B.Tech. ECE

"Applicable with effect from 2023 admitted batch and onwards"

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Engineering Physics	AS1001	BSC	4	3-0-2-0
2	Linear Algebra	AS1002	BSC	4	3-1-0-0
3	Problem Solving with Programming	IT1001	ESC/VSEC	5	3-0-4-0
4	Fundamentals of Electrical & Electronics Engineering	EC1001	ESC	4	3-0-2-0
5	Technical Communication Skills	MS1001	HSMC (AEC)	2	1-0-2-0
6	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Universal Human Values	MS1003			
	Professional Ethics	MS1004			
	Art of Living	MS1005			
			Total	**20**	**14-1-10-0** **25**

Semester 2					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Electronic Workshop	EC1002	VSEC	1	0–0–2-0
2	Digital Logic Design with HDL	EC1008	PCC	3	2–0-2-0
3	Electronic Devices and Circuits	EC1004	ESC	3	2–0–2-0
4	Electronics Measurements and Instrumentations	EC1005	PCC	3	2-0-2-0
5	Data Structures and Algorithms	IT1003	ESC	4	3–0–2-0
6	Network Synthesis & Analog Filters	EC1007	PCC	3	2-1-0-0
7	Principles of Management	MS1006	HSMC(AEC)	2	1–0–2-0
8	Constitution of India	MS1002	HSMC(VEC)	1	1-0-0-0
	Environmental Studies	MS1007			
	Professional Ethics	MS1004			
	Physical Education(Sports)	MS1008			
			Total	**20**	**13-1-12-0** **26**

Exit: After successful completion of one year (first two semesters), a student may get an exit option as per ordinance. They need to do Skill Based Courses of 6 credits additional, in summer, before exit. Department will provide a list of such courses.

Semester 3					**Total Credit: 23**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Electromagnetic Field and Waves	EC2001	PCC	3	3–0–0-0
2	Signal and Systems	EC2002	PCC	4	3–1–0-0
3	Analog Electronics & Linear ICs	EC2003	PCC	4	3–0–2-0
4	Microprocessor Interface and Programming	EC2004	PCC	3	2–0–2-0
5	Biology for Engineers	AS1010	BSC	2	2-0-0-0
6	Multi-Disciplinary Minor-1	MS2501-MS2599 AS2501-AS2599 CS2501-CS2599	MDM	3	3–0–0-0
7	Principles of Economics	MS2001	HSMC (AEC)	2	2–0–0-0
	Introduction to Finance	MS2002			
8	**Community Services**		HSMC (CEA)	2	0-0-0-4
	NCC	MS1010			
	NSS	MS1011			
	Yoga	MS1012			
	Unnat Bharat Abhiyaan	MS1013			
	Ek Bharat Shreshtha Bharat	MS1014			
	NGO	MS1015			
	Prayas	MS1016			
	Other Courses	MS1017-MS1020			
			Total	**23**	**18-01-04-04** **28**

Semester 4					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Control Systems	EC2005	PCC	4	3–0–2-0
2	Analog Communication	EC2006	PCC	3	2–0-2-0
3	CMOS VLSI Design	EC2007	PCC	3	2–0–2-0
4	Probability and Statistics	AS2001	BSC	3	2–1–0-0
5	Antenna and Wave Propagation	EC2009	PCC	3	2-0-2-0
6	Integrated Circuit Technologies	EC2010	PCC	3	3-0-0-0
7	Multi-Disciplinary Minor-2	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
			Total	**22**	**17-1-08-0** **26**

Exit: After successful completion of 4 semesters, a student may get an exit option as per ordinance. They need to do ***Skill Based Courses of 6 credits***, additional, in summer, before exit. Department will provide a list of such courses.

Semester 5					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Digital Signal Processing	EC3001	PCC	4	3–0–2-0
2	Embedded System Design	EC3002	PCC	3	2–0–2-0
3	Microwave Engineering	EC3003	PCC	3	2–0–2-0
4	Digital Communication	EC3004	PCC	4	3–0–2-0
5	Program Elective-I A) Electrical Machines B) Advanced Computer Architectures C) AI & ML Techniques D) Solid State Devices E) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
6	Multi-Disciplinary Minor-3	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
7	Design Thinking and Innovation	EC3501	HSMC (AEC)	2	1-0-2-0
			Total	**22**	**17-0-10-0=27** **27**

Semester 6					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Communication & Networking	EC3005	PCC	3	2-0-2-0
2	Mobile and Wireless Communication	EC3006	PCC	3	2–0–2-0
3	Program Elective-II A) Power Electronics B) Testing & Verification C) Optical Communication D) Detection & Estimation Theory E) Physics of Nanoscale Devices F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
4	Project	EC3559	VSEC	4	0-0-8-0
5	Multi-Disciplinary Minor-4	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
6	**Indian language(I1-I10)** Sanskrit **(I2-I10)** **Foreign language(F1-F10)** German Japanese French **(F4-F10)** **Regional Language(R1-R10)** **(R1-R10)**	 MS1401 MS1402 – MS1410 MS1500 MS1501 MS1502 MS1503-MS1510 MS1600- MS1610	HSMC (AEC)	2	1-0-2-0
			Total	**18**	**11-0-14-0** **24**

Exit: After successful completion of 6 semesters, a student any get an exit option after completion of the summer semester internship (3 credits) and additional 3 credit courses in summer.

I1 to I10, F1 to F10 and R1 to R10 will be decided by concerned department.

Summer Semester					**Total Credit: 3**
Sl. No.	Course Name	Code	Type	Credit	
1	Internship	EC4600	ELC	3	Credit will be added in VII Sem.

Note: Internship will be evaluated in the beginning of seventh semester. Its credit and grades will be reflected in the 7th Semester Grade Sheet.

Semester 7					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Program Elective-III A) Electrical Vehicles B) FPGA Architectures C) Image Processing & Image Vision D) Multiple Input-Multiple Output (MIMO) E) Low Power System Design F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
2	Program Elective-IV A) Radar & Satellite Communication B) MEMS C) Speech Processing D) Emerging Nanoscale Devices E) 6G & THz Communication F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
3	Open Elective-I		OEC	3	3-0-0-0
4	Multi-Disciplinary Minor-5	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
5	History of Indian Civilizations	MS1800	HSMC (IKS)	2	2–0-0-0
	Kautilya's Arthashastra	MS1801			
	Vedic Mathematics	MS1802			
	Vedic Corpus	MS1803			
	Wisdom from the Ages	MS1804			
	Panini's Grammar	MS1805			
	X1 – X9	MS1806 – MS1815			
6	Internship (Summer Semester)	EC4600	ELC	3	0-0-0-6
7	Project	EC4501	ELC	4	0-0-8-0
			Total	**21**	**14-0-8-6** **28**

Semester 8					**Total Credit: 14**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Major Project	EC5601	ELC	8	0–0-16-0
2	Program Elective-V(X1-X199) A) IOT B) System on Chip C) Any Other	EC5501-EC5599	PEC	3	0–0–0-3
3	Open Elective-II		OEC	3	0–0–0-3
			Total	**14**	**0-0-16-6** **22**

*8th Semester courses may be allowed to join via MOOC/NPTEL etc.

LIST OF ELECTIVES

Total Credit: 21					
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Image and Video Processing	IT5504	PEC	3	3
2	Deep Learning	IT5505	PEC	3	3
3	Probabilistic Machine Learning and Graphical Model	IT5506	PEC	3	3
4	Optimization	IT5507	PEC	3	3
5	Deep Learning	IT5508	PEC	3	3
6	Robot Motion Control	IT5509	PEC	3	3
7	Foundations of Robotics	IT5510	PEC	3	3
8	Advanced Graphics & Animation	IT5511	PEC	3	3
9	Virtual Reality	IT5512	PEC	3	3
10	Software Design & Architecture	IT5513	PEC	3	3
11	Software Requirements and Estimation	IT5514	PEC	3	3
12	Software Testing and Quality Management	IT5515	PEC	3	3
13	Data Visualization	IT5516	PEC	3	3
14	Big Data Analytics	IT5517	PEC	3	3
15	Parallel and Distributed Computing	IT5518	PEC	3	3
16	Principles of Wireless Communications	IT5519	PEC	3	3
17	Cloud and Edge Computing	IT5520	PEC	3	3
18	Embedded Systems and IoT	IT5521	PEC	3	3
19	Information Security Laws and Regulations	IT5522	PEC	3	3
20	Network Security	IT5523	PEC	3	3
21	Cyber Physical System Security	IT5524	PEC	3	3
22	Visual Recognition	IT5525	PEC	3	3
23	Computer vision	IT5526	PEC	3	3

24	Natural Language Processing	IT5527	PEC	3	3
25	Database Security	IT5528	PEC	3	3
26	Blockchain Technology	IT5529	PEC	3	3
27	Remote Sensing and GIS	IT5530	PEC	3	3
28	Social Network Analysis	IT5531	PEC	3	3
29	Generative AI and LLMs	IT5532	PEC	3	3
30	Large Language Model Conditioned Human-Robot Interactions	IT5533	PEC	3	3
31	Distributed Systems	IT5534	PEC	3	3
32	Optimization	IT5535	PEC	3	3
33	Probabilistic Graphical Models	IT5536	PEC	3	3
34	Cyber Security and Digital Forensics	IT5537	PEC	3	3
35	OMICS	AS5501	PEC	3	3
36	Data Analytics Fundamentals for Biology	AS5502	PEC	3	3
37	Scripting and Computer Environments	AS5503	PEC	3	3
38	Next-Generation Sequencing Tools and Algorithms	AS5504	PEC	3	3
39	Data Engineering for Molecular Structure Prediction	AS5505	PEC	3	3
40	Circuits and Instrumentation for Biomedical Engineering	AS5506	PEC	3	3
41	Biomechanics	AS5507	PEC	3	3
42	Biosignal Processing	AS5508	PEC	3	3
43	Mathematics and Statistics for Biology	AS5509	PEC	3	3
44	Molecular Biology	AS5510	PEC	3	3
45	Anatomy & Physiology	AS5511	PEC	3	3
46	Advanced Medical Instrumentation	AS5512	PEC	3	3
47	Biomedical Imaging	AS5513	PEC	3	3
48	Solid State Devices	EC5503	PEC	3	3

49	Testing and Verification	EC5505	PEC	3	3
50	Analog Integrated Circuit Design	EC5506	PEC	3	3
51	Advanced Digital Communication	EC5507	PEC	3	3
52	Statistical Signal Analysis	EC5508	PEC	3	3
53	Radiating Systems	EC5509	PEC	3	3
54	Introduction to Machine Learning	EC5510	PEC	3	3
55	Principles of Wireless Communications	EC5511	PEC	3	3
56	Recent Advances in Machine Learning	EC5512	PEC	3	3
57	Hardware Design Methodology	EC5513	PEC	3	3
58	Physics of Nanoscale Devices	EC5514	PEC	3	3
59	Radar & Satellite Communication	EC5515	PEC	3	3
60	Micro-electromechanical Systems	EC5516	PEC	3	3
61	Speech Processing	EC5517	PEC	3	3
62	Emerging Nanoscale Devices	EC5518	PEC	3	3
63	6G & THz Communication	EC5519	PEC	3	3
64	RF Integrated Circuit Design	EC5520	PEC	3	3

Multidisciplinary Minor

Entrepreneurship & Innovation				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	MS2501	Fundamentals of Entrepreneurship	3	2-0-2-0
IV	MS2502	Social Entrepreneurship	3	2-0-2-0
V	MS2503	Entrepreneurial Finance	3	2-1-0-0
VI	MS2504	Innovation Management	3	2-0-2-0
VII	MS2505	Managing Corporate Entrepreneurship	3	2-0-2-0
		Total	**15**	

Economics & Finance for Engineers				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	MS2506	Indian Economics	3	2-0-2-0
IV	MS2507	Money and Banking	3	2-0-2-0
V	MS2508	Economics of Business Environment	3	2-1-0-0
VI	MS2509	Start-up Economics	3	2-0-2-0
VII	MS2510	Digital Economics	3	2-0-2-0
		Total	15	

Science of Happiness				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	CS2501	Introduction to Science of Happiness	3	2-0-2-0
IV	CS2502	Understanding Domains of Happiness	3	2-0-2-0
V	CS2503	Happiness Indices	3	2-1-0-0
VI	CS2504	Assessment of happiness	3	2-0-2-0
VII	CS2505	Independent Study of Science of Happiness	3	2-0-2-0
		Total	**15**	

Biological Data Analytics				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2501	Proteomics and Genomics	3	2-0-2-0
IV	AS2502	Next Generation Sequencing	3	2-0-2-0
V	AS2503	Cheminformatics for Engineers	3	2-1-0-0
VI	AS2504	Systems Biology and Modeling	3	2-0-2-0
VII	AS2505	Molecular Structure Prediction	3	2-0-2-0
		Total	**15**	

Medical Diagnostics and Therapeutic Technology				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2506	Basics of Human Anatomy & Physiology	3	2-0-2-0
IV	AS2507	Biomedical Instrumentation	3	2-0-2-0
V	AS2508	Bio-MEMs and Nanotechnology	3	2-1-0-0
VI	AS2509	Medical Imaging	3	2-0-2-0
VII	AS2510	Tissue engineering and Gene therapy	3	2-0-2-0
		Total	15	

Mathematical Analysis				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2511	Real Analysis	3	3-0-0-0
IV	AS2512	Introduction to Topology	3	3-0-0-0
V	AS2513	Differential Geometry of Curves and Surfaces	3	3-0-0-0
VI	AS2514	Measure Theory	3	3-0-0-0
VII	AS2515	Functional Analysis	3	3-0-0-0
		Total	15	

Frontiers in Physics				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2516	Light Matter Interaction	3	2-1-0-0
IV	AS2517	Physics of Space and Time	3	2-1-0-0
V	AS2518	Magnetic Materials and Applications	3	2-1-0-0
VI	AS2519	Quantum Materials & Devices	3	2-1-0-0
VII	AS2520	Green Energy Physics	3	2-1-0-0
		Total	15	

M.Tech. IT- Machine Learning and Intelligent Systems (MLIS)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** / **23**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Probabilistic Machine Learning and Graphical Model	IT4006	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Optimization	IT4007	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech. ECE- Communication Engineering (CE)

Semester 1					Total Credit: 18
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Advanced Digital Communication	EC4075	PCC	4	3-0-2-0
2	Statistical Signal Analysis	EC4076	PCC	4	3-0-2-0
3	Radiating Systems	EC4077	PCC	4	3-0-2-0
4	Introduction to Machine Learning	EC4078	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
			Total	**18**	**14-0-08-0** / **22**

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	EC4035	PCC	4	3-0-2-0
2	Recent Advances in Machine Learning	EC4036	PCC	4	3-0-2-0
3	Elective - 1	EC5500-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					Total Credit: 16
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	Thesis- Part 1	EC6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					Total Credit: 15
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	EC6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. ECE- Communication Engineering (CE)

Semester 1					Total Credit: 20
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Advanced Digital Communication	EC4075	PCC	4	3-0-2-0
2	Statistical Signal Analysis	EC4076	PCC	4	3-0-2-0
3	Radiating Systems	EC4077	PCC	4	3-0-2-0
4	Introduction to Machine Learning	EC4078	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**16-0-08-0** / **24**

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	EC4035	PCC	4	3-0-2-0
2	Recent Advances in Machine Learning	EC4036	PCC	4	3-0-2-0
3	Elective - 1	EC5500-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					Total Credit: 11
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	EC5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance

B.TECH- ECE

Applicable with effect from 2023 admitted batch and onwards

Engineering Physics (AS1001)

Objective: Students will be able Demonstrate ability to collect, process, and analyze scientific data, display critical thinking skills in applying physics knowledge in the experimental process.

Course outcome

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

- To analyze dynamics of system of particles for applications in Physics and Engg.
- Identify, formulate and solve engineering problems requiring principles of physics
- Gain knowledge about modern physics and quantum mechanics
- Apply quantum physics to understand solid state materials
- Design & conduct experiments, analyze & interpret data

Classical Mechanics

Symmetry and conservation laws, Fermat's principle, Principle of least action, Euler Lagrange equations and its applications, Degrees of freedom, Constraints and constraint forces, Generalized momentum, Concept of phase space, Hamiltonian.

Quantum Mechanics

De Broglie's hypothesis, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization, Eigenvalues and eigen functions. Infinite potential well and energy quantization. Finite square well, potential steps and barriers - notion of tunneling, band structure of solid.

Solid State Physics

Energy Bands, Carrier transport in semiconductor, mobility and resistivity, electron effective mass, Density of states, Fermi-Dirac distribution function, intrinsic carrier concentration, Mechanism of carrier scattering, Einstein relationship.

Text Books

- Classical Mechanics; H. Goldstein, C. Poole, J. Safko; Pearson Education, Third Edition (2002)
- Modern Physics by A. Beiser; McGraw-Hill Higher Education, Sixth Edition (2003)
- Introduction to Quantum Mechanics by D. J. Griffiths; Pearson Education, Second Edition (2005)
- Introduction to Solid State Physics by C. Kittel; Wiley Students Edition, (2005)
- Physics of semiconductor devices, S M Sze, John Wiley & Sons, 2006

Reference Books

- Theoretical Mechanics by M. Spiegel; McGraw Hill Education, 2017
- Feynman Lectures of Physics Vol-1 and Vol-3; The Millenium Edition, Pearson (2012)
- Quantum Physics for Atoms, Molecules, Solids, Nuclei and Particles by R. Eisberg and R. Resnick; 2nd Edition, New Delhi Wiley (2012)

Linear Algebra (AS1002)

Objective: Students will be able to solve linear equations & develop understanding of vector spaces, linear transformations, Eigen value, diagonalization and orthogonalization, least square solutions and singular value decomposition etc

Course Outcome

Students will be able to

- Understand the concept of matrices, their properties & solve linear equations
- Understand basic concepts of vector spaces, subspace, linear dependence etc
- Calculate the rank-nullity of a matrix / linear map, eigenvalues, and eigenvectors.
- Apply the Gram-Schmidt process, Find the SVD, Jordan Canonical form .
- Apply concepts of linear algebra to various applications.

Matrices and Vector Spaces

System of linear equation, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordan method, Determinant, Cramer's rule, Vector spaces, Linearly independence and independence, Basis, Dimension.

Linear transformation & Diagonalizability

Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeneous equations, Eigenvalue, eigenvector, Cayley-Hamilton theorem, Diagonalizability, minimal polynomial

Inner product space

Inner product space, Cauchy-Schwarz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process, Orthogonal projection, Spectral theorem.

SVD & Jordan Canonical Form

Positive, negative, and semi-definite matrices. Decomposition of the matrix in terms of projections, Strategy for choosing the basis for the four fundamental subspaces, Least square solutions and fittings, Singular values, Primary decomposition theorem, and Jordan canonical form.

Text/Reference Books

- K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Pearson (2015).
- Gilbert Strang, Introduction to Linear Algebra, 4th Edition, Cambridge Press (2009).
- S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
- S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer (2012).

Problem Solving with Programming (IT1001)

Objective: Students will be able to understand programming language (in this case C language), develop a problem solving approach from programmer's perspective.

Course Outcome

Students will be able to:

- break down complex real-world problems into smaller, manageable subproblems and develop logical approaches for solving them through programming.
- learn to debug code, identify and fix logical errors, and write test cases.
- develop a systematic approach to problem-solving, logical reasoning, and iterative refinement.

Introduction to Computers & Demo

Computer hardware, Computer Networks, IP Address, Proxy, Gateway, Operating Systems, Disk/Directory/Files system, Application Software. Professional Ethics.

Programming Basics: Structure of a simple C program, Constants and Variables, Basic Data Types, Precedence and Associativity, implicit and explicit type conversion, Selection Statements, Loop Structures

Functions and Arrays: User-defined functions, function definition, Storage class and Scope, Macros, Nested, and Recursive Functions, One Dimensional arrays, Passing Arguments, Two and higher Dimensional Arrays, Strings, String Library Functions

Pointer and Structure: Addresses and Pointers, Structures, Dynamic Memory Allocation, Linked List, Stack, Queue. Data Files.

Text Books

- "Engineering Problem Solving with C", Delores M. Etter, Fourth Edition, 2012, Pearson.
- "C: How to Program", Paul Deitel and Harvey Deitel, Ninth Edition, 2022, Pearson.

Reference Books

- "Computer Systems: A Programmer's Perspective", Randal E Bryant and David R O'Hallaron, Third Edition, 2015, Pearson.
- "Problem Solving and Program Design in C", Jeri R. Hanly and Elliot B. Koffman, Eighth Edition, 2015, Pearson.
- "Programming in C", Brian Kernighan and Dennis Ritchie, Second Edition, 2015, Pearson.

Fundamentals of Electrical and Electronics Engineering (EC1001)

Objective: Students will be able to understand the fundamental concepts of electrical and electronics engineering.

Course Outcome
Students will be able to:

- Understand working principles of basic electrical and electronic devices and circuits.
- Design basic electronic circuits

Introduction
Basic physical laws, circuit elements, KVL, KCL, Network Theorems

Transients
R-L, R-C, R-L-C, Sinusoidal Steady State, Real/Reactive Power, Three Phase,

Transformers/AC/DC machines
Working Principles of Transformers/AC/DC machines

Semiconductors
Semiconductors, Band Diagram, n-type and p-type semiconductor, junction diode, diode biasing, Zener diode, DC Power supply

Transistors
Introduction to Bipolar Junction Transistor, MOS Capacitor, Introduction to Operational Amplifier, Schmitt Trigger, Multivibrator, Oscillators

Text Book

- Microelectronic Circuits SEDRA/SMITH 7th Edition Oxford University Press
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.

References

- Network Analysis, M E Van Valkenberg, 3rd Edition, PHI, 2000
- Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches, R A DeCarlo and M Lin, 2nd Edition, Oxford University Press, 2000

Technical Communication Skills (MS1001)

Objective: Students will be able to enhance and polish communication skills which will formally help them to be effective professionals by understanding importance of effective communication, presentation and designing of work.

Course Outcome
Students will be able to:

- Speak and participate in GD
- Write technical letters, CV, product development plans etc

Introduction
Introduction to types of communication, Lab sessions and mock presentation pertaining to Communication Styles, Content Management and Delivery Making Effective Public presentations, Speech and diction correction and counseling

Formal communication
Written communication, Problems and solutions Lab sessions will have exposure to: Cover letter, CV preparation Group discussion and Personal Interview Report writing and Proposal development plan, Interview: types and techniques SWOT Analysis.

Reference Books

- Winning at Interviews by Edgar Thorpe Books on Technical Writing

Constitution of India (MS1002)

Objective: Students will be able to understand the Fundamental features of the Indian Constitution, Union Government, Rights and Duties, Statutory Institutions.

Course Outcome
Students will be able to:

- Understand Indian Constitution, its composition and functions, Union and state Government
- Understand Rights and Duties, Statutory Institutions etc

Introduction
Evolution of the Indian Constitution, Acts, Fundamental features of the Indian Constitution, Union, State and Local Government.

Rights and Duties
Fundamental Rights and Duties, Directive Principles, Relation between Federal and Provincial units: Union-State relations, Administrative, legislative& Financial, Inter-State Council, NITI Ayog, Finance Commission of India, Union List, State List, Concurrent List, Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Reference

- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi
- Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
- Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi

Universal Human Values (MS1003)

Objective: Students will be able to understand the human values.

Course Outcome
Students will be able to:

- Understand the importance of human values, family, society, nature etc.
- Develop commitment and courage to act.

Introduction
Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

Self Reflection
Right understanding Strengthening of self-reflection, Development of commitment and courage to act, Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Reference

Professional Ethics (MS1004)

Objective: Students will be able to understand the awareness on Engineering Ethics and Human Values.

Course Outcome
Students will be able to:

- Understand social responsibility of an engineer etc.
- To appreciate ethical dilemma while discharging duties in professional life.

Values
Human Values Morals, Integrity, Work Ethics, Honesty, Courage, Empathy etc. Kohlberg's theory, Gilligan's theory, Models of Professional Roles.

Ethics
Codes of ethics, Challenger case study, Safety and Risk, The Three Mile Island And Chernobyl Case Studies, global issues, moral leadership

Reference

- Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
- Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
- Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
- Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
- John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Youth Empowerment and Skills (MS 1005)

Objective: To equip students with practical tools and techniques that will make them more creative, efficient, confident, clear-minded, stress-free, joyful and energetic

Course Outcome
Students will be able to:

- learn challenges and will learn group processes, talks, presentations and hands-on learning methodology that helps students to enhance their lives.
- Participate in Group discussions and role-plays to inculcate life-skills and human values
- Yoga Asanas and Pranayama to increase concentration & build confidence
- Breathing techniques (like the world-renowned and well-researched Sudarshan KriyaTM)
- Talks and Presentations to bring out attitudinal and behavioral changes towards achieving student excellence.

Personality Development
Personality Development Self-awareness, Emotional Intelligence / Coping with Emotions, Mind Management, Coping with Stress, Health and Nutrition, Social Adaptability and Effectiveness Effective Communication Skills, Interpersonal Relationship Skills, Lifestyle and Environment

Ethics
Ethics, Morality and Integrity, Time Management and Goal Setting, Professional Skills, Active Learning and Effective Learning Strategies, Decision Making

Reference

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Electronic Workshop (EC1002)

Objective: The objective of this course is to familiarize the students with the PCB design and SMT**.**

Course Outcome
Students will be able to:

- Fabricate design on PCB and
- learn SMT Fabrication and other aspects of SMT and PCB

Introduction
Introduction to System/PCB, Design the PCB

Fabrication on PCB
Full wave Rectifier & Flasher Circuit

Clipper and Clamper
Design and fabrication on PCB/SMT

Text Book

Reference Book

Digital Logic Design with HDL (EC1008)

Objective: The objective of this course is to familiarize the students with the design of digital systems using Verilog HDL**.**

Course Outcome

Students will be able to:

- Design digital circuits, strong skill set of Verilog HDL,
- Write Test bench and implementing any digital system on FPGA.

Introduction

Number System, r-1s complement, Sign and Magnitude Numbers, r's Complement Numbers, Gray Code, Boolean Algebra & logic minimization, k-map, Logic Family (BJT and CMOS based), Data-flow description using Verilog

Combinational Logic Design

arithmetic circuit design, Design using MSI components, Multiplexers and De-multiplexers, Encoder, Decoder Binary Adders, Subtraction and Multiplication. Structural design and implementation using Verilog HDL

Sequential Network

Concepts of Sequential Networks, State Diagram, Latches and Flip, Flops, Counters and Shift Registers, state machine, Finite state machine; HDL Implementation of Digital circuits, Behavioral description of sequential circuits using HDL

Memory Elements and Arrays Registers

RAM and ROMs, programmable logic array, Memories. Field Programmable Gate Array (FPGA), LUT, Slices, Semi-custom and Ful custom design, Implementation of the digital system on FPGA

Text Book

- M. Morris Mano, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", 5th Edition, Pearson Education Inc

Reference Book

- Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Second Edition, Prentice Hall, Computer Arithmetic Algorithms, 2nd Edition by Israel Koren

Electronic Devices and Circuits (EC1004)

Objective: This course is designed for the students seeking an extensive understanding of electronic devices and circuits and problem solving techniques. Being a freshman and a core course in electronics engineering, the lucidity is maintained throughout.

Course Outcome
Students will be able to:

- Design electronic circuits, amplifiers and
- Independently to drill any real world problems related to EDC.

Semiconductors
Semiconductor Diodes& Circuits: Physical operation of p-n junction diodes, Light emitting diodes, photo diode, circuits

Small Signal and Large Signal Analysis
Small & Large Signal Analysis of BJTs and FETs.

Energy band diagrams
Flat-band pinch-off voltage, JFET, Complementary MOS (CMOS), V-I Characteristics.

Text Book

- S. Sedra, K. Carless Smith Microelectronics, , 7thEdition, Oxford University. Integrated Electronics, JMilllman and C Halkias, TMH Press.

Reference Book

Electronics Measurements and Instrumentations (EC1005)

Objective: To introduce students to the basics of measuring instruments. To make them aware of working and practical application of instruments and sensors.

Course Outcome
Students will be able to:

- Understand the working principle of various instruments that will help to make better use of measuring instruments.
- Will be able to use different kind of sensors and
- How to select a suitable measuring instrument for the any measurement

Static Characteristics and Errors
Measurements, classification of instruments, Static characteristics of measurement instruments, Types of errors, Loading effect.

Electronic Instruments for Measuring Basic Parameters
DC Voltmeters, AC Voltmeters, Ammeters, Shielding & grounding, CTPT. Oscilloscopes: Basic construction, working, Kinds of Oscilloscopes.

Signal Generation and measurement techniques
Sine wave generators, Harmonic distortion analyzer, Spectrum analyzer.

Transducers
Transducers Classification, Selection Criteria, Characteristics, Construction, Application of following of different transducers..

Text Books

- A.K. Sawhney, Puneet Sawhney,A Course In Electrical And Electronic Measurements And Instrumentation, DhanpatRai Publications, 2012 H. S. Kalsi, Electronic Instrumentation, 3 edition, McGraw Hill Education, 2017

Reference Books

Data Structures and Algorithms (IT1003)

Objective: To make student learn the linear and non-linear structures in which data can be stored and their pros and cons & to write algorithms using different data structures.

Course Outcome
Students will be able to:

- Understand data structures, linked-lists, trees, binary search trees, AVL trees, stacks, queues, priority queues, and hash-tables and graphs, ADT
- To apply & implement learned algorithm design techniques and data structures to solve problems.

Introduction, Arrays and Linked Lists
Basic Terminology, Elementary Data Organization, Asymptotic notations Efficiency of an Algorithm, Time and Space Complexity and trade-off**,** Single and Multidimensional Arrays, Sparse Matrices, Single, Double and Circularly Linked List, Header node based Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List

Abstract Data Types (ADT), Searching and Sorting, **Priority Queues**
Stacks: Primitive Stack operations (Push & Pop) Implementation and Application of stack, Queue Implementation and Applications, Doubly Ended Queue, Sequential search, Binary Search, Comparison Sorting Techniques, Efficient Sorting Techniques, linear sorting techniques, Queue Definition & Implementation.

Hashing, Trees & Graphs- Hash table, hash function, collison & resolution strategies, Linear and Quadratic Probing, Trees, Binary Tree Representation, Expression Tree, Binary Tree Traversals, Binary Search Trees, Sequential & linked Representations of Graphs, Adjacency Matrix, Adjacency List, Graph Traversals, Connected Components, Minimum Cost Spanning Trees, Prims & Kruskal algorithm, Dijkstra algorithm

Text Books

- E. Horowitz, S. Sahni, S. Anderson-Freed “Fundamentals of Data Structures in C”, Second Edition, 2008, Universities Press.
- R. Kruse et al. , *Data Structures and Program Design in C,* Pearson Education
- S. Lipschutz , *Data Structures, Schaum's Outlines Series,* Tata McGraw-Hill.
- Mark Allen Weiss, “Data Structures and Algorithm Analysis in C (DSAC)”, Second Edition, 2002, Pearson Education India.

Reference Books

- “Algorithms Design”, Jon Kleinberg and Eva Tardos, First Edition, 2013, Pearson.
- “The C Programming Language”, Brian W. Kernighan and Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
- “Introduction to Algorithms”, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, Third Edition, 2009, MIT Press.

Network Synthesis and Analog Filters (EC1007)

Objective: To elaborate on the principles and applications of electrical network theorems for solving complex circuits and to analyze the steady-state & transient behavior of electrical networks using mathematical techniques.To introduce the fundamentals of filter design and their implementation in signal processing systems

Course Outcome
Students will be able to:

- Apply electrical network theorems and mathematical techniques to analyze and solve complex circuits.
- Perform transient and steady-state analysis of RL, RC, and RLC circuits, including sinusoidal and frequency-domain responses.Design and implement passive and active filters for various signal processing applications.
- Analyze and synthesize two-port networks and evaluate their performance using standard parameter representations.

Basic elements of a network
Basic RL and RC circuits, RLC circuits. Network Theorems: Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer.

R-L, R-C, R-L-C circuits
Initial conditions for networks, Differential equations, Transients in R-L, R-C, R-L-C circuits, Sinusoidal Steady-State Analysis, Laplace Transform Circuit Analysis in S-domain, Frequency Response of a Network, Design of Passive Circuits from Network Functions.

Two-Port Networks
Open Circuit Impedance Parameter (z Parameter), Admittance Parameter (y Parameter), Transmission Parameters, Hybrid Parameters (h Parameters), Two-Port Parameter Conversion, Interconnection of Two-Port Networks.

Filters
Passive Filters, Low Pass, High Pass, Band Pass, Band Reject Filters, OPAMP-Based Active Filters.

Text Books:

- M. E. Van Valkenburg, Network Analysis, Prentice Hall, 1955.
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.
- W.H. Hayt and J.E. Kemmerly: Engineering Circuit Analysis; 8th edition. McGraw-Hill, 2013.

Principles of Management (MS1006)

Objective: This course is designed to be an overview of the major functions of management. It explores how organizations develop and maintain competitive advantage within a changing business environment. Upon completion, students should be able to work as contributing members of a team utilizing these functions of management.

Course Outcome

Students will be able to

- Understand how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment.
- Practice the process of management's four functions: planning, organizing, leading, and controlling.

Nature and Functions of Management

Importance and Process of Management, Development of Management Thoughts, Managerial Roles.

International Business and its Environment

Globalization & WTO, Dynamics of development Global business environment, Internal Tech. of Forecasting.

Need for Organization

Principles and Process of Organizing, Authority, Delegation and Decentralization

Staffing and Directing

Requirement of Effective Direction

Text Book

- Koontz, Weihrich, Aryasri. Principles of Management, TATA McGraw Hill, New Delhi, 2004.

References

- P. C. Tripathi, P. N. Reddy, Principles of Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Prasad LM, Principles and Practice of Management, Sultan Chand & Sons, New Delhi.
- Samuel C. Certo, S. TrevisCerto, Modern management 10 Ed, PHI Learning, New Delhi, 2008
- James A. Stoner, Edward Freeman, Daniel Gilbert, Management, PHI Learning, New Delhi, 2007
- Williams/ Kulshrestha, Principles of Management, Cengage Learning, New Delhi, 2011

Environmental Studies (MS1007)

Objective: To make student learn the importance of environmental studies, different resources, ecosystem etc.

Course Outcome

Students will be able to

- Understand the Multidisciplinary nature of environmental studies.
- Structure and function of an ecosystem
- Environmental Pollution etc.

Nature of Environmental studies, Ecosystems

Definition, Scope and importance, Need for public awareness. Different resources, Concept of an ecosystem, Structure and its function, Food chains, Different eco systems, Biodiversity, Threats, In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution & Field Work

Causes, effects and control measures of different pollution, Nuclear hazards, Pollution case studies, Disaster management, Water conservation, rain water harvesting, watershed management, Case studies on Environmental ethics, Climate change, global warming, Case studies. - Wasteland reclamation, Environment Protection Act, Water Act, Wildlife Protection Act, Visit to a local polluted site and Study of ecosystems.

References:

- Agarwal, K.C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt.Ltd. , Ahmedabad — 380 013, India, Email: mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P.Cooper, T.H.Gorhani, E &Hepworth, M.T.2001. Environmental Encyclopedia, Jaico Publ. House. Mumbai, 1196p
- Dc A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment(R)
- Gleick, 11.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473

Physical Education (Sports) (MS1008)

Objective: To aware the students on the importance of physical education for a healthy life and train them on various sports, games, yoga, etc. for physical fitness.

Course Outcome
Students will be able to

- Understand the knowledge of various ways for maintaining both physical and mental wellness

Know your body
First Aid for basic medical conditions, CPR for emergency, Diabetic and Obesity condition of Indian and world, Importance of physical education.

Yoga and Meditation
Yoga for wellness and concentration, Meditation for wellness

Athletics and Aquatics
Rules, benefits and mastering of various track and field events such as Sprint, Marathon, Hurdles, Long Jump, High Jump, Javelin throw, Shot Put, Discus throw, etc.
Rules, benefits and mastering of various styles of swimming, butterfly, freestyle, backstroke, and breaststroke, Sports for physical fitness like Cricket, basketball, football, volleyball, etc.

References:

- Dr. V K Sharma, “Health and Physical Education”. New Sarasvati House Publishers.
- “Yoga: A Healthy Way of Living”. By National Council of Educational Research and Training.
- Mark Young. “The Complete Beginners Guide to Swimming”.
- Dr. Ashwini Bhardwaj. “A Complete Guide to Family Safety and First Aid”. GoodWill’s Publishers.

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Electromagnetic Field and Waves (EC2001)

Objective: To let the Second Semester B. Tech. (ECE) students exposed to basic laws of Electromagnetism and to demonstrate their application on RF Communication.

Course Outcome

Students will be able to:

- Understand the different types of coordinate systems Divergence and Stokes's Theorems.
- Learn boundary conditions, Maxwell's equations and its applications.
- Visualize wave propagation in different medium.
- Apply Smith chart to solve problems of Transmission lines

Vector Calculus

Cartesian, Cylindrical and Spherical Coordinates systems, Line, Surface, and Volume Integrals, Gradient, Divergence, Curl and Laplacian, Divergence and Stokes's Theorems

Electromagnetic Fields

Review of Static Electric and Magnetic Field, Boundary Conditions of Electric and Magnetic fields, Electrostatic Boundary Value Problems: Poisson and Laplacian equations and its solution, Time varying fields, Maxwell's equations for time varying fields

Wave Propagation

Wave equation and its solution, Propagation of wave in lossless, lossy and conducting medium, Power and Poynting Theorem, Wave Polarization: Linear, circular and Elliptical. Reflection of a Plane Wave at Normal Incidence, Reflection of a Plane Wave at Oblique Incidence

Transmission line

Transmission Line Parameters, Transmission Line Equations, Input Impedance, Standing Wave Ratio, Smith Chart: Basic Operation of Smith Chart, Impedance matching: Single Stub, Double Stub, Quarter wave matching Techniques

Text Books

- N. O. Sadiku, Elements of Electromagnetics, 5th Edition. Oxford University Press, 2010.
- W H Hayt and J A Buck, Engineering Electromagnetics, Oxford University Press, 2000

Reference Books

- K. Shevgaonkar, Electromagnetic Waves, 1st Edition. McGraw-Hill, 2006.
- F. Harrington, Time-Harmonic Electromagnetic Fields, 2nd Edition. Wiley-IEEE, 2001.
- K. Cheng, Field and Wave Electromagnetics, 2nd Edition. Pearson, 2014.

Signals and Systems (EC2002)

Objective: To demonstrate an understanding of the fundamental properties of signal and systems.

Course Outcome

Students will be able to:

- Analyze the different types of signals and systems.
- Determine the linearity, causality, time-invariance and stability properties of continuous and discrete time systems.
- Represent continuous and discrete systems in time and frequency domain using different transforms.
- Recognize the characteristics of linear time invariant systems.

Classification of Signals and Systems

Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids. Classification of signals: Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals Classification of systems CT systems and DT systems: Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable

Continuous Time Signals & Linear Time Invariant Continuous Time Systems

Fourier series for periodic signals Fourier Transform and properties, Laplace Transforms and properties. Impulse response, convolution integrals, Differential Equation, Fourier and Laplace transforms in Analysis of CT systems, Systems connected in series / parallel.

Analysis of Discrete Time Signals

Sampling and Quantization, Discrete Fourier Transform and Properties, Discrete Fourier transform (DTFT) and Properties of DTFT, Z Transform and Properties of Z- Transform.

Linear Time Invariant-Discrete Time Systems

Impulse response, Difference Equations-Convolution sum- DFT & Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel

Text Books

- “Signals and Systems”, Simon Haykins and Barry Van Veen, 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.
- “Signals and Systems” Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002

Reference Books

- “Fundamentals of Signals & Systems”, Michael Roberts, 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
- “Linear Systems and Signals”, B. P. Lathi, Oxford University Press, 2005.
- “Digital signal processing: principles algorithms and applications” Proakis, John G. : Pearson Education India, 2001

Analog Electronics and Linear ICs (EC2003)

Objective: To demonstrate an understanding of the analog electronics and linear integrated circuits

Course Outcome
Students will be able to:

- Understanding the types of amplifiers for analog electronics applications.
- Know the concept of various positive and negative feedback in electronic circuits.
- Solve circuits for designing ICs for applications in semiconductor industries.
- Become proficient in the analysis and design of circuits utilizing modern transistors.
- Understand the designing concept of power amplifiers in terms of the conversion efficiency and power delivered to the load.

Operational Amplifier
Type of Amplifiers, Op-Amp, non-idealities of Op-Amp, equivalent circuit, 741-IC, Op-amp used in negative feedback: inverting, non-inverting amplifier, integrator, differentiator, Instrumentation amplifier, Op-Amp as computational block

Feedback Systems
Properties of feedback system, Barkhausen criterion, Op-Amp with positive feedback, Oscillators, wave shaping circuits, filters, 555 timers, Schmitt Triger, PLL

MOSFET amplifiers
CSA, CGA, CDA, Cascode, Cascade, pole and zeros calculation, 3-dB bandwidth, current mirror.

Power amplifiers
Power amplifier circuits, Class A output stage, class B output stage and class AB output stages, class C amplifiers, push pull amplifiers with and without transformers. Complementary symmetry & quasi complimentary symmetry amplifiers.

Text Books

- Adel S. Sedra, Kenneth C. Smith, Microelectronics Circuits Theory and application, 6th edition, Oxford press.
- Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd edition, McGraw Hill, 2017
- R Gayakwad, “Op-amp and Linear Integrated Circuits”, 4th Ed.,Pearson Education.2005

Reference Books

- J Millman and C Halkias, Integrated Electronics by, TMH Press, 1995.
- W D Stanley, “Operational Amplifier with Linear Integrated Circuits”, 3rd Ed.,

Microprocessor Interface and Programming (EC2004)

Objectives: Students will be able to learn about the architecture of microprocessors, fundamentals of assembly language programming, interfacing with peripheral devices and enabling them to create products and solutions for real time problem.

Course Outcome

At the end of this course, students will demonstrate the ability to:

- Explain 8086 architecture and its instruction set
- Develop assembly language programs for the 8086 microprocessor
- Design memory organization
- Interface peripheral chips with respect to PPI, timer, DMA controller etc
- Describe the interrupt response of 8086 family processors and understanding of multi-processor system.

Introduction to Microprocessors

Introduction of Microprocessors and Micro-controllers, Concept of Pipelining, CISC and RISC, Von Neumann vs Harvard architecture, Different microprocessor family, features and evolution

8086 processors and Interrupts

8086 Architecture, Instruction Set, Minimum and Maximum mode configurations, Interrupts, Programmable Interrupt Controller 8259, Architecture, Commands, Interfacing

Peripherals and Interfacing

8255 Programmable Peripheral Interface, Architecture, Commands, Modes, Interfacing
8254 Programmable Interval Timer, Architecture, Modes, Concept of DMA

Memory Design, Multiprocessors and Advanced Microprocessors

Memory Design, Multiprocessor systems, Problems in Multiprocessor systems, Bus Contention, Features and Architecture of Pentium 80586, Microcontrollers

Text Books

- D.V. Hall, Microprocessors and Interfacing, 3rd Edition, McGraw Hill, 2017.
- K M Burchandi, A K Ray, Advanced Microprocessor And Peripherals 3rd Edition McGraw Hill, 2017.

Reference Books

- J. E. Uffenback, 8086/8088 Family rd Edition (English) 3rd Edition, Prentice Hall 2013.
- Y. Gandole, A Text Book Of Advanced Microprocessors and Microcontroller: Intel 80286,80386,80486, 80586 Microprocessor and 8051 Microcontroller, Lambert Academic Publisher, 2012.

Biology for Engineers (AS1010)

Objective: The objective is to provide the fundamental knowledge of Modern Biology and its application.

Course Outcome

Students will be able to:

- Get basic understanding of the Advanced Biology
- Get exposure to different areas of Biology including Cell Biology, Microbiology, Molecular Biology, Biochemistry and Immunology.
- Learn the principles of different advanced laboratory techniques used in biological research works and interdisciplinary research.

Introduction

Introduction to living organisms, Different cell organelles and cellular processes. Prokaryotes and Eukaryotes cells.

Structures and functions

Structures and functions of bimolecules, DNA, RNA, Carbohydrates, Proteins and Lipids.

Immunity, Electrical signal & Biomaterials

Antigen, Antibody, Antigen-Antibody interactions, Electrical signal of cells, HH model. Concept of Stem cells, Differentiation, Characterization**,** Biomaterials for tissue engineering, 3D bio-printing, DNA origami and Biocomputing.

Text book

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell.

References

- Prescott, Harley, and Klein's Microbiology by Joanne M. Willey, Linda Sherwood, and Christopher J. Woolverton.
- Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer.
- Immunology by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby.

Principle of Economics (MS2001)

Objective: This course introduces economic analysis of individual, business, and industry choices in the market economy. Topics include the price mechanism, supply and demand, optimizing economic behavior, costs and revenue, market structures, factor markets, income distribution, market failure, and government intervention. Upon completion, students should be able to identify and evaluate consumer and business alternatives in order to achieve economic objectives efficiently.

Course Outcome

Students will be able to:

- Understand that economics is about the allocation of scarce resources, that scarcity for ceschoice, tradeoffs exist and that every choice has an opportunity cost.
- List the determinants of the demand and supply for a good in a competitive market and explain how that demand and supply together determine equilibrium price.
- Understand the role of prices in allocating scarce resources in market economies and explain the consequences of price controls.
- Define an externality and a public good and why explain the presence of externalities and public goods make markets inefficient. Analyse various government policies aimed at solving these inefficiencies.

Introduction to Economics

Production Possibilities, Supply and demand, analysis; The price system and the mixed economy

Elasticity; Consumer choice and the theory of demand

The profit-maximizing competitive firm and market supply; Long-run supply in competitive markets, Production and cost

Types of Market:

Monopoly; Perfect Markets; Monopolistic competition and oligopoly; Antitrust policy and regulation of markets

Introduction to macro Economics

Macro-Economic Equilibrium GDP; Unemployment; Inflation

Text Books

- Principles of Economics: Gregory Mankiw
- Economics: Samuelson

Introduction to Finance (MS2002)

Objective of the Course: This course is a rigorous introduction to the study of the basic principles of finance and their application to the usual financial issues and decision-making of business enterprises. The main objective of this course is for the student to obtain at least a good working-knowledge of the topics stated in the tentative course outline below for use in future courses and for careers.

Course Outcome
Students will be able to:

- Identify the objective of the firm and the role of managerial finance.
- Outline the implications of the separation of ownership and control.
- Evaluate financial statements using ratio analysis.
- Explain the general concept of valuing financial assets.
- Explain the characteristics of debt and equity securities.
- Identify why firms need to invest in working capital Outline the alternative sources of long-terms fund.

Introduction to financial Management
Financial statement basics, Ratio Analysis

Time value of Money
Capital Budgeting, Relationship between risk and return

Long term financial decisions
Working Capital Management, Dividend Decision

Introduction to Financial Systems
Capital Markets, Introduction to International finance and risk Management

Text Books ·

- Ross, Westerfield, Jordan, Essentials of Corporate Finance
- James C. Van Horne and John M Wachowicz, Fundamentals of financial management.
- Jonathan Berk, Financial Management

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Control Systems (EC2005)

Objectives: To introduce them to the basic of control systems. How a basic control system is formed? How they can analyze and build a control system.

Course Outcome

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

- analyze a control system if given to them. They will
- be able to find the equivalent mathematical model for it and if the system is
- not stable they will be able to, by the use techniques learned in this course,
- stabilize the system.

Introduction to Control System

Basic Concepts of Control Systems, Feedback characteristics of Control Systems.

Time response Analysis

Standard Test Signals. Time response of different order of systems. concept of stability.

Frequency Response Analysis

Frequency domain specifications, Gain and Phase Margin.

Stability in frequency domain

Root locus concepts, Effect of adding open loop poles and zeros, Nichol's chart, controllers.

Text Books

- N S. Nise, Control Systems Engineering, International Student Version, 6th Edition, Wiley, April 2011.
- R H. Bishop, Richard C. Dorf, Modern Control Systems, 12th edition, Pearson
- Higher Education, 2010.
- I.J. Nagrath and M Gopal, Control Systems Engineering, 6th edition, New Age International Pvt Ltd, 2017

Reference Books

Analog Communication (EC2006)

Objectives: To make the student learn the fundamentals of communication systems and to let the students be exposed to technological progress in communication systems.

Course Outcome

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

- analyze and design various transmission techniques.
- to tackle the challenges in designing a transceiver for a communication system..

Introduction

Basic elements of a communication systems.

Analog Baseband and Bandpass Transmissions:

Baseband versus passband communication,
Modulation and need of modulation, Analog modulation and demodulation- AM, DSB-SC, VSB, SSB, Comparison of different modulation techniques, Phased locked loop and applications, Pulse modulation: PAM, PPM, PWM..

Angle Modulation and demodulation

Non-linear modulation and concept of instantaneous
frequency, Relationship between PM and FM, Power and bandwidth of angle modulated signals, Narrowband and wideband FM, NBFM generation-direct and indirect method, Demodulation of FM signals and effect of non-linear distortion, Deemphasis and Preemphasis Filtering, Superheterodyne analog AM/FM receivers.

Noise in analog modulation systems

White Gaussian noise, Bandpass noise, PSD of noise, Noise analysis-DSB-SC, AM, SSB, FM.

Text Books

- A B Carlson, Communication, Pearson, 2000
- B P Lathi and Z. Ding, Modern Analog and Digital Communication Systems, Oxford Press, 2002

Reference Books

CMOS VLSI Design (EC2007)

Objectives: To make the student learn the fundamentals of design styles used in CMOS ICs, covering both full-custom and semi-custom design approaches.

Course Outcome

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

- Understand the fundamentals of MOSFET, CMOS Technology, and Scaling.
- Understand the fundamentals of the CMOS static and dynamic logic implementation and physical design
- Apply logic optimization techniques to improve the PPA of any CMOS ICs.
- Perform physical design and static timing analysis (STA).
- Make the skillsets aligned with India's semiconductor mission and VLSI industry.

Introduction to CMOS

MOSFETs, threshold voltage, Inverters: ratioed, ratioless, CMOS Inverter. DC transfer characteristics, Dynamic characteristics, Static and dynamic power consumption, standby power consumption, activity factor MOS leakage, delay computation using average current method, exact analysis, RC-delay model, interconnects, MOS capacitances.

Compact models and physical design

MOS SPICE Models, level-1, level-2, level-3, BSIM models, Verilog-A models, SPICE model parameter extraction, Short channel effects, Technology Scaling considering long-channel and short-channel transistors, CMOS Fabrication steps, Layout, stick diagram, Euler Path, junction sharing, calculation of parasitic. LVS, DRC, corner and PVT analysis, yield, PPA.

Combinational Logic Optimization

Pass transistors, CPL, Transmission gates, DCVSL logic, input reordering, progressive sizing, method of logical effort, critical path optimization using logical effort and RC-delay model.

Sequential Logic Implementation

Master-slave D-FF implementation using pass transistor and/or transmission gate, setup time, hold time, Static timing analysis, Min and Max delay constraints, hold time violation, clock skew, STA, dynamic logics: charge-precharge based, Dominos, charge-sharing.

Text Books

- J. M. Rabaey et al. & Digital Integrated Circuits A design perspective 2 nd edition, PHI.
- Weste, Harris, CMOS VLSI Design: A Circuits and Systems Perspective 4th edition, Pearson.
- Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis
- and Design Tata McGraw-Hill.

Reference Book

Probability and Statistics (AS2001)

Objective: This course provides an elementary introduction to probability and statistics with applications. The topics covered in this course are basic concept of probability and statistics, random variables, probability distributions, Bayesian inference, joint probability distributions, random vectors, central limit theorem, confidence intervals.

Course Outcome

Students will be able to:

- Understand the basic concepts of probability and random variables.
- Apply the standard discrete and continuous probability distributions to real problems and use the inequalities.
- Extend the concept of random variables to higher dimensions and approximate probabilities by central limit theorem.
- Analyze the data by using statistical techniques of point and interval estimation and testing of hypotheses.

Probability: Axiomatic definition, Properties, Conditional probability, Bayes rule and independence of events, Random Variables, Distribution function

Probability Distributions: Discrete and Continuous random variables, Expectation, Function of random variable, Moments, Moment generating function, Chebyshev's and Morkov's inequality. Bernoulli, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson, Discrete uniform, Continuous uniform, Exponential, Gamma, Normal.

Random vector: Joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation, Levy's Central limit theorem (independently and identically distributed with finite variance case), Normal approximation to Binomial and Poisson

Statistics: Introduction: Population, Sample, Parameters, Point Estimation: Method of moments, Maximum likelihood estimation, Unbiasedness, Consistency, Interval Estimation: Confidence interval, Tests of Hypotheses, Linear Regression.

Text/Reference Books

1. Sheldon M. Ross, An Introduction to Probability Models, 10th Edition, Academic Press, Elsevier.
2. Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.
3. Rohatgi, V. K. and Saleh, A. K. (2000), An Introduction to Probability and Statistics, 2nd Edition, Wiley-interscience.
4. Bertsekas, D. P. and Tsitsiklis, J. N. (2008), Introduction to Probability, Athena Scientific, Massachusetts.
5. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2012), An Introduction to Linear Regression Analysis, 5th Edition, Wiley

Antenna and Wave Propagation (EC2009)

Objectives: To provide a comprehensive introduction to the fundamentals of antenna, its types, design and measurement parameters.

Course Outcome

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

- Learn the basics of radiation principle and foundational concepts through mathematical analysis.
- Gain insight about fundamental parameters and terminology used in Antenna Engineering.
- Analyze and design various types of antennas to achieve a specified performance.
- To understand various modes of EM wave propagation.
- To acquire hands-on experience with antenna measurements and testing

Radiation Integrals and Auxiliary Potential Functions

Vector Potential for an Electric and Magnetic Current Sources, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-Field Radiation, Duality Theorem, Reciprocity and Reaction Theorems.

Fundamental Parameters of Antennas

Principle of Radiation, Radiation Pattern, Field Regions, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Bandwidth, Polarization, Input Impedance, Antenna Radiation Efficiency, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation.

Antenna Arrays

Uniform linear arrays of isotropic elements, array factor and directivity. Broadside & Endfire array, Principle of pattern multiplication. Binomial array.

Working Principle of Antennas & Wave Propagation

Linear Wire Antennas, Monopole, folded dipole, Yagi-Uda, Log
periodic, Parabolic reflector, Horn, V-antenna, Rhombic antenna, Microstrip antenna, Resonant and non-resonant antenna. Atmosphere, Ground wave propagation, Sky-wave propagation, space wave, propagation, Troposcatter and Duct propagation

Text Books

- C A Balanis, Antenna Theory and Design.3rd Ed., John Wiley & Sons. 2005.
- R. Harish, and M. Sachidananda. Antennas and wave propagation. Oxford University Press, USA, 2007.
- Reference Books
- R. S. Elliot, Antenna Theory and Design. Revised edition, Wiley-IEEE Press. 2003.
- R. E. Collin, Antennas and Radio Wave Propagation. McGraw-Hill. 1985.
- R. K. Shevgaonkar, Electromagnetic waves. Tata McGraw-Hill Education, 2005.

Integrated Circuit Technology (EC2010)

Objectives: The subject provides an in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to device fabrication..

Course Outcome

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

- Achieve in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to the final device realization.
- Understand the latest device fabrication technologies and basic principles underlying state-of-the-art processes involved

Semiconductor materials and manufacturing

Historical perspective, Modern CMOS Technology, Crystal growth, and wafer preparation: crystal structures, wafer fabrication, crystal defects, gettering

Lithography

Light Sources, Masks, Wafer Exposure System, Photoresists, Modern Photolithography Techniques, DUV, EUV, Resolution enhancement methods, Other lithography Techniques

Thermal Oxidation and Interfaces

Oxidation kinetics and its dependencies, substrate doping effects, impurity redistribution during oxidation, oxide charges, High-K Dielectrics

Doping in Semiconductors & Etching Technologies

Diffusion from Macroscopic and microscopic viewpoint, Analytical solutions of Diffusion equation, evaluation of diffused layers, Ion Implantation and implant range, Ion stopping and ion channelling, Transient Enhanced Diffusion (TED), Wet and dry etching, Plasma chemistry, plasma etching mechanisms, high density plasma, atomic layer etching, planarization methods CMP

Deposition Technologies and Interconnects

CVD, hetroepitaxy, PVD, sputtering systems, LPCVD, MOCVD, PECVD, ALD, MBE, Metal deposition, multilayer interconncets and their issues, Electromigration silicidation, salicide process

Text Books

- J. D. Plummer and P.B. Griffin, “Integrated Circuit Fabrication Processes: Science and Technology”, by Cambridge University Press, 2024

Reference

- S. M. Sze, VLSI Technology, McGraw Hill Education.
- G. S. May and S M Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons,
- S. K. Gandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, John Wiley & Sons,

Digital Signal Processing (EC3001)

Objective: To learn about the basics and advanced topics in the field of Digital Signal Processing.

Course outcomes

Students will be able to:

- Students will learn to utilize the advanced approaches of processing the signals and various aspects of discrete system design.

Introduction

Review of the fundamental concepts of digital signal processing, Sampling and Quantization, Convolution and correlation, DTFT, DFT and FFT

FIR & IIR

Filter concepts, Structures for realization of FIR and IIR Systems and their analysis, Recursive and Non-recursive structures, Windowing methods, comparison of design methods.

Multirate DSP

Design of FIR filters, Analysis of finite word length effects, Multirate digital signal processing, optimum linear filters and Power spectrum estimation.

Statistical Signal Processing

Introduction to Statistical Signal Processing, applications of autoregressive (AR), Moving average (MA), and ARMA processes, Applications of DSP etc.

Text Books:

- John G Proakis, Digital Signal Processing, 4th Edition PHI, 2012
- V. Oppenheim and R. W. Schafer, Discrete-Time Signal Processing, 2nd Edition,
- Pearson Education, 2003.
- J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms
- and Applications, 4th Edition, Prantice Hall, 1996.
- S. Haykin and B.V. Been, Signals and Systems, 2nd Edition, John Wiley & Sons. 2003.
- B.P. Lathi, Linear Systems and Signals, 2nd Edition, Oxford University Press, 2005.

Reference Books:

Embedded System Design (EC3002)

Objective: Understanding of Hardware and Software Components of a typical Embedded System, the challenges in " System Level Design" and develop system design skills and to Develop programming skills and practical expertise in designing, debugging and developing small scale and medium scale Embedded systems

Course outcomes

Students will be able to:

- Understand the hardware and software components of embedded systems.
- Develop system design skills and address challenges in system-level design.
- Gain practical expertise in designing, debugging, and developing embedded systems.
- Ability to design embedded electronic hardware and firmware.
- Comprehend microcontroller architecture and interfacing techniques

Introduction

Design process of embedded systems, hardware/software interface, design issues in embedded systems, and system-on-chip technologies.

Implementation

Hardware implementation methodologies, interaction for general microcontrollers, and communication protocols like USB, I2C.

Embedded Processor

Performance, efficiency of ARM architecture, data processing, and parallelism.

Interfacing

Memory interfacing, I/O interfacing, real-time OS, scheduling, and testing.

Text Books

- Wolf, Wayne. Computers as Components – Principles of Embedded Computing System Design. Second Edition, Morgan-Kaufmann, 2008.
- Vahid, F., & Givargis, T. Embedded System Design – A Unified Hardware/Software Introduction. John Wiley, 2002.

Reference Books

- James K. Peckol. Embedded System Design – A Contemporary Design Tool. Wiley Student Edition, 2010.
- Steve Furber. ARM System-on-Chip Architecture. Second Edition, Pearson, 2007.
- Lyla B Das. Embedded Systems: An Integrated Approach. Pearson Education.
- Santanu Chattopadhyay. Embedded System Design. PHI.
- Muhammad Ali Mazidi. 8051 Microcontroller & Embedded Systems: Using Assembly and C. Pearson Education.
- ARMv7 Reference Manual.

Microwave Engineering (EC3003)

Objective of the course: To provide a comprehensive introduction to various devices and passive components used at microwave frequencies.

Course Outcomes
Students will be able to:

- Understand the different types of matching techniques using Smith Chart.
- Analyze and implement metamaterial transmission lines.
- Design RF filters using planar technologies.
- Design microwave amplifiers.

Impedance Matching
Smith Chart, Single and double stub matching, Quarter-wave Transformer, Theory of Small Reflection, Binomial and Chebyshev multi-section matching, Tapered line

Metamaterial Transmission lines
Negative Refractive Index (NRI) Media, Negative-Refractive-Index Transmission-Line (NRI-TL) Metamaterial Medium: Propagation Characteristics of the T and Unit Cell, Effective Medium Propagation Characteristics, Multi-Stage NRI-TL Metamaterial Phase-Shifting Lines

Microwave Filters
Filter design by the insertion loss method, Maximally Flat Low-Pass Filter Prototype, Equal-Ripple Low-Pass Filter Prototype, Filter transformations: Impedance and Frequency Scaling, Band-pass and Band-stop Transformations, Richards' Transformation, Kuroda's Identities, stepped-impedance low-pass filters

Microwave Active Circuit Design
Nonlinear distortion: Gain Compression, Harmonic and Intermodulation Distortion, Third-Order Intercept Point, Dynamic range, Diode Circuits, Amplifier Design: Two port power gain, stability circles, Single stage transistor amplifier design

Text Books

- D.M. Pozar, Microwave Engineering. 4th Ed., John Wiley & Sons. 2012.
- R.E. Collin, Foundations for Microwave Engineering. 2nd Ed., John Wiley & Sons. 2000.

Reference Books

- D.M. Pozar, Microwave and RF design of Wireless System, John Wiley & Sons. 2001.
- Marc A. Antoniades, Microwave Devices and Antennas Based on Negative-Refractive-Index Transmission-Line Metamaterials, PhD Thesis, Department of Electrical and Computer Engineering University of Toronto, 2009.

Digital Communication (EC3004)

Objective: To learn about the fundamental concepts of digital communications.

Course Outcome:
Student will be able to:

- Understand the fundamental principles underlying the analysis and design of digital communication systems.
- Gain knowledge of digital communication methods for transmitting information from a source to one or more destinations in digital form.
- Evaluate the performance of digital communication system in the presence of noise.
- Apply the knowledge of information theory and describe the error control codes like block code, cyclic code.

Digital communication systems and signal representation
Analog versus digital communication, Elements of a digital communication system, Review of probability and random process, Signal spaces: Waveforms and vector spaces, Gram Schmidt orthogonalization, bandpass and low pass representation of a random process, Line Coding, Spectral properties of line codes.

Digital modulation and demodulation techniques
Baseband pulse shaping, Digital modulations and demodulation schemes: Binary ASK, PSK, FSK, QPSK, 8-PSK, DPSK, QAM, Calculation of probability of error.

Optimum signal detection
Design of optimum receivers over AWGN channel, Noise in digital communications, Equalizers.

Introduction to Information Theory
Entropy, Mutual information, Data compression, Source coding, Channel coding, Error correction codes.

Text Book

- B P Lathi and Z. Ding, Modern Analog and Digital Communication Systems, Oxford Press, 2002.
- John G Proakis and M. Salehi, Digital communications, McGraw-hill, 2008.

References

- S. Haykin, Digital communications, Wiley, New York, 1988

Design Thinking and Innovation (EC3501)

Objective: The objective of this course is to learn the innovation cycle of Design Thinking process for developing innovative products.

Course Outcome

Student will able to

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of the Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, and techniques during prototype development and to perceive individual differences and its impact on everyday decisions and further Create a better customer experience

An Insight to Learning, Remembering Memory & Emotions

Kolb's Learning Styles, Assessing and Interpreting, Understanding the Memory process, Problems in retention, Memory enhancement techniques, Understanding Emotions:

Basics of Design Thinking & Being Ingenious & Fixing Problem

Definition, Need, Objective, Concepts & Brainstorming, Stages of Design Thinking Process, Bottlenecks of Processes-Process Centric approach, Creative thinking process, Problem Solving, Testing Creative Problem Solving

Process of Product Design, Prototyping & Testing and Celebrating the Difference

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, User Interface Design, Mobile App Design, Prototype creation, Rapid Prototype Development process, Testing, Test Group Marketing, Group Discussion

Design Thinking & Customer Centricity & Feedback, Re-Design & Re-Create

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Feedback loop, rapid prototyping & testing, final product, Creative Solution".

Text Book

Reference Book

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Data Communication and Networking (EC3005)

Objective: The objective of this course is to describe communication protocols and layered network architectures

Course outcomes:
Students will be able to:

- Explain convention computer system interfacing standards and peer-to-peer data link and communication protocols
- Design basis network systems and Analyze data communication technology
- Analyze data communication technology.

Data Communications
Components – Direction of Data flow – Networks – Components and Categories – Types of Connections – Topologies –Protocols and Standards – ISO / OSI model, Example Networks such as ATM, Frame Relay, ISDN Physical layer: Transmission modes, Multiplexing, Transmission Media, Switching, Circuit Switched Networks, Datagram Networks, Virtual Circuit Networks.

Data link layer: Introduction, Framing, and Error – Detection and Correction – Parity – LRC – CRC Hamming code, Flow and Error Control, Noiseless Channels, Noisy Channels, HDLC, Point to Point Protocols. Medium Access sub-layer: ALOHA, CSMA/CD, LAN – Ethernet IEEE 802.3, IEEE 802.5 – IEEE 802.11, Random access, Controlled access, Channelization.

Network and Transport Layer: Logical Addressing, Internetworking, Tunneling, Address mapping, ICMP, IGMP, Forwarding, Uni-Cast Routing Protocols, Multicast Routing Protocols, Process Process Delivery, UDP and TCP protocols, Data Traffic, Congestion, Congestion Control, QoS, Integrated Services, Differentiated Services, quality of service in Switched Networks.

Application Layer: Domain name space, DNS in internet, electronic mail, SMTP, FTP, WWW, HTTP, SNMP.

Text/Reference Books:

- D. Bertsekas and R. Gallager, Data Networks, 2nd Edn., Prentice Hall, 1992.
- L. Peterson and B. Davies, Computer Networks: A Systems Approach, 4th Edition, Elsevier, 2007.
- L Garcia and I. Widjaja, Communication Networks, 2nd Edn., McGraw Hill,2009
- Kumar, D. Manjunath and J. Kuri, Communication Networking: An Analytical Approach, Elsevier, 2004.
- Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition TMH,2006.
- Andrew S Tanenbaum, Computer Networks, 4th Edition. Pearson Education, PHI.

Mobile and Wireless Communication (EC3006)

Objective: The objective of this course is to develop an understanding of advanced multiple access and diversity reception techniques.

Course outcomes:
Students will be able to:

- Synthesis and analysis of wireless and mobile communication systems over a stochastic fading channel
- Evaluate the performance of wireless communication systems, taking into account the impact of physical channel characteristics on end-to-end transmission.
- Identify the recent technologies in the domain of wireless communication

Cellular concepts: Fundamentals of cellular networks, Frequency reuse, Handoff, Co-channel interference, Adjacent interference, System capacity, Trunking and grade of service.

Mobile radio propagation: Free space propagation model, Log distance path loss model, Shadowing, Various outdoor and indoor propagation models, Types of fading, Doppler shifts, Characteristics of fading channel: level crossing and average fade duration, Diversity Techniques.

Multiple access techniques: Frequency division multiple access (FDMA), Time division multiple access (TDMA), Spread spectrum multiple access: CDMA and frequency hopping, Orthogonal frequency division multiplexing (OFDM).

Recent wireless technologies: Cooperative Communication: Relaying and other similar Networks, LTE Networks, NOMA and others recent trends in 5G and beyond.

Text Book

- T. S. Rappaport, Wireless Communication, 2nd Edition, Principles and Practice, Pearson Education India, 2009.
- Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005

References

- B. Carlson, P. B. Crilly and J.C. Rutledge, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th Edition, McGraw Hill, 2002.
- L. Song and J. Shen, Evolved Cellular Networks Planning and Optimization for UMTS and LTE, 1st Edition, CRC Press, 2010.

French Language (MS 1502)

Objective: To equip students with the necessary skills to understand, speak, read, and write French effectively, allowing them to communicate in everyday situations, including basic grammar, vocabulary, pronunciation, and cultural understanding, often aiming to reach a specific proficiency level

Course outcome

At the end of this course, Students will

- be familiar with the pronunciation of French letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Personal Information, Introducing yourself (name, age, nationality), Family members Basic greetings and farewells

Basic Communication

Asking and answering simple questions, Expressing likes and dislikes, Making requests.

Numbers and Time

Counting, Telling time, Days of the week and months

Everyday Life

Describing daily routines, Talking about hobbies and interests, Weather descriptions

Places and Directions

Asking for and giving directions, Identifying basic places in a town

Shopping and Dining

Making simple purchases, Ordering food and drinks

Basic Grammar

Subject-verb agreement, Present tense verb conjugation, Basic sentence structure, Articles (le, la, les, un, une)

German Language (MS 1500)

Objective: The student will learn the basics of standard German language, and will get to know about the norms of language of German.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of German letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Alphabets, Numbers, Greetings

Phrases

Basic introductory phrases

Calenders

Days of the week, Months

Introduction of self and introduction of others

Map, Time, Vocabulary- things around, Nations and nationalities, stationery, professions, hobbies

Grammar

present tense, past tense, plurals, pronouns, verb conjugations, (regular, and three or four important irregular verbs), prepositions, and so on

Japanese Language (MS 1501)

Objective: The student will learn the basics of standard Japanease language, and will get to know about the norms of language of Japan.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of Japan letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists

Time Delay

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life.

Frame questions in Japanese

Vocabulary of giving and receiving objects. Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions. Talking about the country, town and the environment.

Quantity

Number of people, time, period etc., Stating thoughts and impressions. Conveying movement (e.g. go / come)

Sanskrit Language (MS 1401)

Objective: The student will learn the basics of standard Sanskrit language, and will get to know its importance with respect to national unity, integrity, morality and spirituality.

Course outcome

At the end of this course, Students will be

- familiar with the pronunciation of Sanskrit language
- understand ancient scientific concepts, principles, and methodologies without the limitations of translations or interpretations

Introduction to Sanskrit Phonetics

Devanagiri Lipi: Swar and Vyanjan. (Writing rules,Definition,classification,Pronunciation system),Sanskrit Sentence formationand spoken Sanskrit rules.Translation:From Sanskrit to English or English to Sanskrit. Sanskrit Subhashita.

Sanskrit grammar

Sandhi (introduction, classification, Swar-Sandhi),Kāraka&Vibhakti (Definition, Types, Example). Sabdārūpa&Dhāturūpa.

Introductory Vedic & Classical Literature

Four Vedas, Āraṇyakas, Upaniṣads, Vedāṅgas, Purāṇas.Rāmāyaṇa(by Vālmīki) and **Mahābhārata** (by Vyāsa), Bhagavad Gita etc.

Introductory Vedic Mathematics and Sciences in Sanskrit:

Illustrations from book- Vedic Mathematics written by Bharati Krishna Teertha ji, (published by MLBD) –Calculation pi, square root finding, Philosophical meanings of zero and one. Surya Siddhanta. (Kalganana), Katapayadi Sankhya,NāradāŚilpa Śāstra(Architecture and Vastu Shastra), Aṣṭāṅga Hridayam.

Modern Age Possibilities: Sanskrit for ICT : Paper by Subhash Kak and Saroja Bhate Panini's Grammar and Computer Science.

Text Books:

- Sanskrit Sahitya ka Samikshatmak Itihas by Dr. Kapil Dev Dwivedi.

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M.TECH- EC

Applicable with effect from 2023 admitted batch and onwards

Digital System Design (EC 4001)

Objectives: To make students familiar with the fundamentals of Digital circuit and system Design.

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

- design the digital integrated circuits and systems and
- estimate the performance.

Introduction
MOSFETs, CMOS process design kit, Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter. Dynamic characteristics and interconnect effect: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters..

Combinational and Sequential Circuits

MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates), Behavior of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered FlipFlop..

Dynamic Logic Circuits
Introduction, Basic Principles of Pass Transistor Circuits, Dynamic CMOS Circuit Techniques like Precharge-Evaluation logic, NORA, ZIPPER, Stick Diagrams, Physical Design Rules; Layout Designing; Euler's Rule for VLSI Physical Design

Clock Generation, Distribution, and Timing Analysis
Simple clock generation circuits, Clock Distribution schemes, Input and Output Interface circuits: Set up time, hold time, clock skew, slack, calculation of set up time and hold time violation, clock frequency, propagation delay, metastability, Standard designs of Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM) and Non-volatile Memory, Flash Memory.

Text Books

- Kang, Sung-Mo, and Yusuf Leblebici. CMOS digital integrated circuits. Tata McGraw-Hill Education, 2003

Reference Books

- Uyemura, John P. "Introduction to VLSI circuits and systems." (2002).
- Rabaey, Jan M., Anantha P. Chandrakasan, and BorivojeNikolic. Digital integrated circuits. Vol. 2. Englewood Cliffs: Prentice hall, 2002.

VLSI Technology (EC 4002)

Objectives: : The subject provides an in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to device fabrication

Course Outcomes:

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

- to understand the technology and basic principles underlying the fabrication process of semiconductor devices.

Introduction
Crystal growth, and wafer preparation: crystal structures, wafer fabrication, crystal defects, gettering.

Thermal Oxidation
Oxidation kinetics, impurity redistribution during oxidation, oxide charges, nitridation of Silicon.

Lithography
Photolithography steps, photoresists, wet and dry etching, introduction to E-beam, X-ray and ion-Beam lithography

Basic diffusion process, equations, and profiles
Ion Implantation and implant range, Ion stopping and ion channeling interconnects, modern CVD and PVD techniques and systems, refractory metals, Modern CMOS processes.

Text Book

- J. D. Plummer, M. D. and P. D. Griffin, Silicon VLSI Technology: Fundamentals, Practice, and Modeling, Pearson Education.

Reference Books

- S. M. Sze, VLSI Technology, McGraw Hill Education, Second Edition.
- G. S. May and S M Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons,
- S. K. Gandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, John Wiley & Sons, Second Edition.

Solid State Devices (EC 4003)

Objectives: The objective of this course is to provide a comprehensive understanding of semiconductor physics, including quantum mechanical principles, semiconductor junctions, and the operation of key devices like Bipolar Junction Transistors and Field Effect Transistors

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

- Understand Quantum Mechanical Concepts and Charge Carrier Behavior
- Explore Semiconductor Junctions and Their Applications
- Analyze BJTs, FETs and their models

Basic Semiconductor Physics
Quantum mechanical concepts and atomic states, band structure, charge carriers, diffusion of carriers, BTE, etc.

Junctions
p-n junctions, Schottky barrier junctions, heterojunctions, ohmic contacts, introduction to photonic devices.

Bipolar Junction Transistors
principle of operation,I-V characteristics, Ebers-Moll Model, Gummel-Poon model, small signal amplifier

Field Effect Transistors
MOS Capacitor, MOSFET, principle of operation,I-V characteristics, short channel and non-ideal effects in MOSFETs

Text Books

- Michael Shur, Physics of Semiconductor Devices, PHI, 1995.
- Ben G. Streetman, Solid State Electronic Devices, PHI, 4th Edition.

Reference Books

- S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford Univ. Press, 5th Edition..

Embedded System Design (EC 4004)

Objectives: To make students familiar with the fundamentals of embedded system Design and techniques

Course Outcomes:

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

- to model and design the processor, memory, and controllers for the system applications

Evolution of processors for embedded application
High performance computing and low power computing; Moore's law and Amdahl's law; Brief overview of performance estimation; Performance gap in microprocessor and memory; Introduction of Cache hierarchy in processors; Memory elements and hierarchy (SRAM, DRAM, Flash, Hard Disk).Techniques for hardware Performance improvement; Design Process of embedded system; Hardware/Software Interface

ARM
Performance and efficiency of ARM architecture (ARM 7, ARM 9, ARM 11). Thumb and ARM Instruction set and Programming; Data processing, Data transfer, and Control flow instructions. Data Level Parallelism and Thread level parallelism, Memory Interfacing,, I/O interfacing, Interface IP: AMBA, DDR, Ethernet, USB, Analog IP: Data Converter and PLL, Embedded Memory IP; Serial Communication and Parallel Communication

Sensors and actuators
Interfacing to sensors and actuators, Constraints in design, Reaction constraints and execution constraints, Heterogeneity, Constructivity; Execution and Interaction Semantics, Composition of state machines, Hierarchical state machines.

Real Time Operating systems
Scheduling, Memory and I/O management, Bus I/O and networking considerations, System verification, Testing of embedded systems.

Text Books

Reference Books

- Heath, Steve. Embedded systems design. Newnes, 2002.
- Hennessy, John L., and David A. Patterson. Computer architecture: a quantitative approach. Elsevier, 2012.
- Wolf, Wayne. FPGA-based system design. Pearson Education, 2004.

Testing and Verification (EC 4005)

Objectives: To let the students exposed to Testing and to demonstrate their application on real time system.

Course Outcomes:

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

- handle Verification Students will be exposed to Testing and explore many areas of Testing & Verification

Introduction
Basics of testing and fault modelling: Introduction- Principle of testing - types of testing - DC and AC parametric tests - fault modelling

Testing and testability
Testing and testability of combinational & sequential circuits, algorithms, Boundary scan, Memory, IDDQ.

Testing
Testable memory design - test algorithms for RAMs, IDDQ testing - testing methods - limitations

Built-in self-test
Test pattern generation (BIST) - Output response analysis – BIST architectures..

Text Books

- M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwar Academic Publishers.

Reference Books

- P. K. Lala, "Digital Circuit Testing and Testability", Academic Press.
- N.K. Jha and S.G. Gupta, "Testing of Digital Systems", Cambridge University Press.
- N. Zainalabedin, "Digital System Test and Testable Design: Using HDL Models and Architectures", Springer.

Analog Integrated Circuit Design (EC 4006)

Objectives: Students will be able to learn about the process flow of IC designing, importance and design of analog sub circuits, various amplifiers and will eventually learn the art of designing analog VLSI circuits.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

- Explain process flow of IC designing
- Develop analog sub circuits, Current mirrors etc
- Design various amplifiers like Differential amplifier, Cascode, Telescopic Amplifier etc
- Design analog and understanding of mixed signal circuits

Introduction to Analog IC Design
IC design flow, Device characteristics, Operation of Transistors, Equation and Models.

Analog Sub-Circuits and Single Stage Amplifiers
MOS Diode, Current Mirrors and their types, Single Stage Amplifiers CS, CG and CD and their frequency response, Design of Cascode Amplifier.

Multi Stage Amplifiers
Differential amplifier, op-amps, Compensations, Design of 2 stage op-amp and application

Others Amplifiers and Feedback
Design of Telescopic Amplifiers, Folded Cascode Amplifers, Feedback Techniques and Filters.

Text Books

- Gray, Paul R., and Robert G. Meyer. Analysis and Design of Analog Integrated Circuits. John Wiley & Sons, Inc., 1990
- Allen Holberg, CMOS Analog Circuit Design, 3rd Edition, OUP USA, 2012.

Reference Books

- Razavi, Behzad. Design of Analog CMOS Integrated circuits, McGraw Hill, 2nd Edition, 2017.

Advanced Digital Communication (EC 4075)

Objectives: To make students familiar with the Digital communication concepts and technologies.

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

- Apply mathematical modelling to problems in wireless digital communications.
- Identify modulation and demodulation techniques, coding and decoding scheme for the design of a transmitter and receiver.
- Evaluate the impact of noise on communication performance and design optimum receiver to mitigate these effects.
- Explore emerging technologies and standards in digital communication, such as 5G and beyond, and assess their applications in real-world scenarios.

Introduction
Review of digital communication, Passband pulse and quadrature-amplitude modulation, Pulse code modulation (PCM), Delta modulation, Inter-symbol interference and pulse shaping, Optimum detection, Probability of error analysis.

Introduction to Digital Modulation Techniques
Line Coding, Review of Digital modulation techniques, Multiplexing and multiple access techniques, Adaptive Modulation and Coding, Spread spectrum modulation, Probability of error analysis of digital modulation techniques

Source Coding
Mathematical models for information sources, Entropy and mutual information, Lossless data compression, Coding for discrete sources, Huffman coding, Run-length coding, Lempel-Ziv algorithm, Lossy data compression, Rate distortion functions

Advanced Channel Coding
Review of Linear Block codes and convolutional codes, LDPC codes, Turbo codes, serially concatenated codes, bit- interleaved coded modulation, Polar codes.

Text Books

- J. G. Proakis, Digital Communications, fourth edition, McGraw–Hill, 2001.
- B. Carlson et.al., Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th Edition, McGraw Hill International, 2002.

Reference Books

- R. G. Gallager, Principles of Digital Communication, Cambridge University Press, 2008.
- S. Haykin, Communication Systems, John Wiley & Sons, 2001.

Statistical Signal Analysis (EC 4076)

Objectives: The subject provides an in-depth knowledge of Statistical Signal Analysis

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

- Exploit the knowledge of various mathematical models in wide range of engineering applications.
- Understand fundamental concepts of probability theory, including random variables, probability distributions, and expected values.
- Familiarize with the detection and estimation of random signals.
- Implement estimation and detection techniques, including parameter estimation and hypothesis testing, for real-world signal processing applications

Introduction
Review of random signals, Transformation (function) of random variables, Moment generating function, characteristic function, Conditional expectation, Sequences of random variables, Law of large numbers, Central limit theorem, Jointly Gaussian random vectors, Covariance matrices, Principal component analysis.

Introduction to Random Processes and Random Vectors
Wide-sense stationary processes, Ergodicity, Moments, Autocorrelation and autocovariance functions, Spectral representation of random signals, Poisson process, Gaussian processes, Wiener process, White noise, MA, AR, ARMA models, Overview of Markov Chains

Hypothesis Testing and Detection
Bayes Rule, Likelihood ratios, Sufficient statistics, Minimax Rule, Composite Hypothesis Testing, Neyman-Pearson test, Receiver operating characteristics

Parameter Estimation
Maximum likelihood estimation, Maximum a posteriori probability estimation, Minimum mean-square estimation, Linear least square estimation, Cramer Rao lower bound, Kalman filtering.

Text Book

- Papoulis, Probability, Random Variables and Stochastic Processes, 2nd Ed., McGraw Hill, 1983.
- H. L. Van Trees, Detection, Estimation and Modulation Theory (Part I), John Wiley & Sons, 2001.

Reference Books

- Larson and B.O. Schubert, Stochastic Processes, Vol. I and II, Holden-Day, 1979.
- S. M. Kay, Fundamentals of Statistical Signal Processing - Estimation Theory (Vol. 1), Prentice- Hall, Inc., 1993, ISBN: 978-0133457117.

Radiating System (EC 4077)

Objectives: The objective is to provide a comprehensive understanding of electromagnetic theory, focusing on wave propagation, radiation, antenna, and the working principles of different antenna types, with an emphasis on design and analysis.

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

- Learn the basics of radiation principle and foundational concepts through mathematical analysis and will gain insight about fundamental parameters and terminology used in Antenna Engineering.
- Analyze and design various types of antennas to achieve a specified performance.
- understand various modes of EM wave propagation.
- acquire hands-on experience with antenna measurements and testing

Introduction to Electromagnetic Theory
Review of Maxwell's Equation and boundary conditions, Wave propagation, Normal and Oblique incidence of plane wave at conducting and dielectric media

Radiation Integrals and Auxiliary Potential Functions
Vector Potential, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-Field Radiation, Duality Theorem, Reciprocity and Reaction Theorems

Antenna Fundamentals & Radiation from Wires and Loops
Principle of Radiation, Radiation Pattern, Field Regions, Radiation Power Density, Beamwidth, Directivity, Antenna Efficiency, Gain, Bandwidth, Polarization, Input Impedance, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation. Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Working Principle of Antenns, Antenna Arrays & Microstrip Antennas
Two-Element Array, N-Element Linear Array, Design Procedure, Synthesis of antenna arrays, Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension, folded dipole, Yagi-Uda, Log-periodic, Parabolic reflector, Horn, V-antenna, Rhombic antenna, Resonant and non-resonant antenna. Microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Text Books

- C A Balanis, Antenna Theory and Design.3rd Ed., John Wiley & Sons. 2005.
- R. Harish, and M. Sachidananda. Antennas and wave propagation. Oxford University Press, USA, 2007.

Reference Books

- R. S. Elliot, Antenna Theory and Design. Revised edition, Wiley-IEEE Press. 2003.
- R. E. Collin, Antennas and Radio Wave Propagation. McGraw-Hill. 1985.
- R. K. Shevgaonkar, Electromagnetic waves. Tata McGraw-Hill Education, 2005.

Introduction to Machine learning (EC 4078)

Objectives: To make students familiar with techniques for analysis and modelling of speech both from signal processing and machine learning aspects coving number of applications

Course Outcomes:

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

- principles and algorithms for machine learning

Introduction to Machine Learning
Basic ML concepts and examples, Basic Probability Notations, Bayesian Inference, Basic concepts of statistics, probability and calculus.

Supervised Machine Learning
Regression (Linear Regression, Ridge regression, Regression Trees, Non-linear regression, Bayesian Linear regression, polynomial regression, Lasso regression, Gradient decent) Classification (Random forest, Decision Trees etc Maximum Likelihood estimation, Regularization/MAP, Soft/Hard Margin SVM, SVM Duality

Unsupervised Machine Learning
(K-means clustering (Soft/Hard), KNN (k-nearest neighbors), Hierarchical clustering, Anomaly detection, Neural networks, Principal Component Analysis, Independent Component Analysis, A-priori algorithm, Posteriori Algorithm, Singular value decomposition) Association

Reinforcement Machine Learning
Reinforcement Learning overview, The learning Task, Q-Learning, Nondeterministic Q-Learning, Temporal Difference-Learning, RL-General formulation, Multi-armed Bandits, Markov Decision Process and Deep Reinforcement Learning

Text Books

Reference Books

- Pattern Recognition and Machine Learning by Bishop, Springer, 2006.
- Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, MIT Press, 2012
- The Elements of Statistical Learning, 2nd edition by Hastie, Tibshirani and Friedman, Springer-Verlag, 2008.
- Bayesian Reasoning and Machine Learning by David Barber, Cambridge University Press, 2012.
- Information Theory, Inference, and Learning Algorithms by David Mackay, Cambridge University Press, 2003.

Principles of Wireless Communications (EC 4035)

Objectives: To enable the student to synthesis and analyse wireless and mobile cellular communication systems over stochastic fading channels.

Course Outcomes:

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

- analyse and design wireless and mobile cellular systems, and 2) the students will have the ability to work in advance areas of wireless and mobile cellular environments

Introduction
Evolution of mobile radio communication, Cellular communication, Cellular system design fundamentals: frequency reuse concept, channel assignment, co-channel interference, adjacent channel interference, system capacity, cell splitting, sectoring, etc., Cellular System Architectures: GSM system, Multiple access techniques of cellular networks, Orthogonal frequency division multiplexing LTE architecture, 5G architecture

Physical modelling for wireless channels
Link budget design using path-loss model, Outdoor and indoor propagation models, small scale multipath propagation, Delay spread, Coherence bandwidth, Doppler spread & Coherence time, Flat fading, Frequency selective fading, Fast fading, Slow fading

Diversity in Wireless Communication
Diversity concept, Non-coherent and coherent reception, Time diversity, Repetition coding, Receiver diversity (SC, EGC and MRC), Multiple receive antenna system model and its error performance analysis, Transmit diversity, Channel estimation for multi-antenna system, Diversity order analysis

5G and Beyond Wireless Technologies
Cooperative relaying communications, Cognitive radio networks, Device-to-Device (D2D) Communications, Ambient backscatter communications (AmBC), Reconfigurable intelligent surface (RIS), Non-orthogonal multiple access (NOMA)

Text Books

- J. Goldsmith, Wireless Communications, Cambridge University Press, 2005.
- T. S. Rappaport, Wireless Communications, Prentice Hall, 1996.

Reference Books

- D. Tse and P. Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.
- M. K. Simon and M. S. Alouini, Digital Communications over Fading Channels, John Wiley & Sons, 2000.

Recent Advances in Machine Learning (EC 4036)

Objectives: To provide basics of recent techniques of machine learning and to introduce students with deep reinforcement learning methods

Course Outcome

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

- acquire the advanced methods of machine learning
- understand the Deep Learning algorithms and its properties
- examine the applications of Deep ML and Deep RL in the communication.
- develop student's modeling and analytical skill for solving complex sequential decision problems

Introduction

Artificial Neural Networks, Deep Neural Networks

Generative adversarial networks (GAN)

Q learning, Deep Reinforcement Learning, Deep Q Network, Policy network

Monte Carlo Tree Search, Applications to communication systems, IoT, and cyber physical systems

Text Book

- Vivek S. Borkar, Stochastic Approximation: A Dynamical Systems Viewpoint, Springer, 2nd Edition, 2022.
- 2. Harold Kushner and G. George Yin, Stochastic Approximation and Recursive Algorithms and Applications, Springer, 2nd Edition, 2003.
- 3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Bradford Books, 2nd Edition, 2018.
- 4. David Silver et. al., Mastering the game of Go with Deep neural networks and tree search, Nature, Volume 529, Feb., 2016.
- 5. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press Book, 2016.