presentations, describing and interpreting non-verbal data, project reports/proposals.

V. Stress Patterns: Syllable, Word Stress, Stress Patterns

Group Discussion: Team dynamics, techniques for group discussions, intervention, turn taking, summarizing, body language, tone, relevance, fluency and coherence.

VI. Intonation: Rising intonation, Falling intonation and Rise- Fall intonation

Panel Discussion: Initiating and coordinating discussion, asking for and expressing opinions, providing clarification, coordinating, conducting and participating in meetings.

VII. Rhythm: Stressed-time language, connected speech, Pitch

Public Speaking: Structure, organizing thoughts/ideas, effective transitions, summarizing and concluding, body language, tone, JAM sessions.

Introduction to Entrepreneurship (ET 1101)

Objectives: The course provides students with a structured understanding of how companies operate and can be managed. After the class, students should be familiar with concepts such as governance, strategy, partnering, organizing, etc.

Course Content:

- Introduction: objectives, stakeholders, operations and product life cycles
- Marketing of products and services
- Corporate strategy
- Growth process and strategic plan
- Structure and processes, informal organization
- Performance driving and operations management
- Management of innovation and technology

Textbooks:

1. Course reader in English + copy of the slides presented in class
2. The structuring of organizations, H. Mintzberg
3. Principles of economy, N. Gregory Mankiw
4. Economics, Organization and Management, Paul Milgrom and John Roberts

French - I (HS 1103)

Objectives: To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

Course Content:

i) Topics

- Alphabet
- Numbers
- Nationality
- Profession
- Country and Cities
- Self-introduction and introducing others

ii) Grammar

- Present tense only with 1st group regular and irregular verbs
- Negations
- Prepositions in front of countries and cities
- Likes and dislikes with simple notions

iii) Types of writing

- Very short essay on introduce oneself

Linear Algebra and Complex Analysis (MA 1202)

Module 1 - Linear Algebra: Real and complex vector spaces, Linear dependence, Matrix of a vector system, change of coordinates, Linear transformation, addition and composition; kernel and image, rank; one to one and onto maps, matrix of a linear map, Inner product, Cauchy-Schwarz, Norm, triangle inequality. Euclidean spaces, Orthogonal and orthonormal family and basis, Gram-Schmidt orthonormalization and Fourier Series.

Module 2 - Matrices: Matrix addition and multiplication, singular matrix, determinant, rank, inverse, adjoint, Linear system: abstract study, Gaussian Elimination, Transpose and conjugate matrix; similar matrix, Eigenvalues and eigenvectors of a linear map. Characteristic polynomial of a matrix, diagonalizability, Symmetric and orthogonal matrices, diagonalization of a symmetric matrix.

Module 3 - Complex Analysis: Complex numbers, Polar form, De Moivre's formula, complex differentiation. Cauchy- Riemann equations. Analytic functions, Elementary functions, Contour and contour integral. Cauchy's theorem and integral formula. Taylor's theorem, zeros of analytic functions. Maximum modulus principle, Laurent series, Cauchy residue theorem, poles and residue.

Module 4 - Integral Transform: Laplace Transform: Functions of exponential order and examples. Transforms of elementary, transcendental and special functions. Transforms of

derivatives and integrals and periodic function, unit step function and impulse function. The inverse transform, Convolution theorem, solution of ordinary differential equations (IVP and BVP). Z-Transform, Fourier Transform.

Text and Reference Books:

1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995).
2. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
3. E. Kreyszig, Advanced engineering mathematics, John Wiley (1999).
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
5. D.G. Zill, P.D. Shanahan, A first course in complex analysis with applications.
6. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
7. JL Schiff, The Laplace transform, Springer
8. G. Strang, Linear Algebra and its Applications, Fourth Edition, Books/Cole.

Classical & Quantum Mechanics (PH 1201)

Module 1 (Coordinate systems and Vector Calculus): Vectors, Algebra of Vectors, Multiplying Vectors, Components of a Vector, Base Vectors, The Position Vector \mathbf{r} and Displacement, Velocity and Acceleration, Formal Solution of Kinematical Equations, More about the Time Derivative of a Vector, Motion in Plane Polar Coordinates.

Module 2 (Newton's laws, Types of Forces and Application of Newton's laws): Newton's Laws and Inertial Systems, Base Units and Physical Standards, Algebra of Dimensions, Applying Newton's Laws, Dynamics Using Polar Coordinates.

Fundamental Forces of Physics, Gravity, Some Phenomenological Forces, A Digression on Differential Equations, Viscosity, Hooke's Law and Simple Harmonic Motion.

Dynamics of a System of Particles, Center of Mass Coordinates, Conservation of Momentum, Impulse and a Restatement of the Momentum Relation, Momentum and the Flow of Mass, Rocket Motion.

Module 3 (Work-energy theorems, conservative forces and angular momentum): Integrating Equations of Motion in One Dimension, Work and Energy, Conservation of Mechanical Energy, Potential Energy, What Potential Energy Tells Us about Force, Energy Diagrams, Non-conservative Forces, Conservation Laws and World Energy Usage.

Small Oscillations in a Bound System, Stability Normal Modes Collisions and Conservation Laws.

Angular Momentum of a Particle, Fixed Axis Rotation, Torque and Angular Momentum, Dynamics of Fixed Axis Rotation, Motion Involving Translation and Rotation, Work–Energy Theorem and Rotational Motion, Vector Nature of Angular Velocity and Angular Momentum, Gyroscope.

Module 4 (Central forces, gravitation, Kepler's law dynamics of rigid bodies (2D)): Central Force Motion as a One-body Problem, Universal Features of Central Force Motion, Energy Equation and Energy Diagrams, Planetary Motion, Some Concluding Comments on Planetary motion, Integrating the Orbit Integral and Properties of the Ellipse.

Module 5 (Harmonic oscillators and waves): Simple Harmonic Motion: Review, Damped Harmonic Oscillator, Driven Harmonic Oscillator, Transient Behavior, Response in Time and Response in Frequency.

Types of waves, Energy and Power of a Wave travelling along String, Wave Equation, Standing waves and Resonance, Travelling Sound waves, Doppler Effect and Supersonic speed and Shock waves.

Textbooks:

1. An Introduction to Mechanics by Daniel Kleppner and Robert Kolenkow, Cambridge University Press
2. Berkely Physics Mechanics Vol. 1 by Charles Kittel, Walter D. Knight, Malvin A. Ruderman
3. Physics for Scientists and Engineers, Fishbane, Gasiorowicz, Thornton, Prentice Hall

LABORATORY WORK

Objectives: The objective of the course is to let students understand practically what basic laws and their effects are. They will practice mechanical, thermodynamics, optical and electromagnetism experiments and will be able to develop an intuitive understanding of natural effects. In parallel with the theoretical lectures they will face reality and will be in position to make links with its mathematical expressions.

Mechanics (Semester 1)

- ❖ Maxwell's wheel: free fall, inertia momentum
- ❖ Pendulum: Eigen frequency of an oscillator, momentum, gravity force
- ❖ Collisions of projectiles: 1D motion, elastic and inelastic collisions
- ❖ Vibrating string: standing waves, eigenmodes, influence of boundary conditions
- ❖ Acoustic Doppler effect: analogic mixing of electric signal to detect a change in the frequency
- ❖ Kundt's tube: to determine velocity of sound in air
- ❖ Lee's disk method: to measure thermal conductivity of various insulators
- ❖ Force and momentum: to validate Newton's laws of motion

Introduction to Biology (BI 1201)

Module 1- Evolution: Origin of life and its evolution; Direct and indirect evidence of evolution; Phylogenetic relationship and classification of living organism; Theories of organic evolution; Biodiversity and its importance.

Module 2- Structure and Function: Chemical basis of life, Biomolecules (Carbohydrates, Lipids, Proteins and Nucleic acids), Cell – the basic Unit of Life, Prokaryotic and Eukaryotic cells, Membrane structure and function; Cell communication; Organization of cell organelles, Cell cycle, Cell division -Mitosis and Meiosis.

Module 3- Information Flow, Exchange, and Storage: Concept of gene; genomes and chromosomes; Mendelian principles; Extension of Mendelian genetics; Chromosomal basis of inheritance; Sex-linked inheritance; Chromosomal aberrations and anomalies; Mutations and genetic disorders; DNA replication and repair; Synthesis and processing of RNA; Genetic code; transfer RNA and protein sequences; Regulation of gene expression; Post-translational processing; Epigenetic modification; Genetic engineering and its applications.

Module 4- Pathways and Transformations of Energy and Matter: Pathways and Transformations of Energy and Matter: Introduction to metabolic pathways; Enzymes as biocatalysts; Energy transformation in organisms; electron transport chain, Inherited disorders of metabolism; Food chains and food web; Energy Flow and nutrient cycling in an Ecosystem.

Module 5- Biological Systems: Introduction and basic concepts in systems biology; Technologies used in systems biology (Genomics, Transcriptomics, Proteomics, Metabolomics) and its applications; Tools and techniques for high-throughput data analysis.

Textbooks:

1. Campbell Biology: Concepts And Connections (12th Edition) by Jane B. Reece, Martha R. Taylor, et al.
2. High-Throughput Next Generation Sequencing, Methods and Applications. (Springer). Editors: Kwon, Young Min, Ricke, Steven C.

Introduction to Electronics (EC 1202)

Module 0 - Introduction: Background, Importance of Electronics and its everyday applications

Module 1 - Voltage/Current relationships for R, L, and C parameters, Basics of RC low pass filter, CR high pass filter and LC low pass filter; Resonance phenomena

Module 2 - Semiconductors: Intrinsic and Doped Semiconductors, PN junction, Carrier mobility, PN junction in forward, reverse and no bias, Shockley's equation for a PN junction diode, Diodes: Semiconductor diode (No bias, Forward, Reverse bias, Zener region, Ge Si and GaAs, Temperature effects), Ideal v/s practical, Resistance levels (DC or static resistance, AC or dynamic resistance, Average ac resistance), Diode Equivalent circuits (Piecewise linear, Simplified, Ideal Equivalent circuits), Reverse recovery time, Zener diodes, Light emitting diodes. Diode applications: Load line analysis, Series diode configuration, AND/OR gates, Sinusoidal inputs, Half wave rectification, Full wave rectification, Clippers, Clampers, Voltage doubler, special purpose diodes and their applications

Module 3 - Bipolar Junction Transistor (BJT): Basics of Transistor operation, Common Base Configuration, Common Emitter Configuration, Common Collector Configuration, BJT DC biasing: Fixed Bias, Emitter Bias, Voltage divider bias, Collector feedback bias, Emitter follower Bias, Common base configurations, Miscellaneous bias configurations, BJT ac analysis, Ebers Moll model of BJT

Module 4 - Transistor as a switch, Darlington pair, Linear Regulator circuits using Zener diode and BJT (output current regulation and voltage regulation), Basics of Field Effect Transistors (FETs): basic types and working principle.

Module 5 - Basics of Operational amplifiers: Single ended, double ended operation, equivalent circuit of ideal OPAMP, virtual ground, inverting amplifier, non-inverting amplifier, voltage summer, voltage buffer, Voltage controlled voltage source, Voltage controlled current source, Current controlled voltage source, Current controlled current source. Amplifiers: Signals, Frequency spectrum of signals, Amplifier Circuit symbol, Voltage gain, Power gain and Current gain, Expressing gain in decibels, The Amplifier Power supplies, Circuit models for Amplifiers (Subsections: Voltage amplifiers, Cascaded Amplifiers, Other Amplifier types, Relationships between the four amplifier models), Pulse generators, multi-vibrators, and waveform generators.

Reference Books:

1. Boylestad and Nashelsky, Electronic devices and Circuit Theory, Pearson.

2. Sedra and Smith, Microelectronic circuits, Theory and Applications, 6th Edition, Oxford international student edition.

Data Structures (CS 1002)

Module 1: Introduction to Data Structures: Single and Multi-dimensional Arrays, Sparse Matrices (Array and Linked Representation). Introduction to Algorithms: Algorithm Development, Complexity analysis, Recursion. Growth of Functions & Asymptotic Notations. Rates of Growth: $O(n)$, $\Omega(n)$, $\Theta(n)$, $o(n)$, $\omega(n)$, Run-Time Complexity, Space Complexity, NP-Completeness (Time Permitting). Complexity Class - P, NP, NP Complete, NP Hard, Is $P=NP?$ and Reductions.

Module 2: Linear Data Structures - Stacks: Operations and Applications, Implementing single / multiple stack/s in an Array; Prefix, Infix and Postfix expressions, Applications of stack; Limitations of Array representation of stack. Links Lists: Operation – Creations, insertion, Deletion, Circular Lists, Doubly Linked List. (Approaches, Implementation Issues, Complexity & Efficiency), Amortized Analysis.

Module 3: Array and Linked representation of Queue, De-queue, Priority Queues, Circular Queues: Operations and Applications

Sorting Algorithms & Searching: Bubble sort, Quick Sort, Insertion Sort, Merge Sort, Selection sort, Heap Sort, Radix sort and Bucket sort. Lower bound for comparison-based sorting algorithms. Linear Search, Binary Search.

Module 4: Introduction to Hashing, Deleting from Hash Table, Efficiency of Rehash Methods, Hash Table Reordering, Resolving collusion by Open Addressing, Coalesced Hashing, Separate Chaining, Dynamic and Extendible Hashing, Choosing a Hash Function, Perfect Hashing Function Introduction to Tree as a data structure; Binary Trees (Insertion, Deletion , Recursive and Iterative Traversals on Binary Search Trees); Threaded Binary Trees (Insertion, Deletion, Traversals); Height-Balanced Trees (Various operations on AVL Trees).

Module 5: Graphs I: Representation and Traversal (Preorder, Inorder, Postorder) - •
Representation: Matrix, Adjacency list; Traversal: Depth First Search, Breadth First Search; Graphs II: Basic Algorithms - Minimum Spanning Tree, Shortest Path, All pairs Shortest Path, Transitive Closure

Textbooks:

1. Aaron M. Tenenbaum, Moshe J. Augenstein, YedidyahLangsam, "Data Structures Using C and C++:, Second edition, PHI, 2009.

2. Micheal T. Goodrich and Roberto Tamassia: Algorithm Design: Foundations, Analysis and Internet examples (John Wiley & Sons, Inc., 2002)
3. Cormen T.H., Leiserson, C.E., Rivest, R.L., and C. Stein. Introduction to Algorithms, MIT Press, Second Edition (Indian reprint: Prentice-Hall).
4. Sanjoy Das Gupta, Christos Papadimitriou, Umesh Vazirani, Algorithms; Tata McGraw-Hill Publishers
5. Alfred V. Aho, John E. Hopcroft, Jeffery D. Ullman. Data Structures and Algorithms
6. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran. Computer Algorithms
7. Robert L. Kruse, "Data Structures and Program Design in C++", Pearson, 1999.

Discrete Mathematical Structures (CS 1202)

Module 1 - Foundations of Logic:

- Proof and Programming: Intuitive notion of mathematical proof and its connections with computer programming.
- What is a mathematical theory?: Propositional logic, Predicate logic, Models, Axioms, Rules of Logic, Theorems, Proof techniques.

Module 2 - Set theory:

- Naive set theory, operations on sets
- Paradoxes and crises that shook the world of mathematics - and how it led to development of computer science?
- Cardinality; Countable and Uncountable sets; examples.
 - Set theory and computability theory
 - Decision problems
 - Questions vs Problems
 - Programs vs Problems
- A brief discussion on Automata theory.
- Turing machine vs Algorithm

Module 3 – Algorithms:

- Good algorithms vs bad algorithms : need for a scientific definition.
- Asymptotic notation, complexity of an algorithm
- Complexity classes.

Module 4 - Counting techniques:

- Basic counting - The multiplication principle, Permutations and combinations, Addition and subtraction, Probability (recap), Applications of combinations : Paths on grid, Choices with repetition, Correcting for overcounting

- More counting - Inclusion – exclusion, Multinomial coefficients, Generating functions, Counting orbits, Combinatorial arguments

Module 5 - Graphs and properties:

5.1 Basics

- Motivation, Graphs and Graph models
- Notation & Special types of graphs
- Matrices
- Invariants
- Directed graphs and Markov chains

5.2 Properties

- Connectivity
- Euler circuits
- Planar numbers
- Chromatic number

Textbooks:

1. Discrete mathematics and its applications - Kenneth H. Rosen et al
2. Mathematics for Computer Science - Albert R. Meyer et al
3. Discrete mathematics - Kevin Ferland
4. Invitation to Discrete Mathematics - Jiri Matousek (for slightly advanced readers)
5. Concrete Mathematics - Donald Knuth (for slightly advanced readers)

French - II (HS 1203)

Objectives: To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

Course Contents:

Topics

- Family
- Hobbies and pastimes
- Leisure activities
- Describing habit and routines
- Weather description

Grammar

- Possessive adjective

- Near future
- Past tense
- Negation
- Spatial location : - venir de / aller à + ville ou pays
- Adverb of time: now, this week, tomorrow, last month etc...
- Fixed preposition with some verbs(aller, venir, faire, jouer)

Types of writing

- Post card writing
- Family tree
- Likes and dislikes with advanced notions

Ethics (HS 1202)

Module 1: Why be moral? Introduction to ethical theories. Is and Ought. What is and what ought to be? Fact-value distinction

Module 2: End and Means. Classical dilemma, Debates and theories. Gandhian Ethics. The concept of shreyas and preyas.

Module 3: Justice. Classical theories of justice. Crime and punishment. Malpractices.

Module 3: Rights, Duties and Responsibilities. Natural rights, Fundamental rights and Human dignity. Freedom and autonomy. Duties and responsibilities. Legal rights. Patents and intellectual rights

Module 4: Good Life. Happiness. Harmony. Care and Compassion

Module 5: Case studies of professionals, institutions and organizations

Textbooks / References:

1. Handouts of classical texts by various philosophers will be provided to students. (Socrates, Kant, Hume, Locke, Mills, Bentham, Rawls, Gandhi, etc.)
2. Practical Ethics by Peter Singer
3. Applied Ethics by Peter Singer
4. What We Owe Each Other by T. M Scanlon
5. Fundamental Ethics – for Scientists and Engineers by Edmund Seebauer and Robert Barry

Probability and Statistics (MA 2103)

Module 1: Probability and Random Variables Axiomatic definition of probability, Sample Space, Events, Conditional Probability, Independence of Events, Theorem of Total Probability, Baye's Theorem, Discrete and Continuous Random Variables, Probability Mass Function, Probability Density Function, Cumulative Distribution Function, Moments, Mathematical Expectation, Variance, Standard Deviation, Moment Generating Function.

Module 2: Discrete and Continuous Distributions Binomial Distribution, Poisson Distribution, Uniform Distribution, Exponential Distribution, Normal (Gaussian) Distribution, Markov's Inequality, Chebyshev's Inequality.

Module 3: Random Vectors: Joint Probability Distribution of Functions of Random Variables, Independence of Random Variables, Covariance, Variance, Expectation, Correlation, Multinomial Distribution, Transformations of Random Variables, The Law of Large Numbers, The Central Limit Theorem.

Module 4: Random Processes: Continuous and Discrete Random Processes, Autocorrelation Function, Auto covariance Function, Correlation Coefficient, The Bernoulli Process, The Poisson Process, The Wiener Process, The Markov Chain, Stationarity: Strict-Sense Stationary (SSS) and Wide-Sense Stationary (WSS) Processes.

Module 5: Statistics: Descriptive Statistics: Sample Mean, Sample Variance, Sample Standard Deviation and Sample Correlation Coefficient; Confidence Intervals, Parameter Estimation: Unbiasedness, Consistency, Point Estimator, Maximum Likelihood Estimators.

Textbooks:

1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, Fifth Edition 2016.
2. Sheldon M. Ross, Introduction to Probability Models: 11th Edition, Academic
3. Press Elsevier, 2015. Jean Jacod and Philip Protter, Probability Essentials, Springer, 2004.
4. Hogg, Tanis and Rao, Probability and Statistical Inference: 7th Edition, Pearson, 2006.
5. Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, Pearson, 2008.

Electromagnetics & Optics (PH 2102)

Module 1 – Electrostatics: Physical definitions of Gradient, divergence and curl operators, curvilinear coordinates, Dirac Delta function, Theory of vector fields, Coulomb's law and principle of superposition, Gauss's law and its applications, Electric potential and electrostatic energy, Poisson's and Laplace's equations with simple examples, uniqueness theorem, boundary

value problems, Properties of conductors, Multipole expansion, Electric fields in matter, Dielectrics and polarization

Module 2 – Magnetostatics: Biot & Savart's law, Amperes law, Divergence and curl of magnetic field, Vector potential, Vector potential, Magnetic field in matter, Bound currents, Field H, Classification of magnetic materials, Faraday's law in integral and differential forms, Motional EMF, Displacement current

Module 3 – Electromagnetism: Maxwell's equations, Electromagnetic waves, wave equation, e.m. waves in vacuum and media, refractive index, Energy and momentum of e.m.w., Poynting vector, Polarization of e.m. waves, Reflection and refraction, skin depth, standing electromagnetic waves, Electric dipole radiation, Waveguides with rectangular metallic boundaries, TE, TM and TEM mode.

Module 4 – Optics: Some discussions on geometrical optics, Wave optics: Interference between two coherent waves, Fresnel and Fraunhofer diffraction, Diffraction grating, polarization, Fiber Optics

Labs

1. Geometrical optics with lenses
2. Newton's rings
3. Single-and double-slit diffraction
4. Spectrometry of a glass prism
5. Polarization study with half and quarter wave plates
6. Helmholtz coils
7. Faraday's law
8. B-H loop
9. Hall effect

Signals and Systems (EC 2102)

Module 0: Introduction to Signals & Systems, *Continuous-Time Signals*: Signal Classification, Signal operations, *Discrete-Time Signals*: Signal Classification, Signal operations, Singularity Functions: unit Impulse signal, unit Step signal, unit ramp signal, exponential signal, Continuous/ Discrete-Time Systems Classification.

Module 1: Linear Time-Invariant (LTI) Continuous-Time Systems, Properties of LTI Systems, Impulse Response, Linear Convolution, Causality, Stability, Introduction to Fourier Analysis, Fourier Series for Periodic Signals, Properties of Fourier Series

Module 2: Aperiodic Signal Representation, Continuous-Time Fourier Transforms & its properties, Frequency Response of Continuous-Time Systems, Laplace transform & its properties, Inverse Laplace Transform, Solution of LTI continuous-time systems using Laplace transforms; Transfer Function, pole-zero concepts, Feedback and its effect on pole-zero

locations.

Module 3: Sampling & reconstruction, Discrete-time LTI systems, Discrete-time convolution, Discrete-Time Fourier Transform & its properties.

Module 4: Z-transforms & its properties, Z-transforms converting difference equations into algebraic equations, Discrete Fourier Transform (DFT), Properties of DFT.

Module 5: Fast Fourier Transform (FFT), decimation-in-time (DIT) FFT & decimation-in-frequency (DIF) FFT algorithms, Discrete-time convolution using FFT.

Text Book and References:

1. A V Oppenheim, A S Willsky, Nawab S N, “Signals & Systems”, Second Edition, PHI, 2006.
2. Lathi B P, “Principles of Signal Processing & Linear Systems”, Oxford University Press, 2009.
3. Nagrath I J, Sharan S N, Ranjan Rakesh & Kumar S, “Signals & Systems”, Second Edition, TMH, 2001.
4. Papoulis A, “Signal Analysis”, McGraw Hill.

Digital System Design (EC 2103)

Module 1: Review of Number Systems and Boolean Algebra

Number System & Codes: Binary, Octal, Hexadecimal number systems and their interconversion, Binary Arithmetic, BCD, Excess-3 code, Gray code, code converters. Boolean Algebra: Boolean functions, Axiomatic definitions, theorems/properties, Canonical and Standard forms.

Module 2: Combinational Logic Circuits

Review of Digital Logic Gates and Logic Minimization. Review of Basic combinational logic circuits: MUX/DeMUX, Encoders, Decoders, Comparators, Adders/Subtractors, Multipliers. Implementation of combinational logic: TTL logic, TTL gate implementation, CMOS logic, logic levels, CMOS inverter, NAND/NOR gates, Fan-In/Fan-Out. Pass transistor Logic. Dynamic Logic.

Module 3: Sequential Logic Circuits

Review of Latches and Flip-flops; Inter-conversion between Flip-flops, Multi-bit registers. FSM using sequential logic circuits: Finite State model, State equivalence and minimization, simplification of incompletely specified machines, Structure of sequential machines: State

assignments using partitions, Lattice of closed partitions, reduction of the output dependency, input independency and autonomous clocks, covers and the generation of closed partitions by state splitting.

Module 4: Advanced Design Techniques and Issues

FPGA Architectures. Concurrent Design practices: Folded Combinational Circuits, Pipelining, Systolic Arrays, FIFOs and streaming architectures, Ephemeral History Register. Low Power Design Techniques: Approximate logic, Power gating, Clock Gating. Fault tolerant design: types of faults and errors, error detection and correction codes, redundancy.

Module 5: Timing Issues in Digital Logic Circuits

Timing hazards: static hazards, finding static hazards using maps, dynamic hazards. Timing analysis: Propagation delay, input-output delay, Timing diagrams, Timing specification, Timing analysis, Timing analysis tools. Timing specification for sequential logic: set up time, hold time, clock to output delay, maximum operating frequency, static timing analysis, critical paths, dynamic timing analysis, Techniques to improve timing, pipelining, operating frequency vs latency. Impediments to Synchronous design: Clock skew, clock gating, asynchronous inputs, clock domain crossing. Metastability: basic synchronizers for control signals, clock synchronizing data buses, synchronizer failure.

Textbooks:

1. John F Wakerly; Digital Design: Principles and Practices, 5th ed., Pearson, 2017.
2. Simon Monk; Programming FPGAs: Getting Started with Verilog; 1st ed., McGraw-Hill Education, 2016.
3. Zvi Kohavi and Niraj K Jha; Switching and Finite Automata Theory, 3rd ed., Cambridge University Press, 2009
4. Mano and Ciletti; Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson, 2012

Network Analysis and Synthesis (EC 2104)

Module 1 – Analysis using graph theory: Network Topology, graphs, Edges, Trees, Circuits, Tree branches, Links, Incidence matrix, circuit matrix, Cut-set matrix, their inter relationships $\sum \text{ABT} = 0$ Nodal analysis, Admittance matrix, Mesh analysis Mesh Impedance matrix, Solution of networks containing controlled sources.

Module 2 – Realizability conditions of linear passive networks: Tellegen's Theorem, Energy Functions, Network properties based on energy functions, PR functions; Test for PR function, Hurwitz polynomials and Hurwitz test. Real part sufficiency, Definition of linearity. Passivity, Tellegen's reciprocity, causality.

Module 3 – Two port parameters: Z and Y parameters, interconnection of two ports S parameters and their relation to Z and Y parameters. Reciprocity, passivity and matching conditions on S parameters Measurement of s parameters.

Module 4 – Synthesis of one port networks: Driving point impedance, pole zero locations Passivity Properties of LC, RC, RL networks Synthesis of two element kind networks - Foster and Cauer forms. RLC synthesis Bott and Doffin method, Darlington method and Miyata method.

Synthesis of two port networks: Properties of impedance and admittance matrices - residue and real part condition. Obtaining transfer function from magnitude Darlington synthesis, Miyata ladder synthesis.

Synthesis of singly terminated and doubly resistive terminated networks: Darlington and Miyata synthesis, Reflection coefficient formulation for doubly terminated networks. Miyata synthesis for arbitrary source and load resistances.

Module 5 – Approximation problem: Butterworth, Tchebycheff approximation. Roots of the polynomials. Linear phase approximation- Bessel polynomials and their roots.

Synthesis of filters: LP to HP and BP transformation. Impedance level and cut off frequency scaling. Prototype LP filter based on Butterworth, Tchebycheff and Bessel approximation – Synthesis of Miyata ladder form of singly and doubly terminated prototype filters.

Image parameter theory and Zobel filters: Image parameters. Attenuation and phase pf image terminated filters. LP prototype filters- constant K, m derived filters. M and mm' derived terminations.

Module 6 – Time domain analysis: State space representation of linear networks. Solution of state equation Properties of state transition matrix. calculation of state transition matrix. Eigen values and eigen functions. Stability Choice of state variables for a linear passive network. Derivation of state and output equation for Linear Passive Time invariant network. Relation to immittance formulation of networks.

Module 7 – Active RC networks and synthesis of active filters: Structure of active RC filters- finite gain structures, Sallen Key Filters, Op-Amp based RC filters Huelsman Biquad.

Textbooks:

1. Dante C Youla: Theory and Synthesis of Linear Passive Time Invariant Networks, Cambridge Univ Press, 2016
2. Charles A. Desoer and Ernst Kuh: Basic Circuit Theory, McGraw.
3. Seshu, Balabanian, Bickart: Electrical Network Theory

4. Seshu and Reed: Linear Graphs and Electrical Networks
5. Shu Park Chan: Introductory Topological Analysis of Electrical Networks
6. E A Guillemin: Mathematics of circuit Analysis
7. E A Guillemin: Synthesis of Passive Networks
8. Louis Weinberg: Network Analysis and Synthesis, McGraw.
9. H. J. Carlin and A. Giordano: Network Theory: An Introduction to Reciprocal and Nonreciprocal Networks
10. BDO Anderson Sumeth Vongpanitlerd: Network Analysis and Synthesis: A system theory approach, Dover, 2006
11. Omar Wang: Classical Circuit Theory, Springer, 2008.
12. George Moschytz: Analog Circuits and Filter Theory in the Digital World
13. Vasudev K. Aatre: Network Theory and Filter Design, New Age International.

French - III (HS 2103)

Objectives: The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

Course Content:

General themes

- People: Family, Physical description
- Places: Cafe, Restaurant, Shops, Bank, Post office, Hotel, Road
- Hobbies: Sports, Going out, Shows, Holiday trips
- Daily Life: Work, Shopping,
- Daily activities

Grammar topics

- Pronominal verbs: verbes reflexifs and pronominal verbs
Past Simple - events in the past

- Past participles
Imperfect tense - descriptions in the past (it was, there was)
Imperative - Affirmative and Negative - for instructions and commands
- Near Future Tense
Future simple tense
- Conditional tense

Lean Startup (HS 2101)

Objectives: The primary objective of the course is to enable students to learn how to rapidly develop and test ideas by gathering massive amounts of customer and marketplace feedback.

More specifically, the course aims to:

1. Teach the basic principles of lean start-up
2. Build products that meet customer needs
3. The easiest and fastest ways to build minimum viable products which could be launched quickly.
4. Tactics for experimentation with landing pages, A/B tests, MVPs on real customers

Course Description: The course aims at giving you practical experience in starting a technology-based start-up or leading a new product development initiative in an established corporation. The course is based on the principles of lean-startup developed by Eric Ries and Steve Blank. Lean Startup is a new, field-tested philosophy that provides you with a toolset to minimize failure and increase your chances of success. Through practical experience, student-driven seminars, understanding of business model components in the start-up process, as well as ability to analyze and validate an idea or invention is mainly achieved through customer-based development and experimentation with minimum viable products.

Principles of Economics (HS 2102)

Objectives: The course provides students with a structured understanding of how companies operate and can be managed. After the class, students should be familiar with concepts such as governance, strategy, partnering, organizing, etc.

Course Content:

- Introduction: objectives, stakeholders, operations and product life cycles
- Marketing of products and services
- Corporate strategy

- Growth process and strategic plan
- Structure and processes, informal organization
- Performance driving and operations management
- Management of innovation and technology

Textbooks:

1. Course reader in English + copy of the slides presented in class
2. The structuring of organizations, H. Mintzberg
3. Principles of economy, N. Gregory Mankiw

Electromagnetic Waves (EC 2202)

Objectives:

- Study transmission lines and waveguides and be able to apply those concepts in practice
- Study Electromagnetic waves in free space
- Study the basic concepts of Antennas

Module 0: Review of Electromagnetic Theory. Maxwell's Equations, Vector Analysis.

Module 1: Transmission Lines: voltage and current variations along ideal lines, relation of field and circuit analysis, reflection and transmission, pulse forming line, impedance transformation, standing wave ratio, Smith chart, lossy lines, filter-type and resonant lines, group and energy velocities, backward waves;

Module 2: Electromagnetics in Free Space: Maxwell's equations and their solutions, potential functions, Poynting theorem, guided waves; linear, circular and elliptical polarized waves. Concept of angular spectrum.

Module 3: Dielectric Materials: macroscopic electric field due to a volume of polarized dielectric, complex permittivity and dielectric losses, Maxwell's equations for dielectric materials; reflection and refraction of plane waves.

Module 4: Waveguides and Resonators: TE and TM waves, parallel-plate, rectangular waveguides, evanescent waves in waveguides. dielectric waveguides, and rectangular cavity

resonators;

Module 5: Antennas: Elemental and half-wave dipoles.

Text Books

1. Hayt and Buck: Engineering Electromagnetics, TMH
2. Bhooshan, S: Fundamentals of Engineering Electromagnetics, OUP

Reference books

1. Sadiku, M: Elements of Electromagnetics, OUP

Random Processes for Electrical Engineering (EC 2204)

Module-1: Basic Concepts of Probability Theory, Random Variables, and random vectors

Probability Models in Electrical, Electronics, and Computer Engineering;

Brief revision of probability theory;

Random Number Generators; Random variable (RV) – notion of a random variable, Discrete and Continuous Random Variables, The Cumulative Distribution Function, The Probability Density Function, Probability Mass Function, Expected value of a random variable, function of one random variable, characteristic and moment generating function.

Vector random variables, pairs of RVs, Independence of two RVs, Conditional Probability and Conditional Expectation, Joint distribution of several RVs, Transformation of random vectors, correlation and covariance of two RVs, Jointly Gaussian RVs, Central Limit Theorem and its applications.

Module -2: Random Process

Definition, joint distribution of time samples, mean, autocorrelation, and autocovariance functions, Gaussian Random Process, Discrete-time Random Processes, Multiple Random Processes – cross-covariance and orthogonality, Stationarity - WSS and SSS, ergodicity; Orthogonal expansion of Random Processes – Karhunen-Loeve expansion.

Module-3: Estimation techniques for statistical parameters

Mean square estimation of one RV by observation of another RV;

estimation of mean, variance, correlation, autocovariance etc.;

confidence intervals - Gaussian samples with known mean and unknown variance, unknown mean and unknown variance, Non-Gaussian samples.

Module-4: Analysis, detection, and estimation of random signals

Power Spectral Density (PSD), White Noise, band-limited White Noise;

Hypothesis testing and optimum detection: Binary hypothesis, optimum detection of binary message waveform in presence of white noise, extension to M-ary detection.

Response of linear systems to random signals, Discrete-time systems – MA, AR, ARMA process;

Linear estimation in presence of noise – Optimum linear systems, Wiener filter and its implementation, causal implementation using spectral factorization.

Module-5: Kalman filter and spectral estimation

The Kalman Filter;

Spectral estimation techniques.

Text Books:

1. A. Leon-Garcia, “Probability and Random Processes for Electrical Engineering”, Pearson.
2. A. Papoulis, “Probability, Random Variables, and Stochastic Processes”, McGraw-Hill.

Reference Books:

1. Van Trees, “Detection, Estimation and Modulation: Part I”, Wiley.
2. M. H. Hayes, “Statistical Signal Processing”, Wiley.

Analog Circuits (EC 2207)

Module 1 - Review of Semiconductor devices: BJT: structure and modes of operation. Normal mode. Emitter Base and Collector currents Early effect. BJT model as a 3-T network IAM for CE, CB, CC models. Hybrid Pi model, Alpha cut-off frequency. MOSFET; Structure, Regions of operation, I_d vs V_{gs} , I_d vs V_{ds} . Short channel effects. Model of MOSFET in saturation region. Linear applications of semiconductor active devices- General characteristics of amplifiers - *Voltage Controlled Voltage Source (VCVS)*, *Voltage Controlled Current Source (VCCS)*, *Current Controlled Voltage Source (CCVS)* and *Current Controlled Current Source CCCS* representation. 2-port model, Activity and passivity Mason’s U factor and its Implications

Module 2 - Single Transistor Amplifiers: Biasing: Current sources (current mirrors) for biasing. Simple current mirror, base current compensation, Widlar and Wilson current mirrors.

Single Transistor amplifiers: Resistive loads and active loads - CE, CS; CB, CG; CC, CD with active loads including emitter/source degeneration (with equivalent circuits). Voltage gain, input and output impedances and frequency response. Dominant pole concept. Open circuit time constant (OCTC) approximation for calculating dominant pole

Module 3 - Multistage Amplifiers: Cascade, Differential, Cascode, Darlington, Totem-pole, and CMOS, Push-Pull. Differential Topology-Transfer characteristics of Differential pair. Application of differential topology as amplifier, logic gate, Gilbert cell and analog multiplier, as mixer, cross coupled differential amp as one-port negative resistance. Differential amp: Symmetry of Differential amp, Concept of common mode and differential input in relation to symmetric networks. Differential gain and common mode gain, CMRR. Double-ended to single-ended conversion Biasing for single ended output with current sources, gains and input and output impedances, Frequency response. Simplified frequency dependent model of Differential amplifier. Analysis using BJT and MOS. Cascode topology: Advantages of cascode connection. Equivalent circuit and calculation of gain, input and output impedances, Bandwidth. Folded cascode. opamps: Anatomy of opamp. Stability, Compensation, Slew, Design considerations of opamp. Innovations in circuit topologies of commercial opamps with examples of opamp applications.

Module 4 - Feedback: General properties of feedback. Mixing and sampling. Feedback topologies - Ideal Series-Series, Series-Shunt, Shunt-Series, Shunt-Shunt, effect on appropriate gains, input and output impedances. Loading effect due to feedback circuit on the open loop gains. Method of including loading effects on amplifiers with feedback in all the four topologies

Module 5 - Power amplifiers: Power gain: Definition of power gain Efficiency of amplifier, calculation of power gain and efficiency of CE amplifier. Distortion - Definition, Distortion measures classes of operation, Class B push-pull amplifiers with complementary devices. crossover Class AB, Efficiency. Class D operation Stability of power amplifiers, Impedance Matching

Module 6 - Analog IC Design: CMOS Fabrication Process, IC components and their models; Layout considerations; Analog and Digital Signals and their interconversion, Analog to Digital Conversion (ADC) - Flash ADC, Dual Slope, Successive Approximation. Digital to Analog Conversion (DAC) - Weighted Resistor, R-2R Ladder DAC.

Text Books:

1. Sedra & Smith, Microelectronic Circuits, Oxford Press, 7th edition, 2014
2. Gray, Hurst, Lewis and Meyer, Analysis and Design of Analog Integrated Circuits, 5th edition, Wiley 2010.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2000.

Control Systems (EC 2210)

Module 1 - Introduction and Mathematical Modelling of Control Systems: Closed Loop versus Open loop Control, Transfer functions, Block Diagram, Signal Flow Graph, Laplace Transform Relationships, Modelling of Electrical Systems, Feedback and Control Objectives

Module 2 - Transient and Steady State Response Analyses: Time domain response of First order, Second order and Higher order systems, Steady state error constants

Module 3 - Concepts of Stability: Bounded-input and Bounded-output stability, Routh Stability Criterion, Effect of Integral and Derivative Control Actions

Module 4 - Control System Design by the Root-Locus method: Root-Locus Plots, Guidelines for sketching Root-Loci, Lead compensation, Lag compensation, Lead-Lag compensation

Module 5: Control System Design by the Frequency Response Method: Bode diagrams, Polar plots, Nyquist stability criterion, Stability analyses, Relative stability, Stability margins using Bode plots

Module 6 - PID Control: Proportional (P) and Integral (I) controllers, Proportional Integral (PI) controller, Proportional Integral Derivative (PID) controller, Analog implementation of P, PI, PID controllers using op-amp and RC elements

Module 7 - Control System Analysis and Design using State Variable Methods: State space representation of transfer functions, Solution of time-invariant state space equation, Controllability and Observability criteria, Pole placement methods

Module 8 - Application of Control System Principles to Selected Problems in Electronics & Communication Engineering: Closed-loop control of Robotic arm actuator, Design of PLL for tracking sinusoidal signals of variable frequency and phase

SUGGESTED BOOKS:

1. Katsuhiko Ogata, *Modern Control Engineering*, PHI Learning Pvt. Ltd., 5th Ed.
2. M.Gopal, *Control Systems Principles and Design*, McGraw Hill Education (India) Pvt. Ltd, 4th Ed.
3. F. Golnaraghi and Benjamin C.Kuo, *Automatic Control Systems*, Wiley Student Ed., 9th Ed. (For Reference)

French - IV (HS 2203)

Objectives: The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

Course Content:

General themes

- Accommodation: Units in the house, interior decor
- Everyday objects
- Countries & Cities
- Actions in daily life
- Events: Meetings, Evening out, Family events, Visits, Excursions, Accidents, TV news
- Money and payments

Grammar topics

- Transitive and Intransitive verbs - Direct and Indirect object
- Relative pronoun 'there' - place
- Relative pronouns - who, that/which
- Prepositions of place: go to, be at, come from + a place
- Connectors: but, because

Design Thinking (HS 2201)

1st week:

Exercise 1: Drawing practice using subconscious mind with the help of music.... Al Di Meola (Race with Devil on Spanish Highway), Beethoven Symphony No.9, Hans Zimmer - Kings of the Past, Pink Floyd - Terminal Frost etc. Another exercise was to create a story from subconscious mind.

Exercise 2: 2D drawing from conscious mind and create a story.

Exercise 3: 2D Story making following story board & comic strips type.

2nd week:

Introduction 3D, where 'D' stands for dimension, which means an object has three dimensions. X-axis, Y-axis and extra dimension are the Z-axis which gives height/width/depth to an object.

Exercise 1: Composition exercise 3D, Create a new 3d compound structure using any one symmetrical and asymmetrical pattern with the help of colour paper

3rd week:

3d exploratory prototyping/ connection of variety objects....Bangles, Rubber band, Scooby sticks, Marbles, Paper cups. This is a brain storming activity. Where they will learn how to build a product with the help of very limited object and also they need to calculate the mathematical way to function this game.

4th week:

2D form exploration Tangram

5th & 6th weeks:

Screening short films.

Exercise 1: First write down the basic theme.

Exercise 2: To identify and write down the visual and audio components of this design/narrative and also to state alongside as to what could be its motivation.

7th week:

Context-Concept- We are providing some objects (Syringe, Nail Cutter, and Stapler). Brain storms the following using object which is given them. Note the idea, possibilities and connection as possible.

- In what contexts do you see a use for this product?
- How did this product evolve? What are the alternatives before the product for the same need? What the problem did this product solve?
- Think of 5 important "WHAT IF CONTEXTS" for this product?
- Describe a PERSONA of the product.
- Sketch your 10 new concepts based on this product.
- What can be made it simpler, pleasurable and more meaningful?

8th week:

Typography & Photo montage (collage) – History of typography/ Calligraphy and Photomontage. Typography plays a critical role in strengthening the brand, creating interest to the product, and highlighting a central message. The core purpose of a design is communication. Whether we're

talking about an online ecommerce store or a corporate brochure, typography is a vital component. Typography is the art and technique of selecting and arranging type styles/fonts for texts.

Exercise 1: To write their name in two different styles (Serif and Calligraphy).

Exercise 2: Making a collage art using magazine and newspaper.

9th week:

Book Cover Design: History and evolution of book. History of book covers designing.

Exercise 1: Create a book cover by using typography or any kind of creative image which can describe the book visually.

10th week:

Ideating objects & Mechanical transformation-

Problem review:

- Identify the object.
- User profile of the product.
- Function of the product.
- How many parts is the product made of?
- How is each part manufactured?
- What manufacturing processes are applied?
- What are the alternatives uses the product?
- What are the irritants present in this product?
- If the product had to be redesigned, what would be your approach? Sketch the design.

11th - 15th weeks:

Final Project and Prototype.

Financial Accounting (HS 2202)

Course Content:

Module 1 – Introduction to Accounting (3 lectures): Meaning of Accounting, Objectives of Accounting, Understanding Company management, stakeholders versus shareholders, financial reporting standards, financial reporting.

Module 2 – Understanding Accounting Elements (3 lectures): Elements of financial statements – assets, current assets, liabilities, current liabilities, equity, income, expenses, accounting equation

Module 3 – Accounting Concepts (4 lectures): Business entity concept, money measurement concept, going concern, consistency, matching concept, cost concept, dual aspect concept, materiality, full disclosure; Generally Accepted Accounting Principles (GAAP)

Module 4 – Journal Transactions (3 lectures): Journal, Rules of Debit and Credit, Compound journal entry, opening entry.

Module 5 – Ledger Posting & Trial Balance (4 lectures): Ledger, Posting, Relationship between Journal and Ledger, Rules regarding posting, Trial Balances

Module 6 – Bank Reconciliation & Final Accounts (4 lectures): BRS – meaning & preparation techniques; Profit and Loss account, Balance Sheet, Adjustment entries, etc.

Recommended Text Book:

1. Maheshwari, SN., Financial & Management Accounting (S. Chand & Sons)

Reference Book:

1. Ghosh, TP., Financial Accounting for Managers (Taxmann Publications, 2009)

Introduction to VLSI Design (EC 3101)

Module 1: Introduction; Quality Metrics of a Digital Design- Cost of an Integrated Circuit, Functionality and Robustness, Performance, Power and Energy Consumption; MOS Transistors: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances; Fabrication of MOSFETs: Introduction, Fabrication Process Flow: Basic Steps, The CMOS n-Well Process, Layout Design Rules, Full-Custom Mask Layout Design.

Module 2: MOS Inverters: Static Characteristics; Types of Inverters: Resistive-Load Inverter, Inverters with n-Type MOSFET Load, Pseudo NMOS/PMOS Inverter, CMOS Inverter; V-I characteristics; Switching Threshold; Noise Margin; Buffer design; Fan-In and Fan-out of Inverter/Buffer; Effect on CMOS characteristic by W/L ratio, threshold voltage and process, voltage, temperature (PVT).

Module 3: MOS Inverters: Switching Characteristics and Interconnect Effects; Delay-Time Definitions; Calculation of Delay Times; Inverter Design with Delay Constraints; Estimation of Interconnect Parasitic; Calculation of Interconnect Delay; Delay models; Switching Power Dissipation of CMOS Inverters.

Module 4: Dynamic Logic Circuits: Basic Principles of Pass Transistor Circuits: Working Principle, V-I Characteristics, Capacitances, Timing analysis; Voltage Bootstrapping; Synchronous Dynamic Circuit Techniques; High-Performance Dynamic CMOS Circuits; Design

and analysis of combinational and sequential logics using CMOS, transmission gate logic and dynamic logic; Introduction to VLSI Technology and Systems design.

Lab Module

Design of a CMOS Inverter, combinational and sequential logics; Schematic design of CMOS Inverter; Design entry; Specification; Pre-layout functional simulation; Pre-layout: Current, voltage, performance, power analysis and Noise Margin estimation; Layout design; DRC and LVS check; Post-layout RC extraction; Post-layout simulation; Post-layout functional and timing analysis; Post-layout current, voltage, power and performance estimation. GDS II generation for tape-out.

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis & Design”, 3rd Edition, McGraw Hill.
2. J. M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits, A Design Perspective”, 2nd Edition, Prentice Hall of India.
3. Neil H. E. Weste, David Harris, Ayan Banerjee, “CMOS VLSI Design, A Circuits and Systems Perspective”, 3rd Edition, Pearson Education.

Communication Theory and Systems (EC 3102)

Module-0: Background and general overview

Brief revision of Random Processes – Gaussian Random Process, White and non-white Noise, Orthogonal Representation of Random Processes;

Overview of a communication system: Basic structure and components of a communication system; Efficient utilization of available power and spectrum, Shannon’s Theorem.

Module -1: Basic Digital Modulations

Definition of digital continuous-time (C-T) and digital discrete-time (D-T) signals; difference with analog (C-T and D-T) signals;

Difference between baseband and passband transmissions, transformation of baseband signals to passband signals and vice versa, reason for shifting to passband transmissions using carrier modulation; Overview of modulation in general.

Signal Space representations; Orthogonal, Simplex, Bi-orthogonal signal sets;

Digital modulations – ASK, OOK, PSK, FSK, M-ary ASK, M-ary PSK, M-ary QAM; energy efficiency of constant amplitude modulations compared to dynamic amplitude modulations; Spectrum of digitally modulated signals, bandwidth requirements for transmission.

Module-2: Estimation techniques for noisy waveforms

Estimation of unknown parameters in presence of noise – single observation, multiple observations;
Estimation of unknown parameters of known signal in presence of AWGN; structure of optimum estimators.
Very brief revision of Waveform estimation or estimation of unknown random signal in presence of noise.

Module-3: Optimum Detection techniques and spectral requirements for digitally modulated signals

Detection of Binary Signals in presence of Additive White Gaussian Noise (AWGN), Brief revision of Hypothesis Testing, Optimum Receivers for Binary communication systems, Error Probability.
Optimum coherent receivers for digital modulations – BASK, BPSK, QPSK, Coherent Binary FSK;
Optimum Non-Coherent Detection: ASK, BPSK, FSK; DPSK and other Differential schemes for non-coherent communication;
Extension to M-ary Coherent and non-coherent Signal sets: Baseband M-ary PAM, Passband M-PAM or M-ASK, MPSK, M-QAM;
Shannon's limit on no. of signals (M-ary) and on data rate and spectral efficiency;
Comparison among digital modulations – spectral efficiency (bits per Hz), error probability, energy efficiency, bandwidth requirement.
Spectrum confinement techniques: Need of spectrum confinement – infinite spectrum of PSK and ASK signals, need of continuous phase signals;
Introduction to Phase and frequency modulations with memory: CPFSK, CPM signals;

Module-4: Analog modulations and demodulations

Overview of analog modulations;
Generation of FM and FSK signals using VCO;
AM and FM demodulators, Carrier phase estimation – optimum and sub-optimum structure, carrier tracking, PLL – BW requirement, SNR, application of PLL; COSTAS LOOP;

Module-5: Pulse modulation schemes and waveform coding

Pulse modulation schemes overview - PAM, PFM, PWM, PPM.
Types of Redundancy in analog sources and signals; Temporal Coding techniques for analog sources - Linear Predictive Code (LPC), PCM;
Performance of PCM - quantization noise, SNR, DPCM.
Time-division multiplexing with PCM/DPCM; Introduction to Spectral Waveform Coding - Transform coding (DFT, DCT).

Text Books:

1. J. G. Proakis, "Digital Communications", 4th Edition, McGraw-Hill.
2. Carlson: Communication systems.

3. Van Trees, “Detection, Estimation and Modulation: Part I”, John Wiley.
4. U Madhow, “Introduction to Communication Systems”.

Reference Books:

1. Wozencraft and Jacobs: Principles of Communication Engineering, John Wiley
2. Oppenheim and George Verghese: Signals, Systems and Interference

Programmable Devices (EC 3103)

Module 0 - Introduction: Introduction to the types of computing systems – ASIC, FPGA, ASISP, ASIC and their comparison.

Module 1 - Microprocessor Architecture: Introduction to microprocessor architecture (x86/ARM), Timing Diagrams, Logical view of memory, Internal Registers – General Purpose and Special Registers, Instruction Set, assembly level programming, Stacks for sub-routines, programming techniques, ASM inference of High-Level languages

Module 2 - Peripherals and I/O: I/O interfacing – General Purpose I/O, Addressing/Mapping, Types of I/O - Polling and Interrupt-based; Interrupts – Types – HW/SW, Interrupt Vector Maps, writing ISR; Timers – General timers, counters, watchdog timers; Serial Communication – UART; Examples of Interfacing I/O devices. Microprocessor vs Microcontroller

Module 3 - Programmable Logic Devices: Introduction to programmable logic devices (FPGAs), FPGA architecture, Hardware description languages, applications of FPGAs.

Module 4 - Digital Signal Processors: Introduction to digital signal processors (DSPs), architecture, programming techniques and applications.

Module 5 - Performance Evaluation of programmable devices: Performance metrics, Comparison between processors, FPGAs and DSPs in terms of performance, power consumption, applications.

Text Books:

1. Barry B. Brey, ARM v8 Programmer’s Manual, The Intel Microprocessors, Prentice Hall, 2008.
2. Steve Kilts, Advanced FPGA Design: Architecture, Implementation, and Optimization, Wiley-IEEE Press, 2007
3. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Pearson, 2004

Reference Books:

1. Steve Furber, ARM System on Chip architecture; 2nd ed., Addison Wesley.

2. Kenneth J Ayala, The 8086 Microprocessor: Programming & Interfacing the PC, Cengage Publisher, 2007.

Digital Signal Processing (EC 3109)

Module 0 - Introduction to Digital Signal Processing: Overview of the course, Introduction to discrete-time sequences, operations on the independent variable, elementary signals, Introduction to digital systems and their properties, LTI systems, convolution.

Module 1: Sampling lowpass & bandpass signals, Discrete-Time Fourier Transform (DTFT), Phase and group delay, Z- transform and its use for analysis of LTI systems, Discrete Fourier Transform (DFT).

Module 2 - Analog filter design: Butterworth, Chebyshev, Elliptic & Bessel Filters, Design of high-pass, band-pass, and band-stop filters.

Module 3 - Design of FIR Digital Filters: Symmetric and antisymmetric FIR filters, Design of linear phase FIR Digital Filters using Windows, Design of linear phase FIR Digital Filters by Frequency Sampling method.

Design of IIR Digital Filters: comparison of IIR & FIR filters, IIR filter design by impulse invariance method and bilinear transformation.

Module 4 - Realization of Digital Filters: Structures for FIR systems, Direct form structures, Cascade form structures, Structures for IIR systems: Direct form structures, transposed structures, cascade form structures, Parallel form structures.

Module 5 - Multirate Digital Signal Processing: Decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, Finite Word-Length Effects: IIR & FIR Filters.

Text Books:

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing, Principles, Algorithms, and Applications”, Pearson Education.
2. A.V. Oppenheim, R. W. Schaffer, “Discrete Time Signal Processing”, Prentice Hall of India.

Reference Books

1. B. Venkataramani & M Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, TMH, 2002.
2. Dimitris G. Manolakis and Vinay K. Ingle “Applied Digital Signal Processing: Theory and Practice”, Pearson, 2015.
3. Samir S. Soliman and Mandyam D. Srinath “Continuous and Discrete Signals and Systems”, Prentice-Hall Information and Systems Science Series, 1997.

Machine Learning (CS 3102)

Course Objectives

- **Mastering Foundational Concepts:** The course aims to cultivate a profound understanding of fundamental machine learning theories and advanced methodologies. The course aims to empower the students to craft and implement machine-learning solutions for intricate classification, regression, and clustering problems.
- **Practical Proficiency through Python Implementation:** Specifically designed for undergraduate students, this course emphasizes hands-on expertise. Through Python-based practical sessions, students will gain proficiency in implementing diverse algorithms, spanning Linear Classification, Instance-Based Learning, and Ensemble Methods such as Boosting. This practical orientation equips students to seamlessly translate theoretical knowledge into real-world applications, enhancing their ability to solve complex challenges.
- **Nurturing Expertise in Advanced Topics and Critical Analysis:** The course delves into sophisticated areas like Feature Selection, Manifold Learning, and the Latest Developments in Machine Learning. Additionally, it encourages in-depth exploration of Probabilistic Models and Dimensionality Reduction. The course aims to foster advanced expertise and cultivate a discerning mindset essential for contributing meaningfully to the field.
- **Promoting Rigorous Evaluation and Continuous Learning Culture:** The course offers comprehensive insights into Experimental Design and Performance Measures, enabling rigorous evaluation of machine learning models. Beyond mastering existing techniques, students are encouraged to stay abreast of the latest advancements, fostering a culture of perpetual learning.

Module I: A general overview of Machine Learning topics

- a. Introduction – History of Machine Learning, Programs vs learning algorithms, Different Types of Learning Paradigms: Supervised, Semi-Supervised and Unsupervised Learning, Real life applications.
- b. Introduction to Python libraries suitable for Machine Learning: scikit-learn and SciPy.
- c. A recap of Python Libraries: Numpy, Pandas and Visualization: Matplotlib.

Module II: Supervised Learning

- a. Regression
 - i. Instance based learning: K-Nearest-Neighbor, Linear Regression, Locally weighted linear Regression, Regularization: Ridge Regression and LASSO, Sensitivity Analysis, Multivariate Regression.
- b. Classification
 - i. Linear Classification, Logistic Regression, Bayesian Classification: Naive Bayes, Decision Trees, Splitting Criteria, CART, Overfitting, Random Forests, SVM, Multiclass & Ordinal Classification, Kernels.
 - ii. Performance Measures: Evaluation and Model Selection, Cross-Validation, ROC Curves, Evaluation Measures, Significance tests.
- c. Different ANN architectures: Associative Memory, Hebbian Learning- Attractor Dynamics, Probabilistic Model, Boltzmann Machines, Competitive Learning and the Self-Organizing Map.
 - i. Multi-layer Perceptron and the Universal Approximation Theorem.
- d. Using Weka for Supervised Learning
- e. Using scikit-learn for implementing supervised tasks.

Module III: Unsupervised Learning

- a. Clustering: Partition-based, Density-Based, and Hierarchical clustering.
 - i. Cluster Evaluation Metrics.
- b. Dimensionality Reduction: Feature Extraction & Selection
 - i. Principal Component Analysis, Non-Linear PCA, and Auto-encoders
- c. Recommender Systems: Content-based recommender systems and collaborative filtering, Challenges.
- d. Using scikit-learn for implementing unsupervised tasks.

Textbooks

The content was adopted from the following textbooks

1. Machine Learning by Tom Mitchell.
2. Introduction to Machine Learning by Ethem Alpaydin.
3. Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani and Jerome Friedman.
4. Pattern Recognition and Machine Learning by Christopher Bishop.

Reference Books

1. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern classification, Wiley, New York, 2001.

2. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 2013.

French - V (HS 3111)

Objectives:

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

Course Content:

Topics

1. To accept or to refuse any invitation
2. Showing possession
3. Description of an object
4. Expressing comparison
5. To express an idea
6. Description of a landscape

Grammar

1. Revision of l'imparfait (Past Continuous), le Futur simple (Simple future) et le passé composée (Simple Past)
2. Possessive Pronouns
3. Place of Adjectives
4. Recent Past
5. Forms of negation

Types of writing

1. Informal letter or email
2. A short passage

Principles of Wireless Communication (EC 3201)

Module-0: Brief revision of basic modulations and transmitter-receiver block diagrams

Pictorial representation of baseband and passband transmissions; overall transmitter and receiver structure using simplified functional block diagrams; Communication Standards and Protocols; course objectives and roadmap.

Module-1: Wireless channel models

Part-A: Introduction to Mobile radio propagation: Large-scale Path Loss

Characterization of propagation effects;

Introduction to Large-scale path loss: Free-space propagation – deterministic measure of received signal power; Effect of propagation phenomena: reflection, scattering, diffraction, shadowing; random path-loss models; Link budget analysis;

Part-B: Small-scale fading in mobile radio channel:

Time-Varying Channel Impulse Response; Multipath resolvability and time dispersion, ISI due to time dispersion;

Understanding difference between Narrowband Fading or flat fading and Wideband Fading or frequency-selective fading; Power Delay Profile, Coherence Bandwidth;

Frequency dispersion, Doppler Power Spectrum and Coherence Time; Classification of fading channels: slow, fast, flat, frequency-selective; Introduction to feedback equalization for mitigation of fading.

Narrowband statistical models of received signal envelope and power – Rayleigh and Rician flat fading; Level Crossing Rate and Average Fade Duration; Outage of signal and Burst error;

Module-2: Transmission techniques for efficient utilization of resource blocks

Orthogonal transmission techniques and their importance for mitigation of time-dispersive channels;

Brief Introduction to Multiple access schemes:

Introduction to FDMA, TDMA, SDMA, CDMA, and FHMA; Advantage of CDMA over FDMA or TDMA; Application of CDMA in cellular and other multi-user systems –advantages and disadvantages;

Introduction to Multi-carrier communication (OFDM, SC-FDE, OFDMA, SC-FDMA):

Basics of Multi-carrier communication – Multipath mitigation; Discrete implementation – OFDM, OFDM transmitter and receiver; Challenges in OFDM – ICI, PAPR; System design issues with OFDM;

Code Division Multiplexing (CDM) as alternate orthogonal transmission technique, comparison of energy efficiency between OFDM and CDM;

Intro to SC-FDE; Introduction to multi-user OFDM – OFDMA, SC-FDMA.

Cellular Structure:

Cell and Cluster structure, Frequency Reuse, Handoff, Co-channel and Adjacent Channel Interference, Resource allocation, User Capacity, network architecture, cellular standards; Introduction to 4G and 5G cellular networks.

Module -3: Signal transmission in band-limited channels

Inter-symbol interference (ISI) problem in band-limited channels; Nyquist criterion for pulse shaping in band-limited channels; Signal design for ISI-prone channels – Nyquist pulse, raised-cosine filtering, partial-response signals;

Module-4:

Part-A: Performance improvement techniques – Interleaving, error correction coding etc.

Introduction to linear block codes;

Interleaving in block codes to reduce burst error;

Brief Introduction to Timing diversity: – Code Division Multiplexing (CDM) and RAKE receiver;

Introduction to spatial diversity and MIMO.

Part-B: Introduction to system design for wireless protocols:

System planning and decision making for new wireless protocols and systems.

Text Books:

1. J. G. Proakis, “Digital Communications”, 4th Edition, McGraw-Hill.
2. Van Trees, “Detection, Estimation and Modulation: Part I”, John Wiley.
3. A. Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

Reference Books:

4. U Madhow, “Introduction to Communication Systems”.
5. R. Steele and L. Hanzo, Eds., “Mobile Radio Communications”, 2nd ed., John Wiley and Sons, 2000.
6. T. S. Rappaport, “Wireless Communication”, Pearson Education.
7. W. H. Tranter, K. S. Shanmugan, T. S. Rappaport, K. L. Kosbar, “Principles of Communication System Simulation with Wireless Applications”, Pearson Education.

Computing Systems Architecture (EC 3202)

Module 1 - Instruction Set Architecture (ISA): Introduction to ISA, Basic organization: fetch, decode, and execute; Instruction set types, instruction format, addressing modes, subroutine call and return mechanisms; Structure of machine-level programs; Low-level architectural support for high level languages. Performance assessment.

Module 2 - Computer Arithmetic: Representation of numeric data, signed and unsigned arithmetic – Addition, Subtraction, Multiplication and Division; Range, precision and errors in floating-point arithmetic; Shifters; Design of arithmetic and logic unit (ALU).

Module 3 - Processor Architecture: CISC vs RISC Designs; simple implementation schemes, Datapath design, Control unit: hardwired vs micro-programmed, multi-cycle implementation.

Instruction level parallelism, instruction pipelining, pipeline hazards. Introduction to Out-of-Order processing. Superscalar Processors.

Module 4 - Memory Architecture: Storage systems, introduction to memory hierarchy: importance of temporal and spatial locality; main memory organization, cache memory: address mapping, block size, replacement, and store policies

Module 5 - Interfacing and I/O Organization: External storage; IO fundamentals: handshaking, buffering, programmed IO, interrupt driven IO; Interrupt handling mechanism, Buses: protocols, arbitration, direct memory access (DMA).

Module 6 - OS Support: Introduction to Operating Systems, Processors, Task Management and scheduling, Memory Management, Virtual memory system: page table and TLB. Drivers and Devices

Text Books:

1. John L. Hennessy, David A. Patterson, and Morgan Kaufmann, Computer Architecture: A Quantitative Approach, 5th edition, 2011.

Reference Books:

1. J.P. Hayes, Computer Architecture and Organization, Mc Graw Hill.
2. A.S. Tanenbaum, Structured Computer Organization, PHI.
3. W. Stalling, Computer Organization and Architecture, PHI.

Communication Electronics (EC 3203)

Module 1: High frequency Characterisation of components, Physical realisation of passive components at high frequencies as sections of transmission lines and microstrip

High speed broadband amplifiers – peaking, distributed amplification, gain band width product limit, Negative resistance oscillators

Wideband RF amplifiers - RF amplifier topology, single and double tuned amplifiers, widebanding , Butterworth and Tchebycheff pole design,

Module 2: NOISE -Sources Characterisation and Measurement, Noise in amplifiers Dahlke Rothe model of noise in amplifiers, Friis Formula, Haus's Noise measure Matching for minimum noise figure, Minimum noise circle, LOW noise amplifiers design. Nonlinear distortion in amplifiers – modelling and analysis.

Module 3: POWER AMPLIFIERS – Active 2-ports, Mason U factor, Neutralisation and unilateralisation , Power gain definitions, Stability of power amplifiers Rollet stability factor Gain circles Resistive padding, Impedance matching, matching and biasing networks, Wideband matching Wai kai Chen , Satyanarayana and Youla , Pillai synthesis Classes of power amplifiers Efficiency, Class D efficient switching power amplifiers, power combining.

Module 4: Analog Multipliers: Using diode in feedback – log and antilog, Square law of MOS and exponential law of BJT Diff amp topology Gilbert cell Application as modulator, demodulator, phase detector

Module 5: Sinusoidal oscillators, LC oscillator, negative resistance oscillators VCO phase noise, jitter, stability of oscillators crystal oscillators atomic clocks, Noise in VCO, Injection locking of oscillators

Module 6: Phase Locked Loop (PLL) Non-linear Model of PLL, lock in range and acquisition range, linearised model, loop filter, optimum loop filter Applications of PLL- FM detectors, synchronisation, carrier extraction, integer and fractional frequency synthesizers, noise in PLL and synthesizers

Module 7: Mixers- Heterodyning principle and fundamentals of mixers. Conversion gain. mixers based on nonlinearities of devices, switching mixers, parametric mixers, reactive diode multipliers Manley Rowe relations resistive mixers, Pantell relations noise in mixers SSB and DSB NF. Use of Image rejection filter, balanced mixers

Module 8: Analog signal sampling at Giga sampling rate, Sampling theorem, sampling methods. Issues in designing high sampling rate converters, Time-interleaved converters: concepts and implementation.

References:

1. T H Lee: Design of CMOS RF Integrated circuits, Cambridge Press.
2. Clarke and Hess: Communication Circuits Analysis and Design, Addison Wesley.
3. Niknejad: Lecture Notes EE 242, University of California Berkeley.
4. Perrott: Lecture Notes on High Speed Communication Circuits and Systems (6.976), Massachusetts Institute of Technology
5. Pederson, Mayaram: Analog Integrated Circuits for Communication Principles Simulation and Design, Springer.
6. Pozar: Microwave Engineering, Wiley.
7. Robert Sobot: Wireless communication Electronics, Springer, 2020.

Computer and Communication Networks (EC 3206)

Course Objectives

- Understand the basic concepts of computer networks and internet core

- Apply the knowledge of the MAC layer protocols for computer communication networks
- Develop the different routing protocol algorithms for real time wired and wireless networks
- Design the protocols at every protocol level and evaluate their performance for various computer communication network applications

Course Content

Module 1: Application Layer: Introduction to Computer Networks History, Circuit Switching and Packet Switching, TCP/IP Protocol Stack – Basic Overview, Computer Network core and switching, Delay and losses in networking, Application layer services: DHCP, DNS: network configuration, Hierarchy tree, TLDs, SNMP: network management, NMS, FCAPS, MIB, V2 and V3, HTTP/HTTPS, FTP: browsing and file transfer, SMTP, POP3: email

Module 2: Transport Layer Primitives, Connection establishment -3-way handshake, Connection closing - 4-way handshake, Port number understanding, Difference between TCP and UDP, TCP service model, TCP congestion control and flow control, TCP Reno and Tahoe, Nagle's algorithm

Module 3: IP Addressing schemes, Network partitioning, CIDR, IPv4 classful addressing, IPv6 addressing, Routing decisions – fundamentals, Routing Protocols – link state routing and distance vector routing, Autonomous systems, inter and intra domain routing

Module 4: Data Link Layer Service Primitives – Forwarding, Flow Control, Error Control, Media Access Control - Channel Access Protocols, Framing, Logical link control, Medium access sublayer access methodologies: Token bus topology, Token ring topology, CSMA protocol, *I*-persistent, *p*-persistent and Non-persistent, 802.3 CSMA/CD protocol, 802.11 CSMA/CA protocol, wireless packet data network, ALOHA protocol, Slotted ALOHA protocol, sliding window protocol, End to End Principles of Computer Networks

Module 5: Data encoding techniques, PHY layer devices, Multiplexing and modulation, Guided transmission media, Wireless transmission: Baseband and passband transmission

Text Books:

1. J. F. Kurose and K. W. Ross, "Computer Networking – A top down approach" 6th edition, Pearson.

Reference Books:

1. A. S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th edition, Prentice Hall.
2. L Parziale et al., "TCP/IP Tutorial and Technical Overview" 8th edition, December 2006.

French - VI (HS 3222)

Objectives:

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

Course content:

Topics

1. To Propose or to invite for a program, a party etc.
2. Writing a personal letter
3. Expressing obligation and interdiction
4. To ask for the touristic information
5. To present one's point of view and argue about it
6. To understand the difference between written and spoken language

Grammar

1. Adverb
2. To know how to change verbs into noun and vice-versa
3. The Subjunctive
4. Relative pronouns
5. Expression of duration
6. Direct and Indirect speech in present
7. Basic logical connective

Types of writing

1. A short essay
2. Informal letter or email
3. Film review

Optical Communication (EC 4102)

Module 1 – Introduction: Brief background and history, advantage of optical communication, communication requirements, SNR and bandwidth, Shannon theorem revisited, EM spectrum and its utilization, optical communication bands, basic components of an optical communication system, free space Vs fiber-optic communication.

Module 2 - Light Sources: LEDs, laser diodes, direct modulation of lasers, external modulators – electro-absorption modulators, Mach-Zehnder modulators, phase noise in laser diodes.

Module 3 – Detectors: Principles of photodetection, PIN photodetector, avalanche photodiodes, signal-to-noise ratio.

Module 4 – Optical Fibers: Brief overview, fabrication, modal behaviour, single-mode and multi-mode fibers, loss, dispersion and nonlinear effects, channel model of optical communication.

Module 5 – Free Space: Propagation effects, channel impairments: turbulence, scattering and noise, channel model, channel equalization-diversity, MIMO, adaptive optics.

Module 6 – Modulation Schemes: Review of detection theory- binary communication, optimum receiver for additive ZMGWN for minimum probability of error criterion. LRT test, general binary communication – optimum receiver Decision Rule Decision Boundaries PE calculation, modulation, M-ary with M alphabets, M-ASK, Intensity modulation schemes OOK, NRZ, RZ, Coherent modulation schemes (phase modulation) Differential modulation Phase modulation DPSK QPSK, modulations with memory, Transmitter structure, Receiver structure, OSNR for given PE, spectral efficiency, capacity distance.

Module 7 – Multiplexing: Six dimensions of multiplexing - time, frequency, quadrature, polarization, mode, and space; Components of a DWDM link - Add-Drop Multiplexers/Demultiplexers, Couplers, Polarization controllers, Filters, Isolators

Module 8 – Link Design: Amplification: EDFA, SOA, Raman amplifiers; Dispersion compensation schemes, dispersion-managed systems; Design considerations of a fiber-optic link - Modulation, BER, power budgeting, rise-time budgeting, attenuation limit, dispersion limit.

Module 9 – Advanced Techniques: Phase distortion compensation, nonlinear equalization, Error correction coding, complex multiplexing schemes using other dimensions like polarization and space, faster ADC/DAC with high ENOB

Text book and Reference books

1. Fiber-Optic Communication Systems, G.P. Agrawal, Wiley, 5th Edition.

2. Optical communication systems, Gerd Keiser, Tata McGraw Hill, 4TH edition.
3. Introduction to Fiber Optics by A. Ghatak and K. Thyagarajan, Cambridge University Press, 2017.
4. Optical Networks - A Practical Perspective, Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, Elsevier, 3rd edition.
5. Free space optical communication, H. Kaushal, V.K. Jain, S. Kar, Springer, 2017.

Embedded Hardware Project (EC 4100)

This team project focuses on Embedded Hardware development in order to realize a product or solution by making use of existing embedded hardware and software platforms. Students are expected to make use of the knowledge gained in courses in the first 6 semesters in order to offer a practical solution to a problem addressing the society or the industry. The focus on embedded hardware is done in order to cater to the growing hardware industry and the expose the students to the growing trend of Internet of things.

The team project is also intended to help the students develop a set of key skills to become an innovative engineer. It encompasses:

Teamwork: organize, decide, manage within a team; team member roles and performance

Written and oral communication: structure and synthesis, increase written and oral impact,

interpersonal communication and public communication Approach to solve complex problems: frame the issue; inductive, experimental and recursive approaches; doubt and complexity

Creativity: group creativity methods Build one's academic and career plan Discover the work of an engineer

Reference Books:

1. Raj Kamal, "Embedded systems Architecture, Programming and Design", Tata McGraw-Hill, 2016.
2. Wayne Wolf "Computers as components: Principles of Embedded Computing System Design", The Morgan Kaufmann Series in Computer Architecture and Design, 2013
3. Lyla B. Das, " Embedded Systems an Integrated Approach", Pearson Education, 2013.
4. Shibu K V, " Introduction to Embedded Systems", McGraw Hill Education (India) Private Limited, 2014
5. Sriram V Iyer, Pankaj Gupta " Embedded Real Time Systems Programming", Tata McGraw- Hill, 2012
6. Steve Heath, "Embedded Systems Design", EDN Series, 2013

French - VII (HS 4111)

Objectives:

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easily.

Course Content:

Topics

1. Intergeneration accommodation
2. Internet and cellphone
3. Pollution
4. Love, marriage, divorce
5. Carpool (Covoiturage)

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above mentioned topics.

Grammar

1. Subjunctive
2. Reported speech
3. Connectors

Types of writing

1. Official letter
2. Argumentative essay

Research Project Phase I and Phase II (PR 4000)

Course Content:

The object of Year-4 Project Work & Dissertation is to enable the student to extend further the investigative study taken up under, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from a School at MEC or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
4. Final development of product/process, testing, results, conclusions and future directions;
5. Preparing a paper for Conference presentation/Publication in Journals, if possible;
6. Preparing a Dissertation in the standard format for evaluation;
7. Final Seminar presentation before a Committee.

French - VIII (HS 4222)

Objectives:

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easily.

Course Content:

Topics

1. French education system
2. Employment/Unemployment

3. House exchange

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above-mentioned topics.

Grammar

1. Future perfect
2. Nominalization

Types of writing

1. Article for magazine
2. Writing/ Responding to queries on forum discussion platforms